Perceptions of self-regulating skills among Grade 10 mathematics learners

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DEDICATION

I dedicate this study to my close friend, Daleen Thompson, for her selfless support and typing the interview transcripts in her final days.

Thank you and miss you.

DECLARATION

I, Amarencia C van Rooyen, solemnly declare that this work is original and the result of my own labour. It has never, on any previous occasion, been presented in part or whole to any institution or board for the award of any degree.

I further declare that all information used and quoted has been duly acknowledged by complete reference.

5 March 2019

Signature

Date

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ABSTRACT

Self-regulating skills[1] to plan, monitor and evaluate work, are crucial to enhance academic performance in mathematics. This research firstly aimed to establish how Grade 10 mathematics learners perceive the development of their self-regulating skills, in relation to the planning, monitoring and evaluation of their own learning, as well as in relation to the skills to secure a suitable study environment. In addition, the research explored possible reasons for self-regulating skills perceived to be well-developed or not-well-developed.

Sequential, explanatory mixed method research, using descriptive survey and phenomenological research, was employed. Firstly, quantitative data were purposively and conveniently gathered by means of a researcher-constructed four-point Likert scale questionnaire from a purposefully and conveniently selected group of 130 Grade 10 male and female mathematics learners from the Boipatong and Evaton areas of the Sedibeng West district, Gauteng, South Africa, who took part in the ArcelorMittal mathematics enrichment programme during 2017. The questionnaire gathered quantitative data in relation to the learners' perceptions about the development of their self-regulating skills. Based on the findings of the quantitative research, 16 willing learners were chosen by means of purposive, criterion sampling from the group of 130 participants, to explore possible reasons for the self-regulation learning skills that were perceived to be well-developed or not well-developed, by means of semi-structured face-to-face interviews.

In sum, the findings of the research revealed that the learners who took part in the study appear to be novices in the application of the self-regulating skills to plan, monitor and evaluate their mathematics learning tasks, and apparently also lack self-regulating skills to secure suitable study environments. The main reasons mentioned that possibly influence the development of self-regulating skills are, a lack of understanding of what the planning, monitoring, and evaluation phases of the learning process entail, a limited variety of available strategies to engage in the independent planning, monitoring, and

[1] Literature also refers to self-regulation and self-regulatory skills. In the context of the study, the term self-regulating skills was used.

evaluation of learning, and to remove obstacles from the study environment. Limited opportunities to develop self-regulating skills at school also appear to be a reality. The study is concluded with recommendations to teachers that could enhance the development of self-regulating skills more effectively.

Key words: self-regulation, self-regulated learning, self-regulation strategies, self-regulating skills, mathematics learning

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INTRODUCTION AND PROBLEM STATEMENT

1.1 INTRODUCTION AND RATIONALE

In this study, the researcher describes the nature of self-regulating skills among Grade 10 mathematics learners and explores possible reasons that impact on the development of self-regulating skills, and subsequently their academic performance[2]. Self-regulating skills will be acquired if learners possess strategies to engage in the planning, monitoring, and evaluation of their own work (Schunk, 2005a:173). This study emphasised the planning, monitoring and evaluation of work, as according to Pandero (2017:18), self-regulation models mostly comprise three phases, a preparatory, performance and an appraisal phase, which, according to the researcher, could be aligned to the classification of Schunk (2005a:173) that refers to planning, monitoring and evaluation of work.

Self-regulation theory postulates, that learners become skilled at self-regulation (masters of their own learning) through the application of a combination of meta-cognitive strategies (self-generated thoughts), motivational strategies (feelings), and environmental strategies to ensure conducive study environments (Zimmerman, 2000:14, 15). Self-regulation strategies are plans of actions or procedures to enhance consciousness during the planning, monitoring and evaluation of learning to become more skilled, efficient and competent in managing learning.

Meta-cognitive strategies regulate thought processes during learning and involve the selection of strategies for dealing with the different phases of the learning process; namely, planning, monitoring, and evaluation (Dignath-Van Ewijk, *et al.* 2013:339; Karpicke, *et al.,* 2009:479; Ocak & Yamaç, 2013:381; Pandero, *et al.,* 2017:75; Roth, *et al.,* 2016:227). According to Ocak and Yamaç (2013:381), motivational strategies are linked to self-efficacy, which is one's personal beliefs about having the will to learn and

[2] In the context of the study, the researcher postulates that self-regulated learning will be enhanced if learners are taught strategies that would enable them to develop self-regulating skills to become more effective in the self-regulation of their learning.

being successful (Zimmerman, 2000:17). These self-efficacy beliefs influence self-regulation, motivation, and performance (Bandura, 2015:1026; Bandura & Locke, 2003:87; Ocak & Yamaç, 2013:381). In order to adjust environmental conditions such as establishing a time and place for task completion or studying that would contribute to successful goal achievement, behavioural or environmental strategies[3] are required (Zimmerman, 2000:14, 15).

Reflection plays an important role in all three stages of the learning process (planning, monitoring, and evaluation) and involves actions to adjust performance processes; for example, changing a method or way of learning, or applying alternative strategies to solve problems (Paris & Paris, 2001:89; Zimmerman, 2000:14). Reflection is the ability to draw conclusions from experiences to create a positive change in future processes to complete a task successfully (Ertmer & Newby, 1996:18; Paris & Paris, 2001:89). During the planning phase, the self-regulated learner sets clear goals and selects strategies to achieve the goals. Monitoring follows the planning stage, and now the self-regulated learner makes sure that he is making progress towards attaining the goals he set. Finally, the self-regulated learner evaluates how successful he was in attaining his goals during the evaluation phase (Ertmer & Newby, 1996:11-13; Paris & Paris, 2001:89).

Self-regulating skills are important for mathematics because a major shift has taken place in the nature of mathematics learning goals (Pape & Smith, 2002:93). Traditionally, mathematics learning goals focused on the mastering of facts and procedures. More recently, the focus is on rationalising and solving real-life problems (Ocak & Yamaç, 2013:381). The importance of self-regulating skills in mathematics is emphasised by Darr and Fisher (2004), Van der Walt and Maree (2007:223), Sadi and Uyar (2013:22), and the Department of Basic Education (2011:5), who concur that learners are supposed to develop self-regulation knowledge and skills that would enable them to interact with mathematical ideas. Moreover, Ocak and Yamaç (2013:381) posit that self-regulated learning is a prerequisite for gaining insight into, and making sense of mathematics or not. In addition, Ocak and Yamaç (2013:382, 383) argue that self-regulated learning

[3] In the study, the term environmental strategies will be used.

positively increases learners' attitudes and self-efficacy towards mathematics and leads to a higher performance in mathematics. Marchis (2011:9) also refers to a strong correlation between learners' mathematics results, motivation, and self-regulating skills, and research evidence consistently indicates that self-regulated learners' academic achievements are greater than those of learners who lack self-regulating skills (Anon., 2013; Bandura, 2015:1026; Chick & Vincent, 2005; Marcou & Philippou, 2005:12; Perels, *et al*., 2009:27; Van der Walt, 2006:89; Sadi & Uyar, 2013:23).

The Curriculum and Assessment Policy Statement (CAPS) for Grades 10-12 mathematics states that the *"curriculum aims to ensure that children acquire and apply knowledge skills in ways that are meaningful to their own lives"* (Department of Basic Education, 2011:4). In addition, mathematics aims to develop *"mental processes that enhance logical and critical thinking, accuracy and problem solving that will contribute in meta-cognitive"* (Department of Basic Education, 2011:5). In order to achieve the mentioned aims, Darr and Fisher (2004) emphasise the importance of self-regulating skills in addition to mathematical knowledge for interacting with mathematical ideas in a constructive way. Particular aspects in the mathematics curriculum that point to the importance of self-regulating skills are, amongst others: To encourage learners to have an active and critical approach to learning, and to organise and manage themselves and their activities in a responsible and effective manner (Department of Basic Education, 2011:5).

According to the Minister of Basic Education in South Africa, Angie Motshekga, the Annual National Assessment (ANA) average result for Grade 9 mathematics in 2013 was 14% (Anon., 2013), with a decline in 2014 to 10.8% (Staff Writer, 2014). These disturbing statistics could among others, imply that learners have a limited repertoire of necessary self-regulating skills and knowledge in mathematics to plan, monitor, and evaluate their work effectively (Anon., 2013). Given concerns raised by various teacher unions about the frequency of the administration of the ANA, its administrative demands and not providing time for improvement before learners are re-assessed, the implementation of the ANA was postponed as from 2015 until further notice (Department of Basic Education, 2015b).

Although Ocak and Yamaç (2013:383) conclude that self-regulating skills predict high performance in mathematics, the research findings of Van der Walt and Maree (2007:223-241) confirm that the development of self-regulation does not form part of the South African school curriculum. The researcher therefore finds it reasonable to argue that a lack of self-regulating skills could contribute to the poor performance in mathematics in South African classrooms.

In an attempt to enhance academic performance in mathematics, selected Grade 10, 11, and 12 learners from the Sedibeng West District in the Gauteng Province of South Africa, are recruited by the Department of Basic Education and granted one and a half hours' additional mathematics enrichment training per week, such as coordinated by the ArcelorMittal Science Centre (AMSC) in Sebokeng. These learners seemingly also do not acquire self-regulating skills through the enrichment training, which would enhance academic performance, as shown by the results in Table 1.1. The researcher is involved in presenting enrichment training to Grade 10 and 11 learners at AMSC. The mathematics results of the researcher's Grade 10 and 11 learners after the second school term of 2017, revealed poor academic performance, as indicated in Table 1.1 below.

Table 1.1: Mathematics results term 2 for Grade 10 and 11 learners (2017)

Grade 10 (2017)		Grade 11 (2017)	
%	N	%	N
80-89	1	80-90	1
70-79	0	70-79	1
60-69	0	60-69	1
50-59	2	50-59	0
40-49	15	40-49	2
30-39	26	30-39	2
20-29	4	20-29	8
10-19	11	10-19	17
0-9	5	0-9	21

In support of the aforementioned results in Table 1.1, the 2016 Trends in International Mathematics and Science Study (TIMSS) test results also revealed poor performance among the Grade 10 learners who were the Grade 11 learners at the AMSC in 2017 (Reddy, *et al.,* 2015) (see Table 1.2 below).

Table 1.2: TIMSS mathematics results: Grade 10 (2016)

Grade 10 (:2016)	**TIMSS result**
(Total:50)	Number of learners
40-50	0
29-39	1
28-19	7
18-10	60
9-0	19

Against the background of the argument that strong self-regulating skills are prerequisites for academic performance (Marchis, 2011:10; Ocak and Yamaç (2013:382), the aforementioned results presented in Tables 1.1 and 1.2, possibly indicate that neither teaching at school nor the AMSC enrichment programme explicitly contribute to the development of self-regulating skills that could enhance academic performance of learners in mathematics.

In support of Paris and Paris (2001:93), who argue that self-regulated learning is intensified indirectly through experience at school and directly through explicit instruction by teachers, the researcher posits that it seems reasonable to conclude that explicit instruction, in order to develop self-regulating skills, possibly does not take priority in mathematics classrooms.

A meta-analysis conducted by Dignath and Büttner (2008:251-258) and Dignath *et al.* (2008:101-129), summarised the findings of 49 quantitative survey studies across primary and secondary schools on an international scale, which addressed the properties of self-regulating skills. An important finding emanating from the study is that self-regulated learning can be encouraged effectively a primary and secondary school level, particularly in mathematics. A study by Sadi and Uyar (2013) on the relationship between self-efficacy, self-regulated learning strategies and achievement in Turkey with 9th and 10th Grade learners in Biology, showed that self-regulated learning and motivational strategies drive learners to success in Biology. Ocak and Yamaç (2013) researched the self-regulation learning strategies, motivational beliefs, attitudes and achievements of Grade 5 learners of mathematics in Turkey. The main finding of their study was that self-efficacy is a significant forecaster of mathematics achievement. Another study conducted by Marcou and Philippou (2005) focused on motivational beliefs, self-regulating skills, and mathematical problem solving amongst Grade 5 and 6 learners in Cyprus. The findings of their research indicated that, if self-regulated learning could be promoted, the possibility to increase and maintain motivational beliefs to sustain effective mathematical problem solving could be achieved (Marcou & Philippou, 2005:3-303).

A comprehensive, national study conducted by Van der Walt (2006) investigated whether self-regulating skills were well developed amongst mathematics learners in Grades 7 to 9 in the North-West province, and if teachers encouraged the development of self-regulating skills during the teaching of mathematics (Van der Walt, 2006:84). Similar to a study conducted by De Corte, *et al.,* (2000:695), the study concluded that learners do not apply any self-regulation strategies during the planning, monitoring, and evaluation stages of the learning process, and that the teachers do not nurture the development of self-regulating skills in the mathematics classroom (Van der Walt, 2006:183). Given the aforementioned finding, the researcher argues that if self-regulating skills are not nurtured in the lower Grades, it could be assumed that learners entering the higher Grades, might also experience problems in the application of self-regulating skills.

As none of the above-mentioned studies investigated the self-regulating skills of Grade 10 mathematics learners in South Africa, the present study firstly addressed a contextual gap by focusing on a group of learners in an education district in Gauteng which has been identified as one of the districts with the poorest overall achievement in South Africa, namely, Sedibeng West (Bengtson, 2015). The cited research studies focused on determining the level of self-regulating skills among learners by conducting quantitative survey research or testing and highlighted the importance of self-regulating skills for achievement in mathematics.

None of the studies investigated which of the self-regulating skills (planning, monitoring, evaluation) appear to be the most fragile, or explored possible reasons for self-regulating skills to be well-developed or not well-developed from the learners' perspective. This study therefore addressed a methodological gap by employing mixed method research comprising quantitative and qualitative data collection to quantitatively identify the self-regulating skills which appear to be the least and most fragile from the learners' perspective, and to qualitatively explore possible reasons for self-regulating skills to be well-developed or not well-developed.

The researcher proposes that the present study could have a significant impact for both teachers and learners. Firstly, this study could create a greater awareness of the importance of self-regulating skills in mathematics and the reasons which possibly hamper their development. Secondly, based on the recommendations that were made; teachers could adjust their teaching practises to teach learners strategies to become more skilled at planning, monitoring, and evaluating their own learning, that might enhance academic performance in mathematics. Thirdly, the mathematics enrichment programme presented at the AMSC for Grades 10, 11, and 12 learners where the researcher is involved, could incorporate recommendations about how to nurture self-regulating skills explicitly during the enrichment training.

Given the introduction, the problem statement can be formulated as follows: It appears that self-regulating skills, which could be regarded as a pre-requisite for academic performance in mathematics, are seemingly not nurtured in the typical South African mathematics classroom. In addition, knowledge about the pitfalls regarding the development of self-regulating skills seems limitied. A study that creates awareness of the nature of self-regulating skills, possible pitfalls in developing the skills, and how these pitfalls might be addressed, could enable mathematics teachers to prepare learners to achieve better results in Grade 12.

In order to address the problem, the researcher determined learners' perceptions in relation to how well-developed their self-regulating skills appear to be and, additionally, explored possible reasons for self-regulating skills to be well-developed or not well-developed.

1.2 PURPOSE STATEMENT

Based on the afore-mentioned, the two-folded purpose of this sequential explanatory mixed method study was firstly to describe how well-developed Grade 10 mathematics learners entering the mathematics enrichment programme at AMSC in the Sedibeng West District of Gauteng Department of Basic Education, perceive the development of their self-regulating skills. The data were collected by means of a researcher-developed questionnaire that established the learners' perceptions/opinions about how well developed their self-regulating skills are. Based on this data, the researcher identified which of the self-regulating skills (planning, monitoring, evaluation, and study environment) appeared to be well-developed (average – strong), and not well-developed (average – weak), according to the perceptions of the learners.

Secondly, based on the findings obtained with the questionnaire data, face-to-face interviews were conducted with willing and purposively selected Grade 10 mathematics learners to explore possible reasons for self-regulating skills to be well-developed or not well-developed.

At this point, self-regulated learners are regarded as learners who possess strategies to become skilled in self-instructing, self-monitoring and self-evaluating their work at various stages during the learning process (Bandura, 2015:1025; Schunk, 2005a:173; Pintrich, 2000:459; Zimmerman, 1986:308; Zimmerman, 2008:166). Self-regulated learners perceive themselves as capable, proficient and autonomous to ensure that their learning environments optimise their learning.

The following section presents the research questions that steered the study.

1.3 RESEARCH QUESTIONS

1.3.1 Central question

The central question that drove the execution of this study was two-fold:

Firstly, how well developed do Grade 10 mathematics learners perceive their self-regulating skills to be, and secondly, what are the reasons for self-regulating skills to be well-developed or not well-developed among Grade 10 mathematics learners?

Within the central question, the following secondary questions unfold:

- How should self-regulating skills be conceptualised?
- What contributes to the development of self-regulating skills?
- Why are self-regulating skills important for learning mathematics?
- What are the perceptions/opinions of Grade 10 mathematics learners about how well developed their self-regulating skills are?
- Which self-regulating skills appear to be the best developed among Grade 10 mathematics learners?
- Is there a relationship between biographical variables such as gender, repetition of Grade 10 and living conditions and the perceptions of Grade 10 learners in relation to how well their self-regulating skills are developed?
- What are the reasons for self-regulating skills to be well-developed or not well-developed among Grade 10 mathematics learners?
- What recommendations can be made to enhance the development of self-regulating skills among Grade 10 mathematics learners?

1.3.2 Hypotheses

As one of the research objectives envisaged to examine the impact of the biographical variables (independent variables) on the research participants' perceptions in relation to the development of their self-regulating skills (dependent variable), the researcher formulated the following null and alternative hypotheses. Hypotheses were formulated to enable the researcher to obtain greater depth in the data.

Null hypotheses

- Ho^1 = There is no statistically significant relationship between gender and the perceptions of Grade 10 mathematics learners in relation to the development of their self-regulating skills.
- Ho^2 = There is no statistically significant relationship between the perceptions of mathematics learners who have repeated Grade 10, and those who did not repeat Grade 10, in relation to the development of their self-regulating skills.

- *Ho*^{3} = There is no statistically significant relationship between the living conditions of Grade 10 mathematics learners and their perceptions in relation to the development of their self-regulating skills.

Alternative hypotheses

- *Ha*^{1} = There is a statistically significant relationship between gender and the perceptions of Grade 10 mathematics learners in relation to the development of their self-regulating skills.
- *Ha*^{2} = There is a statistically significant relationship between the perceptions of learners who have repeated Grade 10, and those who did not repeat Grade 10, in relation to the development of their self-regulating skills.
- *Ha*$^{3\,=}$ There is a statistically significant relationship between the living conditions of Grade 10 mathematics learners and their perceptions in relation to the development of their self-regulating skills.

1.4 AIM AND OBJECTIVES

Linked to the central question and the nature of a mixed method study, the main aim of the study was firstly, to describe how well-developed Grade 10 mathematics learners perceive the development of their self-regulating skills to be, and secondly, to explore the reasons for self-regulating skills to be well-developed or not well-developed among Grade 10 mathematics learners.

The main aim was operationalised into the following objectives:

- To determine how self-regulating skills should be conceptualised by means of a literature review.
- To determine what contributes to the development of self-regulating skills by means of a literature review.
- To investigate why self-regulating skills are important for learning mathematics by means of a literature review.
- To determine the perceptions/opinions of Grade 10 mathematics learners about how well their self-regulating skills are developed, by means of a questionnaire.

- To determine which self-regulating skills, appear to be the best developed among Grade 10 mathematics learners by means of a questionnaire.
- To establish if there is a relationship between biographical variables such as gender, repetition of Grade 10 and living conditions and the perceptions of Grade 10 learners in relation to how well their self-regulating skills are developed?
- To explore the reasons for self-regulating skills to be well-developed or not well-developed among Grade 10 mathematics learners by means of face-to-face interviews.
- To make recommendations to enhance the development of self-regulating skills among Grade 10 mathematics learners.

1.5 CONCEPTUAL FRAMEWORK

1.5.1 Concept clarification

The following concepts stood central to the study: Self-regulated learning, self-regulating skills, strategies to develop self-regulating skills in the mathematics classroom, and Grade 10 mathematics.

Early studies on self-regulation were conducted by researchers such as Piaget, Vygotsky, and Bandura, which date back to the 1950s. This was the beginning of constructivist learning theories overtaking instructional theories according to which the learners are given specific instructions, respond to the instructions, thus not taking responsibility for their own learning (Dignath & Büttner, 2008:232). In conceptualising self-regulated learning and the role of self-regulating skills, the researcher draws on the work of the pioneers in the field, namely: Bandura (1999b), Boekaerts (1996), Pintrich (2000) and Zimmerman (1986).

Self-regulated learning is commonly viewed as a process where learners take responsibility for their own learning through active control over their cognitive processes, are motivated to achieve their goals, and possess the willpower to take action (Dignath & Büttner, 2008:232, 233; Pintrich, 2000:458; Schunk, 2005a:173; Zimmerman, 2008:167). Self-regulated learners monitor, judge, and adjust their own thoughts, feelings, and behaviours (Pintrich, 2000:459; Schunk, 2005a:173; Zimmerman, 1986:308; Zimmerman, 2008:168; Zumbrunn, *et al*., 2011:4-6).

This study conceptualises self-regulated learning according to the framework of Pintrich (2000:451-502), one of the pioneers in the field of self-regulation, who argues that self-regulation comprises distinct stages where self-regulation strategies are applied to facilitate distinct thought processes, that play a role in different stages of the learning process, namely planning, monitoring, evaluation. These stages are interactive; therefore, one may be simultaneously engaged in more than one of the stages. During each of the stages, various **self-regulation strategies** (meta-cognitive, motivational, and environmental) are applied to enable learners to become skilled at regulating thinking and learning, to make learning more effective (Bandura, 2015:1028; Ertmer & Newby, 1996:10, Zimmerman, 1986:308, 167; Zimmerman, 2008:169). Continuous adjustments are made to these strategies after reflection and feedback on performance achievements have taken place (Bandura, 1991:248; Darr & Fisher, 2004; Ertmer & Newby, 1996:10; Pintrich, 2000:460; Schunk, 2005a:173; Zimmerman 1986:307; Zimmerman, 2008:169).

During the **planning** stage of learning, Ertmer and Newby (1996:11) and Schunk (2005a:173) assert that before beginning a task, consideration should be given to planning the following: A match between what the task demands and the learner's own personal resources to effectively complete the task[4]. The purpose of planning is to ease the actual performing of the task, to increase the possibility of a successful completion of the task and to produce a product of quality (Bannert & Reimann, 2012:194). Three major activities involved in task completion are: Setting a clear goal, selecting and choosing strategies, and identifying hitches (Cazan, 2012) (*cf.* 2.3.4.1).

As part of the **monitoring** stage, a self-regulated learner mentally checks what he is doing and if he is still on track to achieve a specified goal. He becomes aware of what he is doing, understands where it fits into his established sequence of steps and what he must do next. Monitoring will indicate whether steps should be altered because they do not

[4] In the study, task completion refers to any mathematics learning that can involve homework, assignments or studying for and writing tests and exams.

achieve the desired goal that was set (Ertmer & Newby, 1996:12; Schunk, 2005a:173). During monitoring, the focus is on implementing the steps in the plan to complete a task while monitoring the effects of selected meta-cognitive, motivational, and environmental strategies (Ertmer & Newby, 1996:12; Schunk, 2005a:173; Zimmerman, 2000:20) (*cf*. 2.3.4.2).

The **evaluation** stage involves the assessment of the final learning product, and to establish if learning goals were achieved. The effectiveness of the process that was followed to achieve the goals is evaluated, as well as whether obstacles encountered towards achieving the goals were dealt with efficiently (Ertmer & Newby, 1996:13; Pintrich, 2000:460) (*cf*. 2.3.4.3).

In selecting a supportive **study environment**, planning, monitoring and evaluation play an important role. Planning involves choosing a suitable study environment, then monitoring whether the environment remains supportive during learning, and finally evaluating what changes need to to be made to the environment to support learning better in future (Finn & Metcalfe, 2013:20; Hattie & Donoghue, 2016; Zimmerman, 2008:167) (*cf.* 2.3.4.1 – 2.3.4.3).

Reflection refers to continuous thinking about one's actions, thus involving self-evaluation and passing judgement (Pintrich 2000:461; Schunk, 2005a:173). Reflection serves as a link between planning, monitoring, and evaluation because reflection enables one to draw conclusions and allows for adjustments to be made in order to optimise the learning process (Bandura, 1991:248; Ertmer & Newby, 1996:10; Ocak & Yamaç, 2013:318; Pintrich, 2000:459; Schunk, 2005a:173; Zimmerman, 1986:308; Zimmerman, 2008:169). Reflection informs one whether the selected strategies used during the planning, monitoring and evaluation stages of the learning process were effective, and if changes need to be made to better the learning outcome. Reflection is on-going throughout the entire learning process. Reflection helps learners to draw conclusions from their experiences and create possible action plans for the future (Schunk, 2005a:173) (*cf*. 2.3.4.4).

Strategies to develop self-regulating skills in the mathematics classroom

Self-regulated learning is nurtured (i) indirectly through experience at school, (ii) directly through explicit instruction (Paris & Paris, 2001:93), and (iii) the application of learner-centered, collaborative- and problem-based learning (Paris & Paris, 2001:93, 94). Chapter 2 discusses the application of the aforementioned in detail (*cf.* 2.5.1).

In addition, teachers should explicitly teach strategies to learners that make self-regulation possible, such as setting goals, planning task completion, increasing self-motivation, improving attention, using strategies flexibly, monitoring and assessing work, and seeking help (Peeters, *et al.,* 2014:1966; Zumbrunn, *et al.,* 2011:10-12) (*cf.* 2.6).

Grade 10 mathematics

Grade 10 mathematics curriculum content that is covered at the AMSC extends what is done at school, namely: Algebraic expressions, Exponents, Number Patterns, Equations and Inequalities, Trigonometry, Functions, Euclidean Geometry, Analytical Geometry, Finance, Growth and Decay, Statistics, 2D Trigonometry, Measurement and Probability (Department of Basic Education, 2015a). As problem solving stands central to the mathematics curriculum, well-developed self-regulating skills are of particular importance to be effective in problem solving (Ocak & Yamaç, 2013:381). The mathematics enrichment programme offered at AMSC where the research was conducted, is content-focused and mainly aims to provide learners with additional practise to enhance their academic performance, without explicit attention to developing self-regulating skills.

1.6 RESEARCH METHODOLOGY

1.6.1 Research paradigm

A research paradigm is defined by Nieuwenhuis (2008a:47) as a *"set of assumptions or beliefs about fundamental aspects of reality which give rise to a particular world-view."* In the context of the study, Pragmatism could be regarded as a suitable research paradigm to frame the research, where both quantitative and qualitative data collection instruments were used to collect data. The research paradigm is explained in detail, in Chapter 3 (*cf.* 3.2).

1.6.2 Research design

The researcher employed a sequential explanatory mixed method design where data were collected in two phases: First, the quantitative data were collected, and then the qualitative data were collected. In this design, the qualitative results were used to explain the quantitative results (Ivankova *et al.*, 2008:264). The research design used in the context of the study is explained and motivated in Chapter 3 (*cf.* 3.4.1).

1.6.3 Strategy of inquiry

A mixed-method research employs both quantitative and qualitative strategies of inquiry. The quantitative strategy of inquiry employed in the research was non-experimental descriptive survey research (McMillan & Schumacher, 2014:30), because the researcher wanted to examine learners' perceptions about the development of their self-regulated learning skills.

The qualitative strategy of inquiry comprised phenomenological research (Fouché & Delport, 2003:268) as the researcher wanted to explore reasons for self-regulating skills to be well-developed or not well-developed.

An extended explanation of the strategies of inquiry used during the research follows in Chapter 3 (*cf.* 3.4.2).

1.6.4 Data collection methods

1.6.4.1 A closed Likert scale questionnaire

Quantitative data were collected with a closed researcher-constructed questionnaire where the participants chose an applicable response from a given set of responses (Maree & Pietersen, 2007a:167). The responses of the participants regarding their perceptions of the development of their self-regulating skills were measured using an ordinal and descriptive, closed four-point Likert scale of measurement, i.e., 1 = Novice, 2 = Able, 3 = Skilled, and 4 = Expert, and 1 = Almost always, 2 = Often, 3 = Sometimes, and 4 = Almost never.

More information about the construction of the questionnaire that was used to collect data is provided in Section 3.5.

1.6.4.2 Semi-structured, face-to-face interviews

The choice of the strategy of inquiry for the qualitative component of the study was semi-structured, face-to-face interviews. Interviews are used to learn about a participant's experiences, beliefs, views, and opinions (Nieuwenhuis, 2008b:87). The use of semi-structured, face-to-face interviews in the study is explained and motivated in Chapter 3 (*cf.* 3.5).

1.6.5 Sampling

1.6.5.1 Sampling for the quantitative study

The population for the study comprised all learners who had mathematics as a subject in South African secondary schools. Due to time, logistical, and financial constraints, it was not possible for the researcher to do research with all the mathematics learners in South Africa.

The study population therefore comprised all the Grade 10, 11, and 12 learners enrolled for mathematics at the AMSC in the Sedibeng West district in Gauteng Province, South Africa, during 2017, where the researcher teaches mathematics. As the focus of the research was on Grade 10 mathematics, the researcher approached all the Grade 10 learners (N = 130) to become part of the sampled participants for the study. During 2017, the Grade 10 mathematics learners at the AMSC centre came from the Boipatong and Evaton Townships. In total, 130 Grade 10 male and female participants took part in the study. A thorough explanation of how the sampling procedure was executed follows in Chapter 3 (*cf.* 3.9).

The type of sampling used for the study was non-probability, convenient and purposive sampling. In non-probability sampling, the researcher selects participants who are available, and representative of characteristic the investigator wishes to study (Creswell, 2012:145). The sampled participants were available, and the researcher had easy access to the participants (Leedy& Ormrod, 2014:151) as she lectures mathematics at the AMSC.

1.6.5.2 Sampling for the qualitative study

Purposive, criterion sampling was used to select the participants for the qualitative part of the study. According to Nieuwenhuis (2008b:79), participants are chosen purposively because of particular characteristics that a researcher is interested in. In this study, the participants had to be in Grade 10 and have mathematics as a subject. From the possible 130 learners who completed the questionnaire, 16 willing participants were approached based on their questionnaire responses, to request their participation in the interviews. Leedy and Ormrod (2005:101) indicate that 15 – 25 participants are sufficient to gather qualitative data for a phenomenological study. As data saturation was reached with the 16 participants, more participants were not recruited.

Participants had to comply with the following criteria to become part of the interviews. Based on the average score obtained for the questionnaire data, eight participants (a mix of males and females) who appeared to perceive the development of their self-regulating skills as *average-strong* (scoring an average between 2.95 and 4 on the four-point Likert scale), and eight participants (a mix of males and females) who appeared to perceive the development of their self-regulating skills to be *average-weak* (scoring an average between 2.94 and 1 on the four-point Likert scale) were approached to take part in the semi-structured, face-to-face interviews. The interviews with these participants explored possible reasons that influence the development of their self-regulating skills. An extended explanation of the selection of the participants for the qualitative study follows in Chapter 3 (*cf.* 3.9).

1.7 DATA ANALYSIS AND INTERPRETATION

1.7.1 Data analysis of the questionnaire

Descriptive statistics were used to analyse the obtained data, and summarised the data with frequencies, percentages, means, and standard deviations (Leedy & Ormrod, 2014:295). Inferential statistics were also used to compare the perceptions of the participants' in relation to the self-regulating skills they apply during the different stages of learning, in order to establish which stage appears to be the strongest/weakest among the participants. A t-test was used for this purpose, and if any statistically significant differences were noted ($p < 0.05$) (Pietersen & Maree, 2016b:250) when the comparisons were calculated, Cohen's d was used to determine the effect of the differences in practise (McMillan & Schumacher, 2014:337).

In order to determine whether there were any statistically significant differences between the participants' responses obtained from the questionnaire for the different biographical variables (gender, repetition of Grade 10 and living conditions) the means for the responses regarding the mentioned variables were compared in relation to all the sections of the questionnaire sections. An ANOVA was utilised to determine whether differences that occurred between the different biographical variables were statistically significant (Pietersen & Maree, 2016b:255). To determine the effect size of the statistically significant differences, Cohen's *d* and effect sizes were calculated. In addition, differences in perception for the application of self-regulating skills in relation the various stages of the learning process, were also examined by means of an ANOVA.

A comprehensive explanation of the data analysis procedures used in the context of the study can be found in Section 3.10.1.

1.7.2 Data analysis of the interviews

Verbatim transcripts of the interviews were compiled immediately after each interview. Thereafter, deductive and inductive content analyses of the data were undertaken (Nieuwenhuis, 2008c:99). The procedures applied during the analysis of the interview data are clarified in Chapter 3 (*cf.* 3.10.2).

1.8 RELIABILITY AND VALIDITY OF QUANTITATIVE RESEARCH

Cronbach alpha coefficients and inter-item correlations were calculated to establish the internal reliability or consistency of the questionnaire items (Pietersen & Maree, 2016a:239). Reliability procedures are clarified in Chapter 3 (*cf.* 3.6.1).

The following criteria identified by McMillan and Schumacher (2014:399-401) were taken into consideration for the researcher to ensure that the study complied with validity criteria for the quantitative research design; namely, **statistical conclusion validity, internal validity, external validity** and **construct validity.** The manner in which the researcher complied with validity criteria is clarified in Chapter 3 (*cf.* 3.6.2).

To ensure the validity of the questionnaire, the researcher adhered to the following criteria for validity: **Face validity, content validity,** and **construct validity.** An explanation of how the criteria for the validity of the questionnaire items were upheld, is provided in Chapter 3 (*cf.* 3.6.3).

1.9 TRUSTWORTHINESS OF THE QUALITATIVE RESEARCH

The researcher guaranteed trustworthiness in this study by adhering to the criteria identified by Lincoln and Guba (1985:301-316) and Babbie and Mouton (2002:276-278): **Credibility, transferability, dependability,** and **confirmability**. The researcher explains how she guaranteed trustworthiness in relation to the criteria in Section 3.7.

1.10 THE ROLE OF THE RESEARCHER IN QUALITATIVE RESEARCH

The researcher considered the following issues regarding her role as an instrument during the collection of qualitative interview data, in order to ensure that her role did not compromise the collection of trustworthy data: Historical, social, and cultural experiences, status, race, gender, assumptions, personal connection to the site, and sensitive ethical issues (Creswell, 2009:177) (*cf.* 3.8).

1.11 ETHICAL CONSIDERATIONS

The researcher ensured that ethical issues identified by Creswell (2009:88), were upheld during the research by considering the following: Ethical issues in the research problem, ethical issues in the purpose and questions, ethical issues in data collection, ethical issues in data analysis and interpretation, and ethical issues in writing and dissemination the research. The practical application of ethical principles during the research is discussed in Chapter 3 (*cf.* 3.11).

1.12 POSSIBLE RISKS AND BENEFITS

The researcher identified a number of risks/discomforts and benefits that the study could pose, which were communicated to the participants in the informed consent form. Table 1.3 summarises the possible risks and the strategies employed by the researcher to minimise the risks/discomfort, which were also communicated to the participants.

Table 1.3: Potential risks and strategies to deal with the risks

Probable/possible risks/discomforts	Strategies to minimise risk/discomfort
Conflict of interest and the power relationship because the researcher is also a teacher at the AMSC.	The researcher acknowledges that the group of participants was a vulnerable group due to the hierarchical teacher-learner relationship that exists, that could constitute a power relationship. This results from her (the researcher) being a teacher at the AMSC. She will be using participants from two schools whom she teaches. The participants of two other schools that were involved in the research are taught by a colleague of the researcher, implying that these participants would be unfamiliar with the researcher. The researcher stressed that participation was voluntary, which could contribute to reducing coercion to take part in the research.
Completing questionnaires and taking part in interviews might cause anxiety and stress.	The researcher explained the following to the participants: Participants would not need to prepare or study for the completion of the questionnaire and the interviews. The questionnaires and interviews would not influence the participants' academic results for mathematics. The data would only be used for research purposes to find out if the self-regulating skills of the Grade 10 mathematics learners are developed or not, and how the development of self-regulating skills could be improved. The data collection with the questionnaire took place at times convenient to the participants. Refreshments were provided after the completion of the questionnaire and the interviews. Data collection did not overburden the participants. The questionnaire completion did not exceed 30 minutes and did not disturb teaching time. The interview only lasted 30 minutes per participant. The questionnaire was also translated into Sesotho to enable easy understanding.

Probable/possible risks/discomforts	Strategies to minimise risk/discomfort
Complete anonymity cannot be guaranteed.	In order to identify which participants, have average-strong and average-weak self-regulating skills for the purpose of the interviews, numbers were linked to the names of the participants on a class list before questionnaire completion, in order to identify suitable participants. Participants were informed about the use of linking numbers to names. Participants were made aware of the lack of anonymity during the interviews as well, and had the option not to take part in the interviews. The researcher seldom sees the participants of the two schools whom she teaches, and the participants of the other two schools are totally unfamiliar to the researcher as they are taught by a colleague of the researcher. It was therefore unlikely that the researcher would be able to identify the voices of the participants when transcribing the recorded interviews.

1.13 CHALLENGES OF THE STUDY

Due to protest disruptions in Sebokeng, participants could not be transported to attend the enrichment training at AMSC as was envisaged. Instead, the researcher conducted the enrichment training at the schools of the participants. Data collection therefore also did not take place at AMSC, but at the respective schools of the participants, to which the researcher was accompanied by a safety officer. The noise at the schools posed a challenge, and although an office was allocated for the interviews, many interruptions took place. The researcher was obliged to frequently pause throughout the interviews. A good rapport with the participants ensured a positive atmosphere. Whenever the participant could not fully understand a question, the question was repeated in simpler language. The researcher conducted the research by adhering to the following procedure.

1.14 RESEARCH PROCEDURE

The research procedure comprised the following steps:

Step 1: Identification and motivation of the research problem from the literature.

Step 2: Formulation of problem statement and research questions.

Step 3: Review of relevant literature pertaining to the study.

Step 4: Deciding on the empirical research design.

Step 5: Obtaining ethical clearance.

Step 6: Sampling of research participants.

Step 7: Obtaining informed consent: authorities and participants.

Step 8: Construction of data collection instruments based on the literature review.

Step 9: Administering the questionnaires.

Step 10: Data analysis and interpretation of questionnaires.

Step 11: Conducting the interviews and compiling verbatim transcripts.

Step 12: Data analysis and interpretation of interviews.

Step 13: Combining quantitative and qualitative data.

Step 14: Discussion of findings, conclusions and recommendations.

1.15 CHAPTER DIVISION

The study unfolds according to the following structure:

CHAPTER 1: Introduction and problem statement

CHAPTER 2: The importance of self-regulating skills in mathematics

CHAPTER 3: Empirical research design

CHAPTER 4: Data analysis and interpretation

CHAPTER 5: Summary, findings and recommendations

1.16 CHAPTER SUMMARY

This chapter began with an in depth discussion of the problematic issue involving the lack of self-regulating skills among mathematics learners (*cf*. 1.1). Although well-developed self-regulating skills are imperative to academic performance, they are apparently not modelled and taught in the mathematics classroom (Van der Walt & Maree, 2007:223-241) (*cf.* 1.1).

The research addressed the following gaps:

- To the best knowledge of the researcher, no investigations with Grade 10 mathematics learners have previously been done in South-Africa.
- Research with Grade 10 mathematics learners has not been done in the Sedibeng West district, one of the districts with the poorest overall achievement in South Africa.
- Research has not previously been done to determine learners' perspectives in relation to the development of their self-regulating skills in mathematics.
- This study addressed a methodological gap by employing mixed method research comprising quantitative and qualitative data collection to quantitatively identify how well-developed the self-regulating skills of learners are, and to qualitatively explore possible reasons for self-regulating skills to be well-developed or not well-developed, from a learner perspective.

The identification of possible pitfalls regarding the development of self-regulating skills could create awareness of how these pitfalls could be addressed. This, in turn, could enable mathematics teachers to prepare learners to achieve better results in Grade 12. (*cf*. 1.1).

The concept central to the study, namely self-regulated learning (*cf.* 1.5) refers to a process where learners take responsibility for their own learning by actively controlling their thinking processes and levels of motivation and self-efficacy to achieve learning goals across the various stages of the learning process, namely planning, monitoring and evaluation. In order to become effective at self-regulated learning, learners need to acquire and apply a variety of meta-cognitive, motivational and environmental strategies to become skilled at self-regulation.

Self-regulated learning can be nurtured indirectly through experience at school and, directly through explicit instruction, as well as the application of learner-centered, collaborative- and problem-based learning (*cf.* 1.5).

The main aim of the study was twofold: Firstly, to describe how well-developed the Grade 10 mathematics learners perceived their self-regulating skills to be; and secondly, to explore the perceptions of the learners in relation to the reasons for their self-regulating skills to be well-developed or not well-developed. The twofold nature of the main aim provided the rationale for collecting data quantitatively and qualitatively (*cf.* 1.4).

Framed within a pragmatic research approach (*cf.* 1.6.1), sequential explanatory mixed method design was used (*cf.* 1.6.2). The data were collected sequentially, and the quantitative data collection, was followed by the qualitative data collection. Non-experimental descriptive survey research was used for the quantitative data collection that focused on the Grade 10 participants' perceptions about the development of their self-regulating skills (*cf.* 1.6.4.1). A phenomenological study was used for the qualitative part of the study (*cf.* 1.6.4.2), to enable the researcher to obtain a better understanding of the participants' experiences in relation to the reasons for their self-regulating skills to be well-developed or not well-developed.

A closed four-point Likert scale questionnaire (*cf*. 1.6.4.1) was used to obtain the perceptions of the participants in relation to the development of their self-regulating skills to plan, evaluate, and monitor their learning, as well as to select a suitable study environment. Semi-structured face-to-face interviews (*cf.* 1.6.4.2) were employed to explore the participants' perceptions regarding the reasons for their self-regulating skills to be well-developed or not well-developed.

Non-probability, convenient sampling was used for the quantitative data collection (*cf*. 1.6.5). The Grade 10 participants were recruited from four schools involved in the AMSC outreach enrichment programme, which included the following areas in the Sedibeng West district, Gauteng Province, South Africa, namely Boipatong, and Evaton. The research was done at two schools in Boipatong and two schools in Evaton, with a fairly homogenous group of 130 purposively and conveniently selected male and female participants who took part in the completion of the questionnaire. Based on the findings of the questionnaire data, 16 participants were selected by means of purposeful, criterion sampling (four participants per school (males and females) to take part in the interviews (*cf.* 1.6.5.2). Grade 10 learners were chosen, as the researcher argued that if deficiencies in relation to the development of their self-regulating skills could be identified, the deficiencies could be addressed, and the learners' chances to improve their academic achievement by the time they reach Grade 12, possibly enhanced.

To ensure reliability of the questionnaire, a pilot study was conducted (*cf.* 1.8). In addition, the criteria for internal, external, construct, and statistical conclusion validity were complied with, to ensure the validity of the quantitative research design (*cf.* 1.8). To ensure trustworthiness of the qualitative data, the research complied with the criteria for credibility, transferability, dependability, and confirmability (*cf.* 1.9).

The researcher ensured that her role as researcher did not compromise the collection of data (*cf.* 1.10), and complied with ethical principles during the execution of the research (*cf.* 1.11).

In the next chapter, Chapter 2, the nature and importance of self-regulating skills in mathematics is investigated through a literature review.

CHAPTER 2

THE IMPORTANCE OF SELF-REGULATING SKILLS IN MATHEMATICS

2.1 INTRODUCTION

This chapter aims to provide a comprehensive overview of the importance of self-regulating skills in mathematics. The following issues are addressed in this chapter.

2.2 SELF-REGULATION: HISTORICAL DEVELOPMENT AND THEORETICAL UNDERPINNINGS

In this section, the researcher clarifies the concept self-regulation and illustrates how this concept developed through history, by explaining how theories of learning support the development of self-regulation. The behaviourist, cognitive, and constructivist learning theories are explored in this regard. In addition, a number of personality trait theories that have strong links to self-regulation will be explored.

2.2.1 Behaviourist learning theory and self-regulation

In the late 1950s, learning theories started to shift from behaviourism to cognitivism. Behaviourism is a theory that opposes self-regulation, specifically self-efficacy properties because according to behaviourism, the learner is reactive and does not take a role in his/her learning. The learners are given a stimulus and respond to it, for example an equation in mathematics is given to a learner (i.e. the stimulus) and a correct answer is given (i.e. the response). The learner is not actively involved in his/her own studies, does not discover information independently, and does not takes responsibility for his/her own learning (Ertmer & Newby, 2013a:48).

According to the behaviourists, human behaviour is learned. Practised actions are important to the behaviourist and not the development of the learner's thoughts or emotions. Klinger (2009:156) asserts that the key component is the stimulus given to the learners and the response of the learners, for example applying the correct application of algorithms to obtain correct answers. The learning process is practised by studying worked examples. Learners' behaviours are conditioned through rewards for being successful and disapproval for being unsuccessful. Learners are reactive in the learning process and the teacher sets the environment for learning. The focus is on the teacher and the teacher's actions. The teacher emphasises content through using specific methods; determines where to begin the instruction process and tells the learners exactly what to do before they can give an answer. Through the application of behavioural principles during teaching, learners cannot acquire higher levels of skills to solve problems and to be critical, self-regulated thinkers (Cox, 2011:15, 16, 28; Ertmer & Newby, 2013a:48, 49; Ertmer & Newby, 2013b:65, 66; Klinger, 2009:156; Zhou & Brown, 2014).

According to Ertmer and Newby (2013a:50), behaviourists focus on designing an environment to optimise the transfer of knowledge which is teacher-centred and does not accommodate self-regulation principles where the learners are actively involved in their own learning process (Ertmer & Newby, 2013a:50).

2.2.2 Cognitive learning theory and self-regulation

In contrast to behaviourist theories, cognitive theories of learning are focused on how information is received, organised, stored, and retrieved. Learning is centred around what learners know and how they acquire the knowledge, and less on what they do. The cognitive approach focuses on the development of mental processes that enable a learner to come up with an answer (Ertmer & Newby, 2013a:51). According to cognitivists, new knowledge becomes meaningful by relating it to existing knowledge in the memory, and feedback should guide and support the making of mental connections. Learners are encouraged to use learning strategies that include reasoning, problem solving, mental planning, and goal setting which are involved in the process of self-regulation (Ertmer & Newby, 2013a:51 & 52; Zhou & Brown, 2014).

2.2.3 Constructivist learning theory and self-regulation

According to Paris and Paris (2001:90), three constructivist theories that are fundamental to the development of self-regulation during learning, are those of Piaget (1954), Vygotsky (1978), and Bandura (1999a). Each of the theories and their respective links to the importance of self-regulation will be briefly explained in the subsequent sections.

Fosnot and Perry (2005:10) assert that constructivism is the direct opposite to behaviourism, where individuals are not involved in their own learning processes, and the focus is on the goal of instruction. Constructivism focuses on learning and not teaching. Learning is therefore an active process, mentally and physically, where learners solve problems through reflection on immediate and past experiences and then construct their own understanding (Fosnot & Perry, 2005:10).

2.2.3.1 The constructivist theory of Piaget

Piaget’s theory postulates that a learner’s knowledge is gained by experiencing things and constructing own understanding, instead of passively absorbing factual knowledge (cited by Taber, 2011:49). Ertmer and Newby (2013a:55) add that knowledge should be created through experiencing the world and not by acquiring it through transmission. According to constructivists, knowledge is created through the interaction between both the learner and the environment. They view teaching as shifting from passively transferring facts to actively involving learners in applying their ideas to real-world problem solving (Ertmer & Newby, 2013a:56, 57). The teacher should guide learners on how to construct meaning, how to monitor, how to evaluate and update their knowledge (Ertmer & Newby, 2013a:59; Zhou & Brown, 2014); thus, how to apply strategies to become skilled, self-regulated learners. Learners are also encouraged to talk to peers or a knowledgeable person to articulate their own understanding and ask for assistance when needed (Ertmer & Newby, 2013a:59).

Constructivists therefore shifted the role of the teacher as the active transmitter of information, and learners as the passive recipients of information, to the learners becoming the active participants who are responsible for constructing their own knowledge and solving problems while interacting with the environment (Dignath & Büttner, 2008:235; Kay & Kibble, 2016:24).

2.2.3.2 The socio-cultural theory of Vygotsky

Vygotsky's socio-cultural theory is described by Schunk (2008:463) as a revolutionary process, moving away from conditioning towards cognition. Learners no longer merely receive knowledge passively, but apply logical thinking to actively engage in their learning process (Gredler, 2009:3). Vygotsky asserts that learners arrive at their own understanding by using their own background and other people in their culture (cited by Taber, 2011:50). A teacher's role is to act as a mediator of learning, one who works with the learner to develop cognitive processes that would enable learners to self-regulate their learning (Kozulin, 2003:15-38). In contrast to Piaget, Vygotsky emphasised the importance of human interaction during learning. Zhou and Brown (2014) describe Vygotsky's theory as an interaction between people and the tools that a culture provides for people's cognitive development and thinking. They describe three cultural tools that individuals can use and pass on to each other. These tools are:

- Imitative learning, which happens when a learner observes a teacher applying a learning strategy, then mimics the teacher by applying the same learning strategy to self-regulate learning.
- Instructed learning, which occurs when a person remembers an instruction and then uses the instruction to self-regulate.
- Collaborative learning, where a group of learners support one another in achieving learning outcomes.

Learners complete a task more effectively when they work together with an experienced adult who assists them and scaffolds their efficacy in applying thinking processes (Nel, *et al.,* 2012:63). Scaffolding is when the teacher moves learners gradually to a better understanding and, ultimately, greater independence in their learning process. Scaffolding comprises opportunities for teachers modelling self-regulation strategies, learners observing and repeating the application of the strategies to attain mastery (Nel *et al.,* 2012:63). For constructivists, learning activities and problems are set in the real world. Learning goals are broken into stages, and learning involves scaffolding. Thus, learners must first master learning goals that involve information at lower levels of complexity, before moving to more complex levels of attaining goals (Kay & Kibble, 2016:23).

2.2.3.3 The socio-cognitive theory of Bandura

According to Bandura (1999b:25), learning takes place by observing the behaviour and resultscation of the behaviour of others. In addition, there is a constant interaction between cognitive influences, behavioural influences, and environmental influences (Bandura, 1999b:23). Through observations and the mentioned interaction between influences, a person can develop his thinking skills and learn new ways of thinking and behaving, which involves self-regulation to monitor, adjust, and correct mismatches that hamper success (Bandura,1999b:26).

Bandura (1999b:23) distinguishes between three types of environmental structures that influence learning. Imposed structures are forced upon people whether they like it or not, and people have little control over this type of environment or how they will react to it. Selected structures are environments where people choose who they want to be associated with and what activities they are prepared to do. The constructed structures refer to environments that people construct for themselves, taking into consideration personal, behavioural, and environmental factors (Bandura, 1999b:23). Humans have the capacity to create and self-regulate the environmental conditions that influence every aspect of their lives (Bandura, 1999b:27).

Banks and Mhunpiew (2012:1002) state that Bandura's social-cognitive theory has a practical approach in the development of a person's character. People learn through observation and then choose to imitate, modify, or disregard the observed action. Socio-cognitive theory regards people as self-organised, pro-active, self-reflecting, and self-regulated; thus, not simply products of their circumstances but also contributors to their circumstances (Banks & Mhunpiew, 2012:1002).

According to Bandura (2003:87-89), there are four processes that play a role in self-regulated learning. The processes are **self-observation, self-evaluation, self-reaction,** and **self-efficacy.** These processes are interrelated and each one influences motivation and goal achievement.

Zimmerman and Schunk (2001) (cited by Redmond, 2010) describe **self-observation** as observing oneself, which will give information on your progress to reach your goal as well as motivate behavioural changes. Self-observation is closely linked to self-monitoring and making behavioural changes to reach desired outcomes (Zimmerman, 2002:68) (*cf.* 2.3.4.2).

Self-evaluation takes place when a person evaluates his current performance or goal in comparison to his desired performance or goal. Goals must be specific because attaining the goals will boost self-efficacy (Zimmerman & Schunk, cited by Redmond, 2010). Goals should be valued; then the individual will apply a higher level of effort (*cf.* 2.3.3.3).

Self-reaction to one's performance can motivate a person to have a feeling of self-efficacy and become motivated to achieve his/her goal. Self-reaction also happens when a person has achieved his/her goal. Future goals are re-evaluated and the standards at which goals should be achieved are lifted. The opposite is also probable, namely to lower standards if goals are not achieved. A negative self-evaluation might also motivate and inspire a person to work harder to achieve their goals if they experience the goals as being valuable (Bandura, cited by Redmond, 2010).

A learner's perception of self is the most important component that influences academic motivation. Two types of self-beliefs are dominant in motivation, namely, **self-efficacy** and **self-concept** beliefs (Pajares & Schunk, 2001:239-240) (*cf.* 2.3.2).

Self-efficacy is the belief learners have of their own capabilities and motivation to complete academic tasks with competence (Perry & Steck, 2015:128-129; Tella, 2011:430). Bandura (1993:118) stated that an individual creates and develops his own self-perceptions of his/her capabilities. These self-perceptions form the instrument of how they control their environment, and decide which goals they chase. Self-beliefs make it possible for an individual to direct their thoughts, feelings, and actions.

According to Perry and Steck (2015:128) and Tella (2011:430), learners with high self-efficacy will want to achieve the goals they set for themselves, and will be willing to attempt and complete tasks, thus be more self-regulated. Learners with low self-efficacy will avoid doing a task because they believe it is too difficult or they will not persevere to complete the task. Learners with higher levels of self-efficacy tend to be more self-regulated, which results in higher academic achievements (Perry & Steck, 2015:128-129; Tella, 2011:430). Individuals who have strong self-efficacy beliefs will choose greater challenges, persevere, and set a time limit on how long to persevere when they encounter difficulties.

Bandura (1993:125) stated that an individual creates and develops his own self-perceptions of his capabilities. These self-perceptions are the instruments with which they control their environments and influence which goals they chase. The self-beliefs enable individuals to have control over their thoughts, feelings, and actions. According to Bandura (1993:128), beliefs about capabilities and motivation can be called self-efficacy beliefs, and those determine what individuals do with their knowledge and skills.

Self-beliefs or self-concept is a person's view of himself, his characteristics and his most important personality-traits. Cooley (cited by Pajares & Schunk, 2001:242) argues that one's self-belief is formed by one's perception of how others perceive your worth. General self-beliefs include academic, social, emotional, and physical facets of the self. The difference between self-efficacy and self-beliefs is that self-efficacy is a judgement of the confidence in one's own abilities to achieve a goal, and self-beliefs are your own perception of your self-worth. Self-worth is strongly linked to culture and social structures that include self-perceptions regarding family and peers (Pajares & Schunk, 2001:243).

Bandura (1999b:29) claims that perceived self-efficacy has an important role to play in four self-regulation processes; these are cognitive, motivational, affective, and selection processes (*cf*. 2.3.3.1 - 2.3.3.4). People set goals through a cognitive process. The self-belief that a person has the competence and can achieve a set goal, leads to self-satisfaction and motivation (Bandura, 1993:131). Self-efficacy determines the level of goals a person will select as well as how much effort they will put into attaining their goals and how long they will persevere to reach their goals in facing difficulties. People who lack self-efficacy will slacken their pace when faced with obstacles and even give up totally (Bandura,1993:131) (*cf.* 2.3.3.3).

When individuals distrust their self-efficacy, it has a detrimental effect on their emotional or affective processes. They believe things are tougher than they are in reality, their stress level increases, their heart rate increases, their blood pressure rises, they feel depressed, and they have low confidence. When their self-efficacy skills increase through guidance, they will be able to handle difficult situations without being burdened with stress reactions. For school learners, confidence in academic capability is a critical component of school success (Bandura, 1993:133; Pajares & Schunk, 2001:242).

Learners who have strong self-efficacy beliefs are bolder when it comes to taking on stressful learning situations and mastering difficult learning content (Bandura, 1993:133; Pajares & Schunk, 2001:241). They will also anticipate positive outcomes and envision academic success (Bandura, 1993:135; Pajares & Schunk, 2001:241).

The researcher also took cognisance of a number of personality trait theories that reveal relationships with the development of self-regulation.

2.2.4 Personality trait theories and self-regulation

According to Houghton (2000:16), there is a confirmed relationship between self-regulating skills and personality traits such as perseverance, being organised, self-disciplined, and logical. Having these personality traits means a person will be more self-regulated. The relationship between self-regulation and personality is briefly explored below in the perceptual control theory and the big five personality theory, respectively.

2.2.4.1 Perceptual control theory

According to Powers (2016:147), perceptual control refers to *“behaviour [which] is the process by which we act on the world to control perceptions that matter to us.”* Fundamental to perceptual control theory is that people normally want to control their behaviour. This is not always possible, as some behaviour is uncontrollable if there is a lack of knowledge around it or if the behaviour is due to environmental factors. For example, death can be the reason for uncontrollable behaviour, according to Tai (2009:228). Dyslin (1998:25) indicated that one’s behaviour is controlled by one’s perception of one’s environment and one can be held accountable for this intentional behaviour. According to Taylor (1999:433), people plan their actions or behaviour to reach desired goals, but planned behaviour will only work if the world is as one expects it to be and we know that everyday life is unpredictable.

Using perceptual control theory, we can control and change our perceptions, rather than control the world. We can understand other people’s behaviours in addition to our own (Powers, 2004:130). Powers (1994) states that there is a relationship between self-regulation and perceptual control theory: Attaining a goal is very important in self-regulation and this includes maintaining a perception towards reaching a goal, and the way in which one perceives the environment and takes control over the environment is linked to perceptual control theory. The environment where a task must be done can either lead an individual to worry and withdraw, or it can be a performance environment that contributes to commitment to perform well (Abdalla, *et al.,* 2000:189).

2.2.4.2 Big Five personality theory

McCrae and Costa (1996:63) identified five main personality traits called the Big Five factors. These factors are **neuroticism, extraversion, openness, agreeableness,** and **conscientiousness** (McCrae & Costa, 1996:63). The studies done showed that four of these factors (neuroticism, extraversion, openness, conscientiousness) are hereditary, and one (agreeableness) is linked to the environment (McCrae & Costa, 2005:293).

De Raad and Mlacic (2015:559-561) and Digman (1990:424) indicate that the trait names differ in various literature and the following names can be used:

- Openness to experience or intellect.
- Conscientiousness (or will).
- Extraversion/Introversion (or confidence).
- Friendliness/Hostility (or agreeableness).
- Neuroticism (or emotional stability).

The relationship between self-regulation and the Big Five personality theory will be described in relation to each of the above factors.

Openness to experience or intellect

Openness is a reflection of a person's intellectual curiosity. According to Bidjerano and Dai (2007:71), people with low scores for openness prefer a routine, and those who score high, prefer originality. A learner who scores high on openness will act independently and self-regulated in various activities, because they feel self-efficacious, believe in their intellectual abilities and take responsibility for not achieving their goals due to low effort (Boekaerts, *et al.,* 2000:17; Sadi & Uyar, 2013:21; Wolters, *et al.,* 2003:4; Zimmerman, 2008:167).

Conscientiousness

This trait refers to being disciplined, being goal-oriented, preferring to formulate plans, and being organised. Conscientious people are hardworking and dependable people. Conscientiousness has a very strong relationship with self-regulated learning because it includes factors such as being responsible, being able to plan, organise, and persist in achieving good results. Self-regulated learners will plan the goals that they want to achieve and will also anticipate the consequences of their actions (Bandura, 1991:248; Bidjerano & Dai, 2007:70; Boekaerts, 1996:101).

Conscientiousness is also linked to motivation and a positive attitude towards challenging experiences. Bandura (1991:252) claims that motivation helps people to change their activities after monitoring themselves, to reach the goals they want to achieve. If their motivation is low, people will not put an effort into monitoring themselves.

Extraversion

Extraversion is a characteristic of outgoing individuals who have high energy, positive emotions, and who are sociable and assertive (Bidjerano & Dai, 2007:71). Bidjerano and Dai (2007:71) argue that this personality trait has a weak link to self-regulation because outgoing individuals appear to be sociable and distractible, and they tend to stop cognitive activities prematurely. Due to their personality, outgoing individuals are poor in time management, which plays an important role in self-regulation (Bidjerano & Dai, 2007:71).

Agreeableness

This trait measures one’s temperament; that is, to what extent an individual is compassionate and cooperative. Agreeable people are very helpful, generally well-tempered, and more likely to regulate their study habits and put in an effort into their learning (Bidjerano & Dai, 2007:71). Agreeableness links to self-regulated learning because individuals who are agreeable combine their learning and the regulation of their study habits. Agreeableness also links to time-management and how much effort is put into studies. Self-regulated learning is also associated with how much effort is put into learning, and how an individual manages his time and study environment (Bidjerano & Dai, 2007:71-72).

Neuroticism

Bidjerano and Dai (2007:71) indicate that it is difficult to link neuroticism to self-regulation because neurotic people tend to be poorer in problem solving, and their lack of perseverance leads to them leaving problems unsolved. They may, however, seek help from their teachers and peers when they are incapable to solve problems. Entwistle (cited by Bidjerano & Dai, 2007:71) states that neuroticism is linked to poor critical thinking, poor analytical thinking, and poor conceptual thinking because neurotic people become paralysed when higher order functioning is demanded from them. Neuroticism focuses more on shallow learning than deeper and meaningful understanding of concepts; thus, it has a negative relationship with self-regulation.

The following section elaborates on the conceptualisation of self-regulation.

2.3 SELF-REGULATION: A CONCEPT CLARIFICATION

2.3.1 Self-regulation and related concepts

In the 1960s, psychological theories moved away from learning through conditioning (behaviourism) (*cf*. 2.2.1) and towards learning based on cognitivism (Schunk, 2008:463) (*cf.* 2.2.2) and constructivism (Ertmer & Newby, 2013a:59) (*cf.* 2.2.3). Instead of learners not taking part in their own learning processes, they are now actively involved in their learning processes, which involve **self-regulation**, **self-directed learning**, **self-regulated learning,** and **meta-cognition**. Although the mentioned processes have strong links, it is also difficult to differentiate between them (Dinsmore, *et al,* 2008:396; Fox & Riconscente, 2008:373-389; Saks & Leijen, 2014:190-198; Schunk, 2008:463-464).

An attempt will be made to clarify these processes and indicate how self-regulation, which is the focus of this study, is conceptualised in the context of the study.

2.3.2 Self-regulated learning, self-directed learning, self-regulation and meta-cognition

Four concepts play an important role in understanding self-regulated action during learning, namely self-regulated learning, self-directed learning, self-regulation, and meta-cognition (Bandura, 2015:1026). The subsequent sections explain the role of each of the mentioned concepts. The researcher wishes to clarify that although self-regulated learning and self-directed learning are often used interchangeably, the focus of the present study is on self-regulated learning. **Self-regulated learning** is an active process where learners become independent in regulating their learning (Bandura, 2015:1026; Boeaerts, 1996:100; Dignateh-Van Ewijk *et al.,* 2013:339; Schunk, 2005a:173; Ocak & Yamaç, 2013:381), across three stages, namely planning, monitoring, and evaluation (*cf.* 2.3.3.1). Learners take initiative to identify their learning needs, set learning goals, decide on resources and appropriate strategies to achieve the goals, monitor the progression towards achieving the goals, and evaluate the outcomes of their efforts in achieving their goals (Dignath & Büttner, 2008:233; Knowles, 1975:46; Pintrich, 2000:451; Saks & Leijen, 2014:190-198; Zimmerman, 2000:13).

Self-regulation, the ability to self-regulate, is fostered by teachers who create environments where learners can take control of their own learning. An essential part of self-regulation is that learners must have efficient strategies (Dignath & Büttner, 2008:233; Zimmerman, 2000:13), that would enable them to become less dependent on their teachers and skilled to take more control of their own learning (Boekaerts, 1996:100; Dignath & Büttner, 2008:233; Schunk, 2005a:173). In addition, teachers may provide initial instructions and expectations, in prompting the self-regulation process (Saks & Leijen, 2014:192). Self-regulation increases learners' self-motivation. Learners should take responsibility for, and play an active role in, their own learning, thus replacing the old methods of teacher instruction (Boekaerts, 1996:100; Dignath & Büttner, 2008:232; Medina, 2011:150; Zimmerman, 1986:307).

Similar to self-regulated learning, **self-directed learning** also involves a process where individuals take initiative to independently identify their learning needs, set goals to achieve, identify resources to assist with task completion and evaluate final learning outcomes (Pradeep, 2017:177). However, self-directed learning is mostly used in the context of adult education and includes learning activities outside the traditional school classroom. The concept self-regulated learning is mostly utilised in the school environment. As the focus of this study involves the teaching of mathematics at school level, the emphasis will be on the concept self-regulated learning.

According to Boekaerts (1996:100), Schunk (2005a:173) and Zimmerman (2008:166), self-regulation is defined as a process where learners are **meta-cognitively** involved in their learning and continuously reflect and think about applying strategies to become more skilful at regulating the planning, monitoring and evaluation stages of their learning (cf. 2.3.3.2). Meta-cognition thus involves constant self-awareness and regulatory action during the learning process (Flavell, 1979:906; Karpicke, *et al.,* 2009:472).

Dinsmore, *et al*. (2008:394, 396) state that **self-regulated learning** integrates both **meta-cognition** and **self-regulation** to focus on learners' meta-cognitive monitoring/controlling of the thinking and motivational aspects (e.g., self-efficacy) of self-regulation (e.g., self-efficacy). Dinsmore, *et al.* (2008:400, 401, 405) conclude that monitoring/controlling appears with the same rate over meta-cognition, self-regulation, and self-regulated learning. The difference between the three lies in what is being monitored/controlled (*cf.*

2.4). In self-regulation and self-regulated learning, monitoring/control comprises behaviour, thinking, and/or motivation; while in meta-cognition, monitoring/control of cognition is foregrounded. Meta-cognition mainly involves an individual's consciousness of his thoughts, while the focus of self-regulation is on the person, his environment, and his behaviour to eliminate obstacles towards successful learning (Dinsmore, *et al.* 2008:400). Meta-cognition plays an important role in reflecting about and identifying strategies to eliminate stumbling blocks towards successful learning.

In the subsequent section, the strategies involved in self-regulated learning are clarified.

2.3.3 Strategies involved in self-regulated learning

Different models present strategies to promote self-regulated learning where learners are meta-cognitively, affectively/motivationally, and behaviourally/environmentally active self-regulators of their learning (Boekaerts, 1999:445-457; Hattie & Donoghue, 2016; Pintrich, 2000:451-502, Zimmerman, 2000:13-39). O'Malley and Chamot (1990) developed one of the best-known classifications for strategies, which comprises:

- Meta-cognitive strategies that organise learning (selective attention, planning, monitoring and evaluating learning activity),
- Cognitive strategies that are used for rehearsal, organisation of information, inferencing, summarising meaning, reducing information, imagery, transfer, and elaboration of information; and
- Social-affective (motivational) strategies that enable interaction, cooperation, questioning for clarification, and self-talk.

In the context of the study, the researcher combines the aforementioned model with the classification of Donker, *et al.* (2014:1-26), and also adds behavioural or environmental strategies, also referred to as management strategies (Donker, *et al.,* 2014:1-26) to the model. (In the context of the research, the researcher uses the term environmental strategies).

According to the researcher the following strategies will therefore play an important role in becoming skilled in self-regulated learning, namely, cognitive, meta-cognitive, motivational, and environmental strategies. Each of the strategies is elucidated in the subsequent sections.

2.3.3.1 Cognitive strategies

Although the cognitive strategies do not play a direct role in self-regulation, they are included in the discussion for the purpose of completeness. Cognitive strategies are used to improve learning (Schraw *et al.,* 2006:113). The application of cognitive strategies enables a learner to become skilled at deciphering, memorising, and recalling information (Schraw *et al.* 2006:112). Cognitive strategies include a variety of strategies that a person will use to improve learning, such as simple learning strategies, problem solving strategies, and critical thinking strategies. Simple strategies include, among others, the construction of graphs and drawing tables to capture information (Schraw *et al.* 2006:113). Problem solving strategies are more complex but recent studies showed that it can be broken down into smaller steps that are teachable to learners and will improve learning (Dhillon *et al*. cited by Schraw, *et al.* 2006:113; Woolfolk, 2010:279). Critical thinking refers to the evaluation of the validity of information (McGregor, 2007:172), and involves the application of many strategies such as, identifying the origin of information, analysing whether the origin is trustworthy, reflecting on the information, and contemplating conclusions (Schraw, *et al.* 2006:113).

2.3.3.2 Meta-cognitive strategies

John Flavell, a pioneer of meta-cognition, referred to it as the way in which a person thinks and monitors his own thinking (Flavell, 1979:906). According to Flavell (1985:18), who is supported by Dinsmore, *et al.* (2008:393) and Schraw, *et al.* (2006:114), meta-cognition comprises two components: **knowledge of cognition (meta-cognitive knowledge)** and **regulation of cognition (meta-cognitive regulation)**.

Meta-cognitive knowledge involves three types of knowledge:

- Declarative knowledge: This refers to the knowledge one has of one's own general information processing abilities. Flavell (1985:15) refers to this type of knowledge as *"person knowledge"*; how much learners understand about their memories and the how their memories work (Sperling, *et al.,* 2004:118).

- Procedural knowledge: Also known as *"task knowledge"* (Flavell, 1985:15), refers to knowledge that one should have in order to solve problems successfully.
- Conditional knowledge: Also called *"strategy knowledge"* (Flavell, 1985:15), it involves having the sense to know when to employ specific learning strategies (Paris, *et al.,* 1984:1240). In this regard, the specific learning strategies could comprise those mentioned in 2.3.3.1.

In sum, meta-cognitive regulation involves knowledge of the factors that influence one's performance and knowing how to regulate and maximise learning (Flavell, 1985:16; Sperling, *et al.,* 2004:118).

2.3.3.3 Motivational strategies

According to Ocak and Yamaç (2013:381) and Schraw, *et al.* (2006:115), motivational strategies are linked to motivation and self-efficacy. Self-efficacy refers to one's beliefs that one can learn and perform effectively. These self-efficacy beliefs influence self-regulation, motivation, and performance (Bandura, 2015:1026; Bandura & Locke, 2003:87; Loynachan, 2018; Ocak & Yamaç, 2013:381; Zimmerman, 2000:17). Feelings of capability will lead to setting higher goals, remaining committed and engaged to achieve goals, persisting when faced with challenges, and increasing efforts to achieve goals (Bandura, 1991:248; Bandura, 2015:1026; Bandura & Locke, 2003:87 Boekaerts, 1996:101; Pintrich, 2000:458; Schunk, 2005a:173; Zimmerman, 1986:308; Zimmerman, 2008:168; Zumbrunn, *et al.,* 2011:4-6), that could promote better achievements (Pajares & Schunk, 2001:246).

Van Mater Stone (cited by Ertmer & Newby, 1996:4) summarised the characteristics of self-regulated learners and their motivational strategies as follows:

- They know more about themselves.
- They can organise their knowledge and apply it to their task.
- They are flexible in their planning and actions.
- They have different motivations for succeeding in their tasks.
- They are sensitive and more flexible to the demands of the task.

- They are more opportunistic to be successful in attaining their goals.

2.3.3.4 Environmental strategies

Bandura explains that humans implement a certain behaviour pattern according to environmental influences and events, and that behaviour and environment constantly interact with each other (Bandura, 1999b:23). People choose their own social environment and if an environment is forced upon them, they still have a choice how they are going to react and behave towards it.

The conditions of a study environment can have a motivational and behavioural influence on learners. Planning in advance to have sufficient time, a conducive study environment and adequate resources and support during task completion or studying could increase the likelihood of being more successful in achieving learning goals (Zimmerman, 2000:14, 15). In turn, positive task outcomes could motivate further learning, and increase self-worth (Bandura, 1999b:27).

The strategies that play a role in developing self-regulating skills are summarised in Figure 2.1.

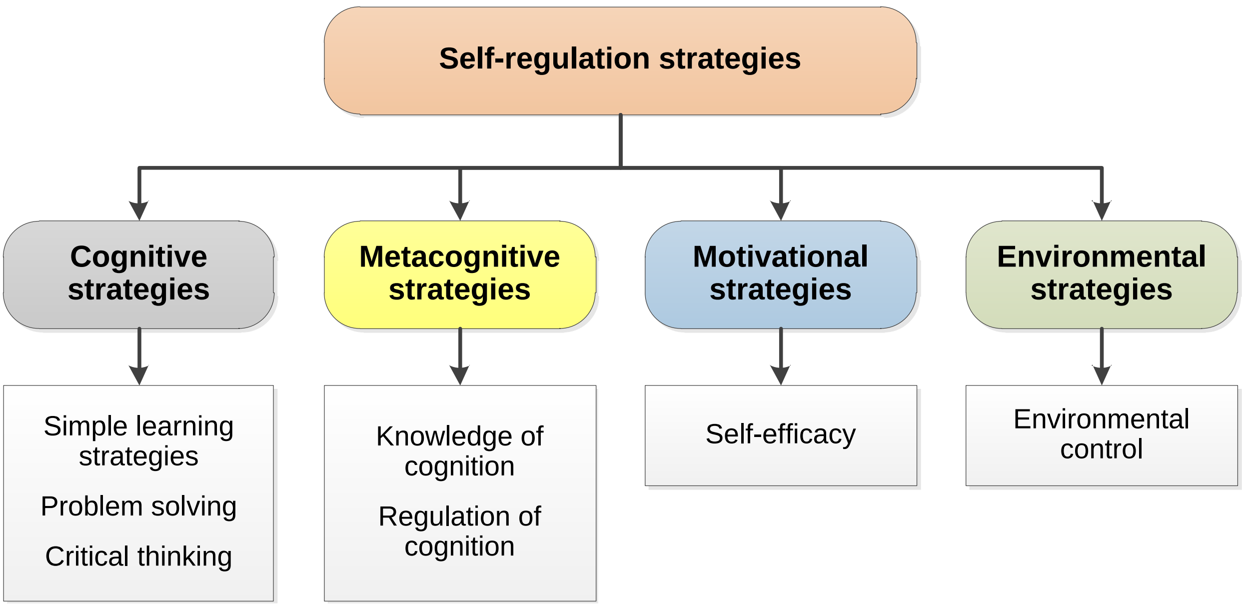


Figure 2.1: Self-regulation strategies (Schraw, *et al.*, 2006:113)

The strategies summarised in Figure 2.1 play an important role in developing self-regulating skills during each of the stages of the learning process of self-regulation. Their application during each of the learning stages, is discussed below.

2.3.4 The stages of learning and self-regulation

Pintrich (1999:461) and Schraw, *et al*. (2006:114) state that the three major learning stages during which a learner needs to become more self-regulated involve planning, monitoring, and evaluation. Zimmerman (2000:16) supports the view of Pintrich (1999:451), and aligned to the view of Pintrich (1999:46), mentions that self-regulation comprises three cyclical phases: *Forethought, performance or volitional control* and *self-reflection.* Forethought implies strategic planning and goal setting, performance or volitional control aligns with self-control and self-observation that takes place during the monitoring process towards achieving goals, and self-reflection coincides with the evaluation phase of judging the effectiveness of goal achievement (Zimmerman, 2000:16).

During each of the learning stages, cognitive, meta-cognitive, motivational, and environmental strategies (*cf.* 2.3.3) play an important role to enable learners to develop self-regulating skills (Bandura, 2015:1028; Ertmer & Newby, 1996:10, Zimmerman, 1986:307; Zimmerman, 2008:169). The application of these strategies will be explored in each of the self-regulation phases in the subsequent sections. As mentioned previously (*cf.* 2.3.3.1), the cognitive strategies do not play a direct role in self-regulation, and they will therefore not be included in the discussion below. Reference will however be made to where the application of cognitive strategies come into play.

2.3.4.1 Planning

Planning involves selecting the correct strategies to set goals and plan the time that is going to be spent on the task at hand (Schraw, *et al*. 2006:114; Schunk, 2005a:173). Effective planning is a component of self-regulation, especially when this planning occurs before starting the task (Schraw, *et al.* 2006:114). Before attempting a task, self-regulating learners will first plan the procedure they will follow to achieve their goal, before embarking on the task. To plan has three advantages: Firstly, it will make the task easier;

secondly, it increases the probability to be successful with the task; and thirdly, the product is of good quality.

Learners who are skilled at planning, will use their past experiences with the application of strategies to complete tasks with similar future tasks, and select strategies that will be suitable to the task to achieve their goal(s) (Bannert & Reimann, 2012:194). A learner must consider what the task demands, their own resources to successfully complete the task, and the weaknesses and strengths in using various strategies.

In summary, the actual planning itself involves setting clear goals, selecting the cognitive strategies that will be used to complete a task (*cf.* 2.3.3.1), identifying obstacles that may be encountered, and establish the time required to achieve goals (Boekaerts, 1996:107, Cazan, 2012; Ertmer & Newby, 1996:10 & 11, Pintrich, 1999:461, Schunk, 2005b:86, Zimmerman, 2008:166, Zumbrunn, *et al*. 2011:10)

Meta-cognitive, motivational, and environmental strategies are required during planning (Ertmer & Newby, 1996:20; Pintrich, 2000:454; Zimmerman, 2000:17).

Meta-cognitive strategies for planning

Proper planning makes the execution of a task easier; increases the probability of successful task completion and ensures a final product of quality. It is important to set task-specific goals that are realistic, and to activate prior knowledge in relation to task content through self-questioning, that could assist in successful task completion. Learners also choose the strategies they want to apply, and decide how, when, and why the strategies will be implemented to complete the task (Zimmerman, 2000:17). The strategies for planning also include concentration in order for a learner to be able to select the main ideas of a task and to be able to process the information they receive (Bandura, 1986:338; Schunk, 2005b:87; Zimmerman, 2008:167).

Motivational strategies for planning

Motivational strategies, among others, relate to strategies to enhance self-efficacy, thus affecting how people think, feel behave and motivate themselves (Zulkosky, 2009:94). Motivation involves learners' feelings, expectations, interests, and the effect these have on them (Zimmerman, 2000:17). Motivational strategies support learners to understand their own emotions, motivation, and attitudes, and what to do to lower anxiety, as well as to reward and encourage themselves. Motivational strategies, such as positive self-talk (e.g. I know I can do this, I feel capable of doing a good assignment) have an influence on how much effort learners will put into the task and how much time they are prepared to spend on the task (García-Sánchez & Fidalgo-Redondo, 2006:185). Coping with stress factors to reduce negative emotions are also important to ensure that learning goals are achieved effectively (Boekaerts, 1996:107; Erlich & Russ-Eft, 2011:7; Pintrich, 1999:462).

Increased self-motivation and self-efficacy will enable learners to stay on track and achieve their goals. Moreover, learners who persevere through difficult learning tasks will find the task more gratifying when they reach their goals (Ertmer & Newby, 1996:12; Zimmerman, 2008:168, Zumbrunn, *et al.* 2011:10).

Environmental strategies for planning

Environmental strategies include among others, the organizing and structuring of the physical learning or study environment to ensure successful learning or task completion (Hattie & Donoghue, 2016; Ocak & Yamaç, 2013:380). Environmental strategies are more focused on the behaviour of learners, and also include managing learning time, and finding, navigating and evaluating resources for successful task completion (Dignath, *et al.,* 2008:101), such as group learning, and help-seeking from teachers, parents and peers (Pintrich, 2000:455). Environmental strategies will help learners to adapt to their environment or change their environment, as needed. The environment that learners use for learning should help them to focus and control their attention. Distractions that will influence the success of achieving one's goals must be removed (Pintrich, 1999:466; Zimmerman, 2008:168).

A self-regulated learner works according to a study plan that will be effective, and also plans for a special time and place to study. This place must ensure optimal study conditions and preferably be a quiet study environment (Ertmer & Newby, 1996:3; Zimmerman, 2008:168).

Another environmental strategy to promote self-regulated learning, is to form a study group and seek assistance from the study group, teacher and parents in completing a task. When learners work in groups, they are more motivated, and have higher levels of goal achievement (Wolters, *et al*. 2003; Ertmer & Newby, 1996:12).

Zou and Zhang (2013:54) make us aware that with the rapid change of technology, our environment in education will also change. Although research on technology and education is still premature, there is already an indication that using technology in education, promotes clearer goal-setting, increases motivation, and confidence, and encourages self-regulation (Zou & Zhang, 2013:54). In this regard, Zimmerman (2008:170) and Zou and Zhang (2013:54) assert that an environment, equipped with computers for study purposes, gives learners more opportunities to develop self-regulating skills.

2.3.4.2 Monitoring

Monitoring includes self-testing skills to determine what changes should be made to achieve set goals and control learning (Schraw, *et al.,* 2006:114; Schunk, 2005a:173). According to Ertmer and Newby (1996:13), monitoring is a complex process because while busy with the learning act, one needs to check whether one is still on track to achieve set goals, or decide whether adjustments should be made to the selected strategies (*cf.* 2.3.3.1) in order to achieve goals. Self-regulated learners control their understanding processes, their feelings, and behaviour to achieve their goals and to better their learning. They alter or better their strategies to enhance their learning process.

According to Pintrich (2000:457) and Zimmerman (2000:20), feedback plays an important role in monitoring. Feedback assists a person to take corrective action. Moreover, feedback should be informative so that learners can see value in the feedback that would lead to greater personal understanding and to a better performance (Finn & Metcalfe, 2013:19).

Meta-cognitive strategies for monitoring

On a meta-cognitive level, the self-regulated learner will determine if the chosen strategies for task completion (*cf*. 2.3.3.1) are working and if progress is made towards goal achievement. Self-monitoring will help a learner to set realistic goals and pay close attention to his thought patterns and make changes to correct his behaviour where necessary (Bandura, 1986:338; Finn & Metcalfe, 2013:19; Flavell, 1979:908; Pennequin, *et al.,* 2010:201; Schraw, *et al.,* 2006:115; Schunk, 2005b:87; Zimmerman, 2008:167).

Positive motivational strategies will influence a learners' preparedness to monitor and evaluate their performance and reflect on the quality of the outcome of their performance (Erlich & Russ-Eft, 2011:10; Loynachan, 2018; Perels, *et al.,* 2009:20; Torrance, *et al.,* 2007:267). Zimmerman (2008:167) and Zumbrunn, *et al*. (2011:38) argue that learners who are self-motivated will stay on track during task completion and persevere in order to achieve their goals.

Motivational strategies for monitoring

Motivationally, a learner will determine if a task is holding his attention and personally, what his feeling towards the task is, his level of confidence to complete the task, and whether he is managing his time well (Ertmer & Newby, 1996:20; Finn & Metcalfe, 2013:19). According to Zimmerman (2008:175), motivational strategies are first and foremost a willingness to put an effort into the task at hand and to achieve the goal as planned. Bandura (1993:123) states that individuals compare their achievements to the successes of their peers and hold the reports from their teachers in esteem. Both have an influence on learners' self-esteem and thus influence their performance. If learners see others' performances surpass their own, it could have a negative influence on their self-efficacy, but if they see themselves mastering the performance it could enhance their self-efficacy and their performance (Finn & Metcalfe, 2013:19). Mood changes also have an influence on how people perceive their performance. If a person feels despondent during task completion, the events to reach a goal might be interpreted negatively. On the contrary, a positive mood will bring about a positive experience (Finn & Metcalfe, 2013:19).

Positive motivational strategies include well-developed self-efficacy and a willingness to put an effort into pursuing goals, which includes positive self-talk during task completion to reduce feelings of anxiety and helplessness (e.g. "I can do this") (Bandura, 1986:337; Bandura, 1993:123; Schunk, 2005b:87; Zimmerman, 2008:175).

Environmental strategies for monitoring

Zimmerman (2008:167) argues that environmentally, a self-regulated learner will determine whether his environment facilitates learning well enough or if he should add more materials or resources to be successful in achieving his goals. Learners who can manage their time and structure their study environments for maximum learning, are successful in their application of environmental strategies. Zimmerman (2008:167) states that when learners seek help from electronic sources, peers, parents, or teachers, they are increasing their chances of success, which also impacts favourably on their feelings and beliefs to be successful. Self-regulated learners will eliminate distractions and renegotiate task requirements with their teachers when they perceive a task as overwhelming (Zimmerman, 2008:168).

2.3.4.3 Evaluation

Evaluation occurs when the outcomes of the learning process and goal achievements are judged according to the desired expectations (Pintrich, 2000:460; Schraw, *et al.* 2006:114). Self-regulated learners will evaluate the process that was used to achieve goals and how effective they were in achieving the goals. Learners will determine if they should modify their behaviour and adjust the environment for completing similar tasks in future. During the evaluation stage, learners must also manage their emotions about the outcomes of their goals (Zumbrunn, *et al.* 2011:5). Upon judging their performance, learners may find that they scored lower than anticipated due to a decrease in motivation. This could contribute to making changes in their behaviour and include efforts to enhance their motivation in future (Ertmer & Newby, 1996:13; Schunk, 2005b:87).

Meta-cognitive strategies for evaluation

On completion of a task, learners need strategies to evaluate the outcomes of the learning process and establish whether they have achieved the goals, and complied with success criteria set at the outset of a learning task (Pintrich, 2000:456; Schraw, *et al*., 2006:115). Meta-cognitively, a learner will evaluate if a specific approach to task completion was successful, and if new strategies should be implemented to assist in more effective task completion. Ertmer and Newby (1996:5) state that self-regulated learners know what is important in terms of learning, and they are able to apply the right knowledge and action for their task to reach their objectives and goals (Marcou & Philippou, 2005:303-304). Ertmer and Newby (1996:5) concur that self-regulated learners can judge the difficulty of problems more successful than novices can, and that they can predict the outcomes of their performance more accurately. The self-regulated learner will set ranking goals for themselves and compare their progress to the goals that they have set (Schunk, 2005b:87). Identifying obstructions during the learning process, sensitises learners to make changes and remove the obstructions in order to improve future achievement (Schunk, 2005b:89). The aforementioned could include reflecting about whether study time was used effectively, or considering changes in environmental conditions for future study (Schunk, 2005a:175).

Motivational strategies for evaluation

Motivationally, a learner will evaluate the successfulness of his own efforts after completing a task, as well as how emotions, motivation and self-efficacy beliefs, possibly contributed to the success or failure of the outcomes of a task (Marcou & Philippou, 2005:303-304; Pintrich, cited by Schunk, (2005b:87). In the event of unsuccessful task completion, a self-regulated learner will be able to identify alternative, more effective strategies (*cf.* 2.3.3.1) for future task completion, and eliminate emotional and motivational stumbling blocks that impacted on self-efficacy beliefs, to increase the chances of future success (Marcou & Philippou, 2005:303, 304). Learners' motivational beliefs will lead to the actions they will take to evaluate their performance and reflect on the achievement of their goals.

Environmental strategies for evaluation

Self-regulated learners use strategies to plan their study time and reflect whether the time was used effectively. They will plan a suitable place for studying and have processes in place to monitor their progress and what changes are needed for better learning. Through monitoring their progress, they use the following strategies: They test themselves; question themselves; assess their understanding through conversation with their peers; and assess the process they followed and the product they have achieved (Ertmer & Newby, 1996:5; Schunk, 2005b:87). Learners will evaluate whether they managed their time well, selected a conducive study environment, and reflect on ways to change environmental conditions, if necessary, for future tasks (Pintrich, 2000:460; Schunk, 2005a:173). The self-evaluation process could lead to a greater personal understanding of what worked and did not work, and what should be changed to improve future performance (Finn & Metcalfe, 2013:20; Zimmerman, 2000:21).

2.3.4.4 The role of reflection in self-regulation

Ertmer and Newby (1996:14) found that reflection is essential for self-regulation and involves self-evaluation and judgements of the strategies used during planning, monitoring and evaluation. (Pintrich 2000:461; Schunk, 2005a:173). Reflection is a strong connector between one's thoughts and actions. Through reflection, knowledge is gained about the task, the self, and strategies used during planning, monitoring, and evaluating (Paris & Paris, 2001:89; Zimmerman, 2000:14).

The process of reflection can focus on present or past action, and self-regulated learners use both. Reflection on past action involves the evaluation of the self-regulating skills that were used after completion of a task, and reflection in action refers to reflecting on self-regulating skills used while completing the task (Ertmer & Newby, 1996:16). Learners need to draw conclusions from past experiences in order to change future approaches for completing tasks successfully (Paris & Paris, 2001:89).

Reflection also takes place in relation to goal achievement. In this regard, Pintrich (cited by Schunk, 2005b:88) distinguishes between performance goals and mastery goals. Performance goals refer to goals that are set to exceed one's peers in performance, and mastery goals focus on personally improving on acquiring knowledge, skills, and competence.

The subsequent section synthesises the link between meta-cognition, self-regulation, and self-regulated action.

2.4 SYNTHESISING THE LINK BETWEEN META-COGNITION, SELF-REGULATION, AND SELF-REGULATED LEARNING

According to Kaplan (2008:479), meta-cognition, self-regulation, and self-regulated learning collaboratively could be regarded as self-regulated action.

2.4.1 Self-regulated action

The literature review highlights that self-regulated action comprises three components; namely, the person *who* is doing the regulating action, the object (*what*) that is being regulated, and *how* the regulation is conducted. Each of the components is clarified below.

2.4.1.1 The "who" of self-regulated action

- *"Other-regulated"* versus *"self-regulated"* (Loyens, *et al.,* 2008:417-418). The self-generation of learning actions for successful learning is crucial.
- *"Controlled regulation"* versus *"autonomous or self-determined regulation"* (Ryan & Deci, 2000:68-70). Regulation can be performed to satisfy an external demand or because it is regarded as personally important.
- *"Co-regulation"* versus *"self-regulation"* (McCaslin, 2004:249). In this perspective, co-regulation in contrast to self-regulation implies that learning in collaboration with others will involve different motives and goals, which influences the learning situation.

2.4.1.2 The "what" of self-regulated action

The "what" of self-regulated action comprises the following components.

- **Cognition:** Strategies that a person will use to improve learning (*cf.* 2.3.3.1).
- **Emotion:** The motivational aspect of self-regulation, for example self-efficacy (*cf.* 2.3.3.2).
- **Behaviour:** Monitoring behaviour or action towards goal-achievement and making changes to be more proficient in the learning process (*cf*. 2.3.3.3).
- **Physical environment:** The organizing of the learning environment to maximise learning (*cf*. 2.3.2.4) (Maggioni & Parkinson, 2008:445-461) (*cf*. 2.3.3.3).

2.4.1.3 The "how" of self-regulated action

The "how" of self-regulation has to do with the planning, monitoring, and evaluation stages of the learning process (Kaplan, 2008:481).

- **Planning:** Planning involves setting clear goals and selecting strategies to achieve those goals (*cf.* 2.3.4.1).
- **Monitoring:** Monitoring ensures that progress is made towards attaining set goals (*cf.* 2.3.4.2).
- **Evaluation:** Evaluation refers to establishing the successfulness of attaining goals (*cf.* 2.3.4.3) (Kaplan, 2008:481).

Kaplan (2008:479) regards meta-cognition, self-regulation, and self-regulated learning as sub-types of self-regulated action, as summarised in Table 2.1.

Table 2.1: Self-regulated action (Kaplan, 2008:479)

Self-regulated action		
Meta-cognition	**Self-regulation**	**Self-regulated learning**
Involves self-awareness and regulatory action.	Involves self-awareness and regulatory action.	Involves self-awareness and regulatory action.
Includes activities for humans at all ages.	Includes activities for humans at all ages.	Includes activities for learners in academic contexts: school, home, extra-curricular, distance learning.
Focuses on an individual's cognition.	Focuses on behaviour which results from individual-environmental interaction.	Contextualises meta-cognition and self-regulation. Integrates individual cognition and behavioural regulation as a result of interacting with the environment.

Although the focus of the study is on skills to self-regulate learning, it is important to acknowledge that self-regulated learning, together with meta-cognition and self-regulation, forms part of self-regulated action (*cf.* 2.4). Meta-cognition emphasises the awareness and regulation of one's individual thought processes during self-regulated action. Self-regulation results from one's interaction with the environment, and self-regulated learning integrates one' thinking about the own thought processes (meta-cognition) with the regulation of one's interaction with the environment.

Given the explanation of self-regulation, self-regulated learning, and meta-cognition, the researcher synthesises her conceptualisation of self-regulated learning in the context of the study, in Figure 2.2.

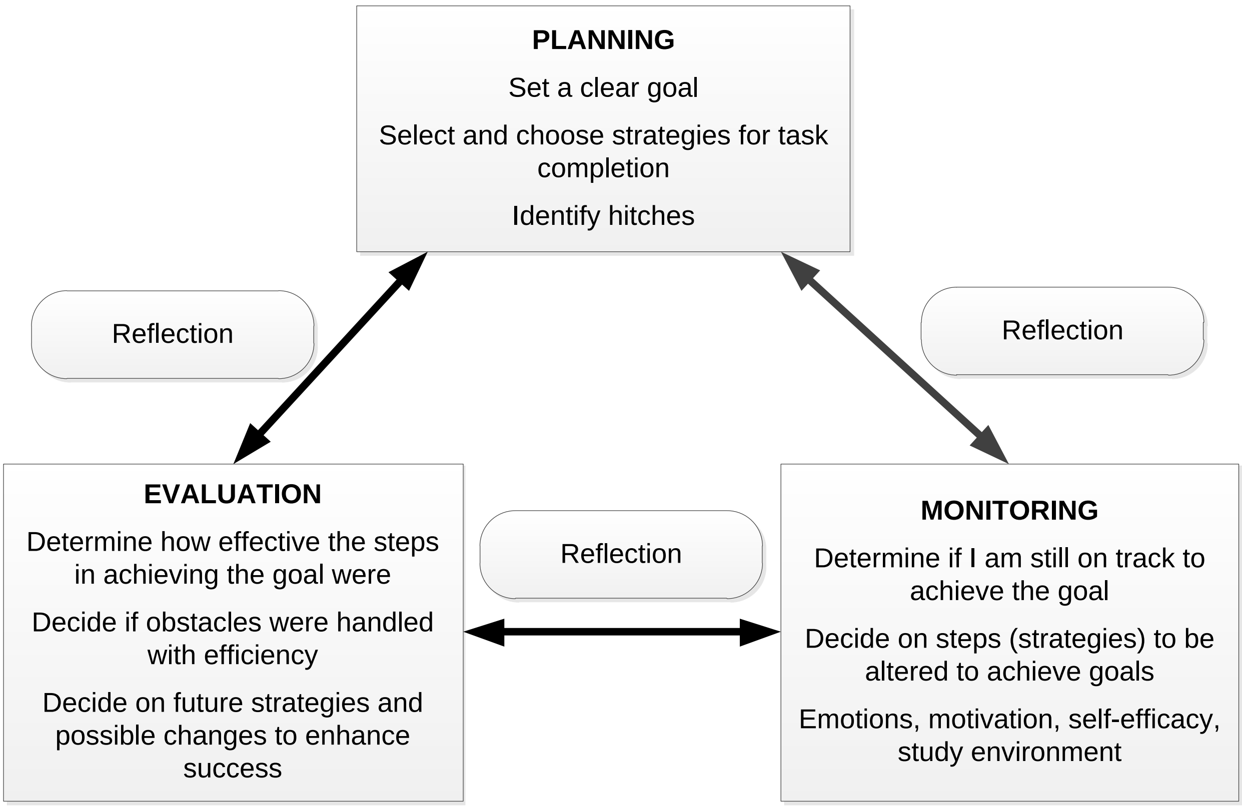


Figure 2.2: Conceptualisation of self-regulated learning in the context of the study

According to Figure 2.2, this study conceptualises self-regulated learning according to the framework of Pintrich (2000:451-502), who argues that self-regulated learning comprises three stages, where strategies are applied to facilitate distinct thought processes towards achieving goals during *planning, monitoring, evaluation.* These stages are interactive, and one may be simultaneously engaged in more than one of the phases.

Reflection that involves meta-cognition, serves as a link between planning, monitoring, and evaluation, in order to draw conclusions and make adjustments to strategies applied during learning to optimise the learning process (Bandura, 1991:248; Ertmer & Newby, 1996:10; Fosnot & Perry, 2005:34; Ocak & Yamaç, 2013:318; Pintrich, 2000:459; Schunk, 2005a:173; Zimmerman, 1986:308; Zimmerman, 2008:169).

During each of the stages, meta-cognitive, motivational, and environmental strategies are applied to regulate thinking and to make learning more effective and skilful (Bandura, 2015:1028; Dignath-Van Ewijk, *et al.* 2013:339; Ertmer & Newby, 1996:10, Karpicke, *et al.,* 2009:479; Pandero, *et al.,* 2017:75; Roth, *et al.,* 2016:227; Zimmerman, 1986:307; Zimmerman, 2008:169). Continuous adjustments are made to these strategies after feedback on performance has taken place (Bandura, 1991:248; Darr & Fisher, 2004; Ertmer & Newby, 1996:10; Pintrich, 2000:460; Schunk, 2005a:173; Zimmerman, 1986:307; Zimmerman, 2008:169).

In order to provide the rationale for a study that focuses on self-regulating skills in mathematics, the researcher had to take cognisance of the importance of developing self-regulating skills in mathematics.

2.5 THE IMPORTANCE OF SELF-REGULATED LEARNING IN MATHEMATICS

The CAPS (Department of Basic Education, 2012:11) describes mathematics as "*a language that makes use of symbols and notations for describing numerical, geometric, and graphical relationships. It is a human activity that involves observing, representing, and investigating patterns and qualitative relationships in physical and social phenomena and between mathematical objects themselves. It helps to develop mental processes that enhance logical and critical thinking, accuracy, and problem solving that will contribute in decision making*." According to the researcher, the aforementioned processes support self-regulated learning. Mathematical problem solving enables learners to understand the physical, social, and economic world around them, and, most of all, teaches them to think creatively (Mishra, 2008:18, 20).

2.5.1 The CAPS curriculum and teaching mathematics

The nature of mathematics as described according to the CAPS (Department of Basic Education, 2012:11), supports the development of learners who are self-regulated. In particular, the following aspects, underscore the importance of self-regulation in mathematics.

- Mathematics is a science that teaches logical reasoning, problem solving and contributes to meta-cognitive thinking.
- Mathematics develops mental processes that enhance critical thinking and accuracy.
- Mathematics helps self-evaluation.

Taking the aforementioned into consideration, the researcher argues that to be able to reason logically, solve problems, and make decisions in mathematics, the application of important thinking processes across the planning, monitoring and evaluation stages of learning is involved (*cf.* 2.3.4.1 - 2.3.4.4). In practical terms, learners will have to plan and make decisions about which strategies they want to use to achieve goals, monitor the application of the strategies they have chosen, and evaluate whether the chosen strategies enabled them to be successful in learning. The entire process involving decision making about strategies and reflecting about the suitability of strategies, involves self-evaluation and critical thinking, which is an important tenet of self-regulated learning (*cf.* 2.3.3.1).

The CAPS gives specific guidelines for teaching mathematics (Department of Basic Education, 2012:6). Among others, the following guidelines specifically point to the development of self-regulated learners.

- Learners should be encouraged to be active and critical participants in their learning process.
- Rote learning and uncritical learning should be avoided.
- High knowledge and high skills in mathematics should be achieved in each Grade.

The learners should *inter alia* be taught to:

- Identify and solve problems.

- Make decisions using critical and creative thinking.
- Work effectively on their own and in a team.
- Collect, analyse, organise, and critically evaluate information.

Although the CAPS curriculum does not provide explicit guidelines regarding the nurturing of self-regulation when teaching mathematics, the implied importance of developing self-regulated learning is evident from the aforementioned guidelines for teaching mathematics.

Learners should be equipped with skills and values so that they can participate effectively and meaningfully in the society, and rote learning and uncritical learning must be replaced by taking an active and critical role in their learning, thus implying that learners should become self-regulated in terms of monitoring their learning processes (*cf*. 2.3.4.2). Self-regulated learners are learners who will be able to solve problems, make decisions, and think creatively, and can work effectively on their own as well as in a group (*cf*. 2.3.3.1 - 2.3.3.4, 2.6.6, 2.6.7). In addition, self-regulated learners will able to collect, analyse, organise, and critically evaluate information in relation to their learning (*cf.* 2.3.3).

Although Ocak and Yamaç (2013:383) concluded that self-regulating skills predict high performance in mathematics, the research findings Van der Walt and Maree (2007:224) confirm that the development of self-regulation does not form part of the South African school curriculum. The researcher therefore finds it reasonable to argue that a lack of self-regulating skills could contribute to the poor performance in mathematics in South African classrooms, and that ways to promote self-regulation in mathematics classrooms needs to be explored in more depth.

2.5.2 The mathematics enrichment programme at the AMSC

2.5.2.1 Background: Purpose and time frames

AMSC opened in September 2006 to provide a high-standard outreach programme and enrichment training for both learners and teachers in the Sedibeng West district of the Department of Basic Education. The programme specifically aims at taking the subjects mathematics and science to new levels in secondary schools. At AMSC learners are supported in selecting careers like engineering, with the aim to provide pipeline engineers to ArcelorMittal South Africa. Learners receive one hour per week mathematics enrichment training, in addition to their normal mathematics period on the time table. Due to safety reasons, learners stayed at their respective schools during 2017, and the AMSC lecturers presented the enrichment training at the schools.

2.5.2.2 Content focus

The outcomes of the enrichment training at AMSC are to improve the performance of Grade 10, 11, and 12 learners in Mathematics, Science, Life Sciences, and English. With this in mind, an annual teaching plan (ATP) is also used to assist the school teachers. The teachers of the learners involved in the enrichment programme at AMSC, may submit special requests for assistance in certain topics.

The Grade 10 mathematics curriculum that is also covered at the AMSC, extends what is done at school, and focuses on the following content areas, namely: Algebraic expressions, Exponents, Number Patterns, Equations and Inequalities, Trigonometry, Functions, Euclidean Geometry, Analytical Geometry, Finance, Growth and Decay, Statistics, 2D Trigonometry, Measurement and Probability (Department of Basic Education, 2017). As problem solving stands central to all the content areas in the mathematics curriculum, well-developed self-regulating skills are of particular importance for the learners to be effective in problem solving (Ocak & Yamaç, 2013:381).

2.5.2.3 Teaching approach

The teaching approach at AMSC moves away from talk and traditional chalk board methods to actively using technology in the classes, such as the programme: Youcandomaths (YCDM). Yet, the learners are not exposed to explicitly acquiring self-regulation strategies that will enable them to become more skilled in self-regulated learning.

As the researcher explored during the interviews ways in which the teachers of the research participants nurture self-regulation at school, it was important to gather information about how self-regulation could be effectively nurtured in the mathematics classroom from the literature, against which the classroom practises of the teachers could be compared.

2.6 PROMOTING SELF-REGULATION IN THE MATHEMATICS CLASSROOM

According to Paris and Paris (2001:91) and Zumbrunn, *et al.* (2011:11), self-regulated learning is nurtured mainly in the following ways:

- indirectly through experiences at school; and
- directly through explicit instruction

Moreover, teaching practises, such as direct instruction and modelling, guided and independent practise, social support and feedback, reflective practise and collaborative learning (Paris & Paris, 2001:91; Zumbrunn, *et al.,* 2011:11-16), provide opportunities for enhancing self-regulated learning. Classrooms where teaching is learner-centered, project-based, or problem-based, and inquiry-driven tend to influence learners' intrinsic motivation which will promote self-regulated learning (Paris & Paris, 2001:93, 94). In addition, open-ended tasks that do not require fixed answers and cultivate a sense of engagement are ideal to foster self-regulated learning (Paris & Paris, 2001:94).

Given the aforementioned, promoting the development of self-regulating skills in mathematics will be viewed against the background of two theories of learning, namely cognitivism (*cf*. 2.2.2) and constructivism (*cf*. 2.2.3). A behaviourist approach (*cf*. 2.2.1) that relies on direct teaching of information should not be totally rejected in the mathematics classroom. Basic knowledge, skills, and rules should be mastered in mathematics; and a behaviourist, direct approach to teaching has a place when new knowledge, skills, and rules are introduced. However, advanced learning that aims to develop self-regulating skills, requires the application of cognitive and constructivist approaches to teaching and learning (Klinger, 2009:156).

2.6.1 Developing self-regulating skills in the mathematics classroom: A cognitive and constructivist approach to teaching and learning

A cognitive approach focuses on what learners know and how they acquire knowledge, and less on abstract concepts and procedures (De Corte, *et al.,* 2000:687). The cognitive approach focuses on equipping learners with skills to become effective at executing activities such as, reasoning, discovery of information, problem solving, planning, and goal-setting during learning (Ertmer & Newby, 2013a:51, 52, Zhou & Brown, 2014). Teachers need to model and verbalise the application of self-regulation learning strategies to learners to enable them to become skilled at the aforementioned activities (Peeters, *et al.,* 2014:1966; Schraw, *et al.*, 2006:115).

Darr and Fisher (2004) argue that self-regulation is promoted when learners interact with mathematical ideas in a constructive way. The constructivist approach to teaching mathematics therefore argues for the use of real-world scenarios when teaching mathematics. The learners need to be actively involved in building their understanding. The teacher should provide opportunities for learners to explore, discover, and apply their ideas in the classroom. The teacher will act as facilitator (Klinger, 2009:157) and knowledge acquisition advances from teacher to learner, learner to learner, and even from learner to teacher (Prideaux, 2007:10). The constructivists believe that the classroom environment is very important, and that the atmosphere in the classroom must be filled with joy, motivation, engagement, creativity, and attention. Not only is the atmosphere in the classroom important, but also the organisation and arrangement of the classroom. The classroom should be arranged in such a way that group discussions can take place, through which learners are encouraged to take ownership of their learning (Prideaux, 2007:11).

2.6.2 Teaching self-regulation through direct instruction and modelling

Zumbrunn, *et al.* (2011:14) describe direct instruction as explaining in detail, without any room for doubt or confusion. Although direct instruction does not enhance self-regulated learning, it is necessary for some learners, especially younger learners, who still need to learn self-regulated learning strategies. Through direct instruction, the teacher can demonstrate and model self-regulated learning strategies (Schraw, *et al.,* 2006:115; Zumbrunn, *et al.* 2011:14). According to Zimmerman (2000:29), the development of self-regulating skills takes place according to four levels, as explained below.

- Level 1: Learners observe the major features of a strategy from watching the teacher’s model.
- Level 2: Observation of the strategy needs to be followed by the learner imitating the application of the strategy I with assistance.

- Level 3: Learners need to receive an opportunity to independently practise the application of the strategy under structured conditions (*cf.* 2.6.3).
- Level 4: Learners can apply the self-regulating strategies across different contexts with ease and without assistance.

Teachers should model learning strategies by thinking aloud. When learners then set out to work on their own with the strategy, they will know the expectations and requirements for applying the learning strategy (Sabornie & de Bettencourt, 2009:56). Learners can also learn strategies intentionally from observing their peers modelling solutions to problems; this particularly increases their self-efficacy when learners and their peers have similar aptitudes and abilities.

Teachers' epistemological beliefs influence the development of self-regulation strategies (Barnard, *et al.,* 2008:261; Klieme & Vieluf, 2009: 89), for example, the promotion of self-regulated learning may be ineffective if the teacher's beliefs about the acquisition of knowledge do not regard learner autonomy during learning as important (Vieluf & Klieme, 2011:297).

2.6.3 Teaching self-regulation through guided and independent practise

Zumbrunn, *et al*. (2011:14) describe that during guided practise, the teacher carefully observes how the learner solves a problem and offers help when needed. During guided practise, learners are responsible to implement learning strategies. Guided practise increases the development of self-regulating skills and encourages independent learning.

Independent practise will automatically flow after guided practise when a mathematics exercise is done. The learners have an opportunity to become skilled and practise the application of self-regulation strategies independently (Zumbrunn, *et al.,* 2011:15). Mathematics is a subject that lends itself to many opportunities to apply self-regulation strategies independently through class exercises and homework.

2.6.4 Teaching self-regulation through social support and feedback

Ryan and Kaplan (cited by Zumbrunn, *et al.* 2011:16) state that social support from peers and teachers form an important part in enhancing self-regulated learning. When the learners receive support from their teachers and peers, their academic achievement improves, and they become more motivated. Social support comes in the form of feedback when the teacher and peers state what was done well, what needs improvement, and which steps could be employed to improve work (Zumbrunn, *et al.* 2011:16). Labuhn, *et al.* (cited by Zumbrunn *et al.* 2011:16) examined the effect of feedback on mathematics and found that feedback from teachers enhances the use of self-regulation strategies and increases mathematics achievement amongst learners.

2.6.5 Teaching self-regulation through reflection

Ertmer and Newby (1996:19) concur that learners do not acquire self-regulating skills by listening to a teacher. The skills rather become a habit through explicit instruction, questioning, and practise. The teacher must make time for practising the application of self-regulating skills during class-time, guiding the learners, and giving feedback until learners become comfortable with the process and begin to reap the benefits thereof (Ertmer & Newby, 1996:19).

Ertmer & Newby (1996:14) state that reflection can give information about the outcomes and the effectiveness of a learner’s chosen strategies to complete a task, enhance learners’ meta-cognitive knowledge, and encourage them to evaluate themselves and their strategies during the planning, monitoring, and evaluation of learning.

Questions can be used as a strategy to prompt learners to become skilled at reflecting on their learning (Kistner, *et al.* 2015:176). Table 2.2 provides examples of questions that could prompt reflection during learning about the application of meta-cognitive, motivational, and environmental strategies during the stages of learning.

Table 2.2: Questions to prompt self-regulation

PLANNING		
Meta-cognitive strategies	**Motivational strategies**	**Environmental strategies**
What is the goal of the task? What strategies would be most effective for this task? What do I know about this task? What useful skills do I have?	How do I feel about this kind of task? Do I like this kind of work? Does the task demand a lot of concentration and effort?	When and where do I study/ work best? Do I have sufficient time to study/do this task? What kind of study conditions will I need to complete this task?
MONITORING		
Meta-cognitive strategies	**Motivational strategies**	**Environmental strategies**
Are the strategies I have chosen to work with on this task, the correct strategies? Do I understand what I am doing? Am I making progress towards achieving the goal?	How am I feeling as I work on the task? What is my level of confidence? Is the task interesting and holding my attention?	Am I giving myself the time I need? Is the environment in which I am working conducive, or do I need to find another place? Do I need to add outside resources to help me complete the task?
EVALUATION		
Meta-cognitive strategies	**Motivational strategies**	**Environmental strategies**
How well did my approach work with this task? What did I do when the strategies did not work? Did I achieve the goal? What new goals do I have after completing the task? How could I improve the approach that I used to complete the task?	How much effort was required to do this task? Did I remain motivated throughout the completion of the task? How am I feeling about the outcome of the task?	How well did I organise my study environment? What could I have changed? Did I choose a good time and place to study? What obstacles did I encounter during the completion of the task, and how did I deal with those obstacles?

(Adapted from Ertmer & Newby, 1996:20)

Teachers can promote reflection by making time for learners to reflect in class on the tasks they perform. According to the researcher, reflection can become a habit if it is regularly used.

2.6.6 Collaborative/cooperative learning

Collaborative or cooperative learning requires learners to work together in small groups towards achieving a common goal, emphasising the social construction of knowledge, and collaboration throughout the entire learning process (Hatami, 2015:2164). Collaborative/cooperative learning implies that learners are responsible for their own learning and understanding, and the learning and understanding of their group mates. Learners need to brainstorm together about different ways to complete tasks successfully, which requires learners to have a high degree of self-regulation, and the application of self-assessment/evaluation strategies (Johnson, *et al.,* 1998:15; Johnson, *et al.,* 2014:90). Research conducted by Hatami (2015:2166-2167) revealed that cooperative learning, and learners being involved in self-assessment have a positive impact on self-motivated learning strategies and academic achievement.

During collaborative learning, group members need to reflect on how well they are achieving their goals and maintain effective working relationships among group members. The teacher monitors the group activities and provides feedback on how well the groups are progressing towards achieving the goals. Group members' involvement in processing information and reflection upon their actions will allow for the development of self-regulating skills.

2.6.7 Problem-based learning

Ram, *et al*. (2007) indicate that problem-based learning is based on constructivist learning theory, and learners establish and develop critical thinking and problem solving skills by solving real-world problems in small groups. The teacher has to ensure that learners make satisfactory progress towards articulating the problem, pinpointing what they need to learn in order for them to understand the problem, and deal with solving the problem, all of which plays a role in enhancing the development of self-regulating skills.

Throughout the problem solving process, self-regulating skills are directly implemented (Vula, *et al.,* 2017:56). Expert problem solvers analyse problems, plan how to approach the solving of a problem, and reflect on the viability of their problem solving strategies. The novice problem solver that does not possess well-developed self-regulating skills, will try a hit-and-miss approach (Darr & Fisher, 2004).

Flemming (2014) and Shinde and Kolmos (2011) indicate that problem-based learning fosters self-regulation, increases learner involvement, and promotes self-motivation and self-responsibility during learning. Problem-based learning assists learners to become reflective and assess their own and others' work, which fosters independence, curiosity, and skills for self-directed, life-long learning.

2.6.8 Opportunities to apply general processes to develop self-regulation in mathematics

Darr and Fisher (2004) stress the importance of a classroom environment that recognises self-regulated learning as critical to nurturing the types of thinking and behaviour that support self-regulation, particularly in the mathematics classroom. Teachers must make the mathematics class more interesting in order to improve learners' self-efficacy and achievement in Mathematics (Boekaerts, 1996:100; Tella, 2011:430).

Boekaerts (1996:101) and De Corte, *et al.,* (2000:695) state that successful teaching no longer refers to achieving high results in examinations or transferring information to learners to memorise. To be successful in learning, learners must be prepared to be less dependent on their teachers. Learners must be equipped with strategies to develop self-regulating skills that would enable them to become responsible for their own learning during formal schooling, and to independently update their knowledge after school. Self-regulated learning makes learners independent of their teachers (Boekaerts, 1996:101). In the mathematics class, the teacher should create opportunities and support learners to be actively involved in their learning (Blair, *et al.,* 2015:459). Teachers can, for example, ask learners to describe the method they use for solving a problem, which will give learners an opportunity to reflect on their problem solving strategies (De Corte, *et al.,* 2000:695).

Teachers should explicitly teach and model the following processes to learners that will facilitate the development of self-regulating skills (Darr & Fisher, 2004; De Corte, *et al.,* 2000:692; Kramarski, *et al.,* 2013:2; Mason, 2013:124-125; Montague, 2008:37-39):

- Goal setting: Learners need to be encouraged to set a long-term goal that they wish to achieve. In addition, setting short-term goals will help them to see if they are still on track (Pajares, 2008:111; Zumbrunn, *et al.*, 2011:10).
- Planning: Learners should be encouraged to plan before participating in a learning task. Planning involves setting a goal for the task, identifying strategies for achieving the goal and determining the time frame and resources to achieve the goal (Pajares, 2008:112; Zumbrunn, *et al.,* 2011:10). Before a learner solves a problem, the teacher should give the class guidelines and strategies on how to solve the problems and to achieve goals, suggest activities to reach the goals, and set time restrictions within which goals should be achieved. When the learners internalise the guidelines and strategies provided by the teacher, they will be able to access them and assess their progress. The result of this process is that learners will become aware of their own behaviour and the teacher will become aware of problems in learners' thinking or skills that can be subsequently addressed by the teacher (Du Toit & Kotze, 2009:58). When the learners are trained to use the internalised strategies, their problem solving skills will improve, and they will be more competent to operate on a meta-cognitive level (Du Toit & Kotze, 2009:60).
- Learners should be encouraged to rehearse self-regulating strategies verbally before applying them. Self-recording cards, cue cards, or prompt sheets could be used to remind learners of the questions they need to use to self-regulate their actions (Mason, 2013:141; Montague, 2008:42). Learners need to self-regulate aloud until they have become comfortable with the process and complete their work accurately (Montague, 2008:42). Cues and prompts can be reduced when learners have become acquainted with self-regulation processes.
- Discussion during problem solving: One of Vygotsky's main developmental theories is that learners must discuss how to solve a problem using language. This will help them to restructure their perceptions in terms of the achievement of their goals. It will also help them to monitor if they are on the right track to achieve their goals or whether they need to divert their strategies (cited by Du Toit & Kotze, 2009:61).
- Opportunities for enhancing self-motivation: When a learner receives opportunities to use self-regulation strategies independently to remain on track towards achieving a

goal, it assumes he is taking control over his own learning and his intrinsic motivation is developed, which is an important factor for self-regulation (Pajares, 2008:112; Zumbrunn, *et al.,* 2011:10). Learners should also see the value of learning tasks in order for them to spend time setting goals and to complete tasks (Pajares, 2008:112).

- Attention control: Learners need to be supported to control their attention in order to self-regulate. This process requires clearing of the mind and seeking a learning-friendly environment (Pajares, 2008:111; Zumbrunn, *et al.,* 2011:11).
- Self-monitoring and self-assessment: Learners need to take on the responsibility of monitoring and assessing their progress towards achieving their goals as an indication that they are self-regulated learners (Pandero, *et al.,* 2017:76; Roth, *et al.,* 2016: 229; Zumbrunn, *et al.,* 2011:12). According to Ertmer and Newby (1996:12), self-monitoring is a complex process. This is because while one is busy with a task, the place of self-monitoring must be understood and how it fits in, in order to plan what should be done next. Throughout doing their tasks, self-regulated learners monitor what they are doing and conclude whether they are making progress towards achieving their goals. They must monitor if the steps they are taking are correct or whether changes should be made. Ertmer and Newby (1996:13) suggest strategies that can be used when monitoring work, namely, visualising the performance and the effect of the performance, asking questions to oneself such as: Did I put enough effort into my work? Was my concentration enough? Was the environment conducive for studying? Some learners may also use peer checking, self-testing, and seeking a teacher's help or help from others (Zumbrunn, *et al*., 2011:12).
- Help-seeking: Help-seeking in order to complete a task should be encouraged among learners. What distinguishes self-regulated learners from others is that they are willing to seek help from others to achieve the goal of becoming more independent in their learning (Zumbrunn, *et al.,* 2011:12).
- Self-evaluation: When learners can independently evaluate the effectiveness of their own learning strategies, and make adjustments for similar tasks in future, they are more likely to become self-regulated learners (Pajares, 2008:112; Zumbrunn, *et al.,* 2011:12). Learners who self-regulate, assess either the product or goal they achieved, and the process they followed. The learners could be encouraged to use

a portfolio or a written report that determines the following: The extent to which their goals were achieved, how successful their overall learning process was, if their supporting steps were effective in reaching their goal, how well they handled the obstacles they encountered, and how effective and efficient their plans were, as well as what must be modified, if necessary, for similar tasks in future (Ertmer & Newby, 1996:13; Montague, 2008:37).

Several researchers have suggested guidelines to teach self-regulation strategies to learners (Hattie & Donoghue, 2016; Sabornie & de Bettencourt, 2009:56). In summary the steps involve the following actions:

- Teachers should determine the most efficient learning strategy to complete a task, explicitly explain the strategy to the learners and explain to them why and when this strategy would be the most effective. For this purpose, direct instruction and numerous opportunities for intensive application and practise are required, as teachers should not assume that learners will discover self-regulated learning strategies themselves and become skilled in their application automatically (Braun, *et al.,* 2012:565; Ylvisaker, 2006). Learners need to become self-directed; able to choose appropriate strategies for specific learning tasks themselves that align with their learning preferences.
- Learners need opportunities to practise the application of self-regulation strategies with different tasks, to enable them to identify contexts in which the strategies work well/do not work well. In addition, having class discussions about the benefits of using a certain self-regulation strategy, will emphasise its importance and possibly promote motivation for the application of the strategy in future. Self-regulation strategies should be purposively acquired. For this purpose, Ylvisaker (2006) suggests that self-regulation strategies should have a strategic use, and learners should not only acquire a number of strategies without having clarity on their strategic use.
- Learners should also be exposed to opportunities where they attempt to complete a learning task with self-regulation strategies, as well as opportunities where they attempt to complete a learning task without the use of self-regulation strategies. Learners need to evaluate their performance in both situations, and reflect on the advantages/disadvantages of using/not using a self-regulation strategy.

- Hattie and Donoghue (2016) contend that learners must be informed about the success criteria they have to comply with when completing tasks. When learners are informed about what they have to achieve, strategic, goal directed behaviour is enhanced and greater willingness to invest effort in being successful displayed.
- For the effective application of self-regulation strategies, they need to be embedded in subject content, and not in training sessions out of subject content (Hattie & Donoghue, 2016). However, Hessels-Schlatter *et al.* (2017:113), argue that self-regulation strategies are also effectively taught in a context unrelated to the curriculum, such as with games, after which the strategies are transferred to a curriculum-related context.
- Hattie and Donoghue (2016) assert that teachers should allow learners to compare similarities and differences between task expectations, so that they can determine whether self-regulation strategies that were previously applied, would be suitable for the completion of new learning tasks. Learners have to be made aware that a self-regulation strategy that worked previously, might not work in a new and different context.

In this study, the researcher inter alia explored whether, or not, and how the above-mentioned processes are encouraged during the teaching of mathematics in the classrooms of the learners who took part in the research.

The next section deals with dysfunctions and challenges in relation to the developing of self-regulating skills.

2.7 DYSFUNCTIONS AND CHALLENGES IN RELATION TO DEVELOPING SELF-REGULATING SKILLS

2.7.1 Dysfunctions in developing self-regulation

Dysfunctions in self-regulation are linked to poor planning, monitoring, and control strategies. Poor self-regulation is therefore often characterised by efforts to correct poor outcomes only after task completion, that could lead to a loss of self-efficacy and a decline in motivation and interest (Zimmerman, 2000:27). In addition, Zimmerman (2000:27) argues that low self-regulation contributes to poor academic achievement, poor regulation of health that can lead to health problems and poor quality of life; and poor regulation of behaviour and impulse control that can lead to aggressiveness and dangerous behaviours involving alcohol, drug abuse, and crime.

Zimmerman (2000:27) highlighted a number of experiences or inherited personal limitations that could lead to poor self-regulation. A lack of social learning experiences is a main cause of self-regulation dysfunctions. If self-regulation is not modelled, taught and rewarded, in particular by parents, the development of self-regulation is compromised. Similarly, in the presence of a lack of interest, poor concentration, and mediocre efforts, self-reflection could be undermined. Furthermore, Zimmerman (2000:27) indicates that disorders such as depression can cause dysfunctions in self-regulation, and lead to negativity and misperceptions about performance. Learning disabilities such as a low concentration span, trouble with memory recall, reading, or writing can contribute to poor self-regulation. Learners experiencing the aforementioned problems set lower academic goals for themselves, find it difficult to regulate their impulses, and do not assess their abilities accurately.

De Corte, *et al.* (2000:692) state that self-regulation is an important component in mathematics; however, research results indicate a substantial weakness in many mathematics learners. Self-regulating skills are totally lacking in problem solving. The typical strategy used by the learners to solve mathematical problems is to read the problem, quickly decide to follow a certain approach and stick to it. Learners hardly ever consider alternative approaches, which results in no progress being made (De Corte, *et al.,* 2000:694).

Self-regulation strategies to plan, monitor, evaluate and reflect are not applied by the majority of mathematics learners when solving mathematical problems (De Corte, *et al.,* 2000:695). According to Khul (cited by De Corte, *et al.,* 2000:696), developing strategies to control the environment in relation to time control and attention control also need attention, since learners do not apply them.

DaSilva-Marini & Boruchovitch (2014:327) state that the application of self-regulating skills is directly correlated to intrinsic motivation. People who are intrinsically motivated use self-regulation strategies effectively compared to those who are extrinsically motivated and rely on the opinions of others. Too often, learners are stuck with a problem and feel frustrated and disappointed, which results in quitting or stubbornly continuing in the same way and not achieving success (De Corte, *et al.,* 2000:697; DaSilva-Marini & Boruchovitch, 2014:324).

Learners' beliefs about mathematics also have an influence on their self-regulation. Currently learners appear to hold simple and false beliefs about learning mathematics and problem solving. Learners believe that mathematics is a fixed body of received knowledge. These beliefs are acquired through years of listening, watching, and practising in the mathematics classroom (De Corte, *et al.,* 2000:699). Learners also believe mathematics only applies to the classroom problem questions and not in everyday life. This observation raises the importance of designing an environment that is conducive to the development of self-regulating skills (De Corte, *et al.,* 2000:701).

2.7.2 Challenges in developing self-regulating skills

Teachers and learners experience challenges in promoting the development of self-regulating skills. Teacher training seems to be inadequate and does not teach potential teachers how to apply self-regulation strategies, or how to train learners to become self-regulated learners (DaSilva- Marini & Boruchovitch, 2014:328). The challenges that teachers experience in relation to developing learners' skills to self-regulate learning are:

- To prepare lessons to engage learners in acquiring self-regulation strategies and supporting learners to become self-regulated learners (Paris & Winograd, cited by Zumbrunn, *et al.,* 2011:17).
- Time allocation for teaching learners self-regulating skills is also a major challenge, as teachers are pressured to complete the curriculum content in limited time, which leads them to neglect the development of self-regulating skills (Zumbrunn, *et al.,* 2011:17).
- Assessment tasks do not currently support problem solving or preparing learners to be self-regulated (Zumbrunn, *et al.,* 2011:17).
- Teaching environments need to be more adaptive, and cater for learner differences that will allow learners to make individual choices, and increase the chances of becoming self-regulated (Jossberger, *et al*., 2010:24).

- Feedback has been identified as having a powerful influence on learning, but often only focuses on the academic content. Teacher feedback should focus on the learning process, teaching learners how to learn, setting learning goals, choosing the correct learning strategies, and monitoring and evaluating learning through appropriate communication between learners and teachers (Jossberger, *et al.,* 2010:27, 28).
- Research conducted by Van der Walt and Maree (2007:235) revealed that although mathematics teachers support the use of question-posing strategies and think-aloud models to encourage self-regulation, they do not create sufficient opportunities for learners to practise self-regulation procedures. Dignath-Van Ewijk, *et al*. (2013:339) and Spruce and Bol (2015:247) also confirm that teachers do not teach learners how to apply the strategies which play an important role in self-regulation. In addition, although teachers use problem solving strategies during teaching, the phases of self-regulation whilst solving problems (i.e., planning, monitoring, evaluation) are not purposively mentioned. According to Schoenfeld (1985:28), if the phases of self-regulation are not facilitated during problem solving, achievement will be poor. Learners will therefore possess content knowledge in mathematics, but will not know how to plan, monitor, and evaluate their behaviour when involved in task completion (Van der Walt & Maree, 2007:236). According to De Boer, *et al.* (2012:507) and Donker, *et al.* (2014:2), learners will do not spontaneously develop the skills to self-regulate their learning; these need to be taught.
- Cleary and Chen (cited by Zumbrunn, *et al.,* 2011:17) also identified challenges that are outside the control of the teacher. The learners' social identity can pose a major challenge when, socially, they feel it is inappropriate to achieve good grades. This will influence their involvement in becoming self-regulated, and they may choose to ignore certain strategies in completing their homework efficiently. Learners who are intellectually curious are more prone to engage in self-regulation.
- Some of the challenges in South-African schools that could negatively affect the creation of sufficient opportunities for developing self-regulating skills refer to teacher absenteeism, classroom discipline, teacher performance, and time pressures to complete the curriculum. Teacher absenteeism, teachers returning to class late after break time, as well as discipline problems are serious matters that hamper effective

lesson presentations (Govender, 2016) and, according to the researcher, compromise the time during which self-regulating skills can be taught. Teacher performance is also a major problem in South-African schools. Teachers who find certain topics to be difficult lack motivation to teach these topics. They will avoid teaching those parts in the curriculum and, instead, will find ways to spend less time in their classroom (Chisholm, 2011:52). This results in learners not being given enough opportunities to develop the skills to become self-regulated (Van der Walt & Maree, 2007:236).

- Earlier research by Monteith (1998:126), identified constraints for the development of self-regulation in South African schools, specifically where there is a strong influence that drives an individual learner not to perform better than the group. This has a negative influence on setting and achieving personal goals.
- The number of learners in a class is arguably too large, and with that comes a wide range of learner ability, resulting in teachers using rote learning and learners taking a passive role during class time. Malan, *et al.* (2014:1) state that traditional rote learning encourages learners to be dependent on the teacher, leading to a superficial understanding of subject content where self-direction and self-reflection are not encouraged. The more diverse the learner population becomes, the broader the teaching and learning should become. Opportunities that support learners' self-regulated learning should be introduced.

2.8 CHAPTER SUMMARY

This chapter focused on a clarification of the concept self-regulation and its theoretical underpinnings.

Behaviourism seems to oppose self-regulation, as the learner is viewed as reactive and does not take a role in his/her learning (*cf*. 2.2.1). Cognitive teaching and learning theory provides stronger links with self-regulation, as cognitivists view learning as an active process where learners solve problems through reflection on immediate and past experiences, and then construct their own understanding (*cf.* 2.2.2). Constructivist teaching and learning theory supports the development of self-regulated learners, as learners are encouraged to use learning strategies that include reasoning, problem solving, mental planning, and goal setting which are involved in the process of self-regulation (*cf.* 2.2.3). Constructivists view learners as active participants in the learning process, who are responsible for constructing their own knowledge and solving problems while interacting with the environment (*cf*. 2.2.3). Socio-cognitive theory continues, by regarding people as self-organised, pro-active, self-reflecting, and self-regulated; thus, not simply products of their circumstances but also contributors to their circumstances (*cf.* 2.2.3).

The links that personality traits have with self-regulation were investigated (*cf.* 2.2.4). The perceptual control theory and the big five theory have strong positive links with self-regulation. Personality traits that link well with self-regulation include being organised and logical, perseverance, and self-discipline (*cf.* 2.2.4.1) The Big Five personality traits that align well with self-regulation are openness, conscientiousness, confidence, agreeableness, and emotional stability (*cf.* 2.2.4.2).

Self-regulated learning is an active process where learners become independent in regulating their learning by applying self-regulation strategies to become more skilled across the three stages of the learning process, namely planning, monitoring, and evaluation (*cf.* 2.3.1). Self-regulation strategies comprise cognitive, meta-cognitive, motivational, and environmental strategies (*cf.* 2.3.3.1 – 2.3.3.4). Cognitive strategies improve learning, as they enable a learner to become skilled at deciphering, memorising, and recalling information (*cf*. 2.3.3.1). Meta-cognitive strategies assist learners in identifying factors that influence one’s performance and guide a learner in regulating and maximising learning (*cf*. 2.3.3.2). Motivational strategies are linked to controlling emotions, levels of motivation and self-efficacy (one’s beliefs that one can learn and perform effectively) (*cf*. 2.3.3.3). Environmental strategies include the organizing of the learning or study environment, and securing resources to support successful learning or task completion (*cf*. 2.3.3.4).

Self-regulated learners apply self-regulation strategies during each of the phases of the learning process, namely during planning, monitoring, and evaluation (*cf.* 2.3.4). Planning is done before attempting the task by setting achievement goals and planning strategies to execute a task. While busy with the task, a person needs to monitor if he is still on track to achieve the set goals. Evaluation will take place when a task is complete to determine if goals were achieved and if modification of strategies will be needed for completing similar tasks in future. Reflection underpins the entire process of planning, monitoring, and evaluation (*cf.* 2.3.4.1 -2.3.4.4).

Self-regulated action involves three processes, namely meta-cognition, self-regulation, and self-regulated learning (*cf.* 2.4). Meta-cognition emphasises the awareness and regulation of one's individual thought processes throughout the learning process. Self-regulation results from one's interaction with the environment, and self-regulated learning integrates one' thinking about the own thought processes with the regulation of one's interaction with the environment.

The importance of self-regulation in the mathematics class was investigated in Section 2.5. It has been proven that learners who are self-regulated increase their academic achievement. The CAPS emphasise the reduction of rote learning, development of problem solving and critical thinking skills, working independently and with others; thus, supporting the development of self-regulating skills.

Promoting and developing self-regulating skills in the classroom were investigated. Strategies that the teacher can use to promote the development of self-regulating skills include among others, direct instruction and modelling (*cf*. 2.6.2), guided and independent practise (*cf*. 2.6.3), social support and feedback (*cf.* 2.6.4), reflection (*cf.* 2.6.5), cooperative learning (*cf.* 2.6.6), and problem-based learning (*cf.* 2.6.7)

Some factors that cause dysfunctions in self-regulation were identified, namely, a lack of social learning experiences and models of self-regulation, learners lacking interest, learners with poor concentration, and disorders such as depression, learning disabilities, as well as learners' beliefs about mathematics being a fixed body of knowledge that is only applicable within the classroom environment (*cf.* 2.7.1).

Challenges in developing self-regulation refer among others, to teacher training that does not equip teachers with knowledge on how to prepare lessons that engage learners in self-regulation, lack of time to teach self-regulation strategies due to curriculum demands and a lack of opportunity in the classroom for learners to practise self-regulating skills (*cf.* 2.7.2).

The next chapter, Chapter 3, explains the research methodology used in the context of this study.

CHAPTER 3
EMPIRICAL RESEARCH DESIGN

3.1 INTRODUCTION

Chapter 3 clarifies and motivates the methodological intent of the study, and explains how the research was conducted. The layout for the chapter is presented in the text box below.

3.2 RESEARCH PARADIGM

A research paradigm is defined by Nieuwenhuis (2008a:47) as a *"set of assumptions or beliefs about fundamental aspects of reality which give rise to a particular world-view."* In this regard, Creswell (2009:6) states that the beliefs of the researcher regarding the research phenomenon and the role of the research participants during the research will determine the type of research method chosen by the researcher, which could be qualitative, quantitative, or mixed method.

Before identifying a research paradigm for the present research, the researcher took cognisance of the following aspects that influence the choice of a research paradigm. The researcher indicates how she decided which paradigm should frame the research.

- A researcher can decide to approach research either objectively or subjectively, or by using a combination of both (Maree & Van der Westhuizen, 2008:31-32). In the context of this research, the researcher took the role of an objective spectator during the completion of the questionnaire. However, during the interviews, the researcher played a subjective role and became involved in constructing meaning together with the participants.
- It is possible for the participants to play a passive and active role during data collection (Maree & Van der Westhuizen, 2007:31-32). The participants who took part in the study, played a passive role when they completed the questionnaire about the development of their self-regulating skills. They merely responded to predetermined questions. Their interaction turned active during the interviews when they were allowed to construct meaning personally by voicing their opinions and perceptions on reasons for their self-regulating skills being well-developed/not well-developed.
- A researcher can decide to collect data numerically or verbally (Maree & Van der Westhuizen, 2007:31-32). In this research, the researcher collected numerical data about the perceptions of the participants regarding the development of their self-regulating skills. Qualitative, verbal data were also collected to explain the quantitative data, by exploring the reasons that possibly contribute to the participants' self-regulating skills being well-developed/not well-developed.
- Finally, the researcher collected data using both qualitative and quantitative approaches in order to obtain a deeper understanding of the development of self-regulating skills among Grade 10 mathematics learners, that could, in support of pragmatism, lead to practical solutions in relation to the development of self-regulating skills.

Given the aforementioned background, pragmatism could be regarded as a suitable research paradigm to frame the research. Creswell (2009:11) describes pragmatism as a method of research where both the quantitative and qualitative research methods are used, also called the mixed method. This method gives the researcher the freedom to use a combination of data collection instruments to gain a deeper understanding of the research phenomenon (Creswell, 2009:10, 11).

3.3 EMPIRICAL RESEARCH

3.3.1 The literature review

The literature review study consisted of explanations and definitions from a wide variety of sources explaining certain keywords and phrases which are applicable to the research, i.e., **self-regulated learning, self-efficacy, planning, monitoring, evaluation, reflection, self-regulation in mathematics, self-regulation strategies, self-regulating skills,** and **teaching strategies to develop self-regulation in the mathematics class.** Primary and secondary resources were acquired from EBSCOHOST and Google scholar.

3.3.2 Aims and objectives of the study

The main aim of the study was firstly, to describe how Grade 10 mathematics learners perceive the development of their self-regulating skills to be, and secondly, to explore the reasons for self-regulating skills to be well-developed or not well-developed.

The main aim was operationalised into the following objectives:

- To determine how self-regulating skills should be conceptualised by means of a literature review.
- To determine what contributes to the development of self-regulating skills by means of a literature review.
- To investigate why self-regulating skills are important for learning mathematics by means of a literature review.
- To determine the perceptions/opinions of Grade 10 mathematics learners about how well their self-regulating skills are developed by means of a questionnaire.

- To determine which self-regulating skills, appear to be the best developed among Grade 10 mathematics learners by means of a questionnaire.
- To establish if there is a relationship between biographical variables such as gender, repetition of Grade 10 and living conditions and the perceptions of Grade 10 learners in relation to how well their self-regulating skills are developed by means of empirical research.
- To explore the reasons for self-regulating skills to be well-developed or not well-developed among Grade 10 mathematics learners by means of face-to-face interviews.
- To make recommendations for enhancing the development of self-regulating skills among Grade 10 mathematics learners.

3.3.3 Hypotheses

As one of the research objectives envisaged to examine the impact of the biographical variables (independent variables) on the research participants' perceptions in relation to the development of their self-regulating skills (dependent variable), the researcher formulated the following null and alternative hypotheses.

Null hypotheses

- Ho^1 = There is no statistically significant relationship between gender and the perceptions of Grade 10 mathematics learners in relation to the development of their self-regulating skills.
- Ho^2 = There is no statistically significant relationship between the perceptions of mathematics learners who have repeated Grade 10 and those who did not repeat Grade 10, in relation to the development of their self-regulating skills.
- Ho^3 = There is no statistically significant relationship between the living conditions of Grade 10 mathematics learners and their perceptions in relation to the development of their self-regulating skills.

Alternative hypotheses

- *Ha*^{1} = There is a statistically significant relationship between gender and the perceptions of Grade 10 mathematics learners in relation to the development of their self-regulating skills.
- *Ha*^{2} = There is a statistically significant relationship between the perceptions of learners who have repeated Grade 10 and those who did not repeat Grade 10, in relation to the development of their self-regulating skills.
- Ha^3 = There is a statistically significant relationship between the living conditions of Grade 10 mathematics learners and their perceptions in relation to the development of their self-regulating skills.

The next section explains and motivates the research design that was employed in the context of the research.

3.4 RESEARCH DESIGN

The pragmatic framework influenced the choice of the research design, the research strategies, and the data collection methods as discussed below.

3.4.1 Sequential explanatory mixed method research design

A research design comprises a logical strategy to select information that will be judged as being credible to gather information to answer the research questions. It provides a framework for action to be taken to acquire reliable results. Three types of research designs are identified: Qualitative research, quantitative research, and mixed method research (Creswell, 2009:3; De Vos, 2003:391).

In line with the pragmatic paradigm, a sequential explanatory mixed method design, where data are collected in sequence, was chosen. Firstly, the quantitative data, which formed the primary set of data in the study, were collected, followed by the collection of the secondary, qualitative set of data. The qualitative data were used to explain the quantitative data; thus, the term, *explanatory* (Hearn, 2015:431; Ivankova, *et al.,* 2008:264).

The advantage of a sequential explanatory mixed method design is that the implementation is straightforward, and the results presented are easy to describe and to report. The disadvantages of this design are that the research can be very time consuming due to the two phases of data collection.

The advantages of the mixed method design according to Creswell (2009:212) are that all methods of data collection have limitations, but the use of multiple methods can limit the disadvantages. Unexpected results may follow the quantitative design method, that the qualitative design method can examine in more detail.

The data collection process used in the study is described in Figure 3.1.

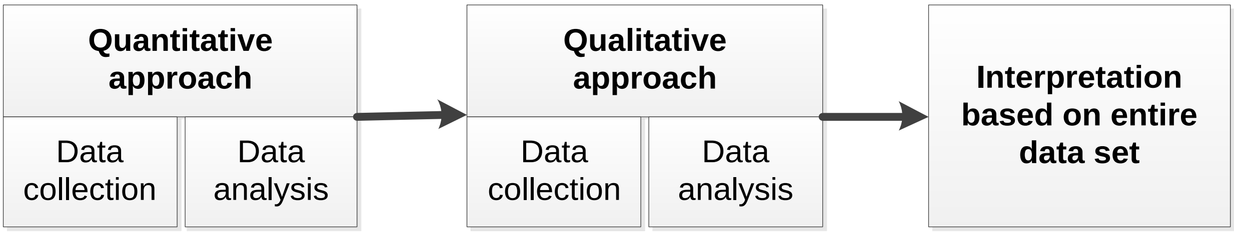


Figure 3.1: The sequential explanatory mixed method design

The qualitative approach elaborates on the quantitative data collection (which was done first). Both the quantitative and qualitative approaches are used to interpret the data (Hearn, 2015:435; Ivankova, *et al.,* 2008: 265).

3.4.2 Research strategy

A research strategy directs a researcher’s efforts to find the best answer to a research question (McMillan & Schumacher, 2014:18). The present research involved the use of quantitative and qualitative strategies of inquiry.

3.4.2.1 Quantitative strategy of inquiry

McMillan and Schumacher (2014:33) state that non-experimental approaches of inquiry describe something that has happened, or study relationships between things without any influence of situations that are experienced. They also mention that using a **descriptive strategy** of inquiry simply describes a current phenomenon by using numbers to portray individuals or a group (McMillan & Schumacher, 2014:30). McMillan and Schumacher (2014:25) maintain that a survey can be used to explore opinions, attitudes, and beliefs between different factors. Considering the above, the best fit for the quantitative strategy of inquiry used in this study was non-experimental descriptive survey research, because:

- The researcher used a questionnaire that examined the participants' perceptions about the development of their self-regulating skills.
- The participants' perceptions were described by using numbers.
- The research did not involve any manipulation of conditions.

3.4.2.2 Qualitative research strategy

For the qualitative nature of the research, a **phenomenological research strategy** was used. Fouché and Delport (2003:268) describe phenomenological research as an attempt to find people's perceptions and understanding of a specific situation. The researcher sets aside personal experiences and focuses on the participants' experiences. A phenomenological research strategy could be regarded as suitable for this research, as the researcher intended to explore the participants' reasons for their responses obtained with the questionnaire.

3.5 DATA COLLECTION METHODS

Due to the quantitative and qualitative nature of the study, different data collection methods were used. The quantitative data collection instrument, a researcher-constructed questionnaire, was administered first, and the qualitative data collection by means of semi-structured interviews, followed.

3.5.1 Quantitative data collection instrument: Questionnaire

A researcher-constructed questionnaire comprising closed questionnaire items (*cf.* Appendix G) was used; where the participants chose an applicable response to a questionnaire item from a given set of responses (Maree & Pietersen, 2007a:161). The responses of the participants, in relation to their perceptions about the development of their self-regulating skills, were measured using an ordinal, and descriptive, closed four-point Likert scale, namely: 1 = Novice, 2 = Able, 3 = Skilled and 4 = Expert; and 1 = Almost always, 2 = Often, 3 = Sometimes, 4 = Almost never, respectively. The Likert scale provided descriptive statements corresponding to the scale values, and the participants had to select the descriptive statement that was the best fit for their perception in relation to the development of their self-regulating skills (Maree & Pietersen, 2007a:167). Table 3.1 explains the descriptive Likert scales.

Table 3.1: Descriptive Likert scales

Scale	Description	Scale	Description
1 = Novice	Someone with no or little experience and knowledge	1 = Almost always	On a daily basis
2 = Able	Someone with limited experience and knowledge	2 = Often	Three to four times a week
3 = Skilled	Having experience and knowledge to do something well	3 = Sometimes	Twice a week
4 = Expert	Very experienced and knowledgeable	4 = Almost never	Once a week

Responses to the questionnaire items would indicate to the researcher if the participants experience problems with the application of strategies involved in self-regulated learning.

The questionnaire consisted of four sections that corresponded with the important aspects of self-regulation as identified in the literature, namely planning, monitoring, and evaluation. Although planning, monitoring and evaluation play an important role in securing a suitable study environment, the researcher decided to add a section that specifically focuses on the study environment, as learners tend to overlook the importance of having self-regulation strategies to secure an effective study environment, and focus on ensuring self-regulation strategies to master learning (Ramsey & Witter, 2010).

There were 19 questions in total, all apportioned between the four sections of the questionnaire. It did not take the participants longer than 30 minutes to complete the questionnaire (Maree & Pietersen, 2007a:159).

The research participants were each given a number that was used as identification of the questionnaire that they completed. This number was linked to the name of the learner on a class list, which would be used to select suitable participants for the qualitative study.

Maree and Pietersen (2007a:158-160) provide guidelines to consider when designing a questionnaire, which were adhered to by the researcher. The following aspects were considered in the design of the questionnaire, namely, the appearance of the questionnaire, instructions, completion time of the questionnaire, criteria for formulating questions, types of questions. In addition, the researcher familiarised herself with the advantages and disadvantages of questionnaires. These aspects are explained in more detail below.

Appearance of the questionnaire

The appearance of the questionnaire was made uncomplicated. The typing was done neatly, the font was easy to read and not too small. The layout was professional, and the instructions for completion and the purpose of learner participation clearly formulated.

Instructions

The instructions on the questionnaires were simple, clear, and concise to ensure ease of understanding (Maree & Pietersen, 2007a:159). During the completion of the questionnaire, the researcher also read the instructions to the participants and answered any queries they had about the questions.

Completion time of questionnaire

The time frame for completing a questionnaire should be less than 30 minutes for learners (Maree & Pietersen, 2007a:159). In this case, all the participants took between fifteen and twenty minutes to complete the questionnaire. Due to safety reasons, the researcher could not administer the questionnaire after school hours. The school principal assisted the researcher in scheduling a time slot on the time table that did not infringe upon teaching time in order for the researcher to administer the questionnaires during school hours.

Criteria considered for formulating questions (wording)

It is very important to use suitable language that all participants will understand, to avoid obtaining meaningless data (Maree & Pietersen 2007a:160). The questionnaire was translated into Sesotho to avoid, or at least reduce, any misunderstandings of the questions. Participants had an opportunity to choose whether they wanted to complete the English or Sesotho version of the questionnaire. Only four participants asked to complete the questionnaire in Sesotho.

The questions in the questionnaire were formulated in such a way that it probed participants' perceptions regarding the development of their self-regulating skills. These questions were structured logically into five sections, namely: Biographical information, planning, monitoring, evaluation, and study environment (*cf.* Appendix G1 & G2). The researcher ensured the correct wording of the questions so that the items were well understood. Some of the guidelines suggested by Cohen, *et al*. (2007:334) and Maree and Pietersen (2007a:160) were applied during the construction of the questionnaire items:

- Clear, explicit language was used.
- Plainspoken statements were formulated.
- Double-barrelled and vague statements were avoided.
- No sensitive questions, that could have offended participants, were included.

Types of questions

The types of questions that were asked in the questionnaire were closed-ended questions, as the researcher wished to obtain answers to specific questions. The questions were given as statements, and the participants were tasked to choose an answer without elaborating thereon. Closed-ended questions provide a set of responses from which a participant chooses one response (Maree & Pietersen, 2007a:160-166). The researcher acknowledges that the use of closed questions has advantages and disadvantages.

The advantages of closed questions are:

- It is easier for participants to understand the meaning of the questions.
- Responses can be compared with one another because questions are asked in the same format (Delport, 2008:165).
- Coding and statistical analysis of data are easy (Delport, 2008:165).

The disadvantages of closed questions are:

- The answer that the participant wants to give, might not be part of the options provided.
- If participants misunderstand questions, responses may become unreliable.
- If a participant lacks an opinion or knowledge, he/she may not answer a question.
- Answers are too simple and lack detail for the object of obtaining rich findings (Maree & Pietersen, 2007a:161).

The researcher is also aware of the following limitations and advantages of using questionnaires for research purposes (McMillan & Schumacher, 2006:211).

Limitations of questionnaires

- Questionnaires limit probing and clarification of answers. However, opportunities to probe and clarify answers were created during the interviews.
- It is impossible to determine if questions are misinterpreted. This could partially be solved through piloting the questions on a small group. Piloting was done before the actual research, and the outcome confirmed that the questionnaire was reliable.
- Participants may answer superficially. The interviews clarified any superficial answers obtained with the questionnaire.
- Return rates can be low if the researcher does not personally collect questionnaires distributed. The participants were present in a group and they completed the questionnaire simultaneously. The researcher collected the questionnaires personally, and 128 of the 130 questionnaire that were issued, were returned. Two participants decided to withdraw from the research.
- Participants may not be willing to answer questions, leading to missing data that could influence the reliability of the research findings. In the context of the research, all questions were answered, thus enhancing the reliability of the research findings

Advantages of questionnaires

- The responses are gathered objectively and anonymously, which limits researcher bias.

- It is generally a speedy process to collect and score information using a questionnaire.
- Questionnaires are effective to determine frequency and strength of attitudes, which augur well with the aim of this research.
- Participants have time to ponder upon their answers.
- Theoretically, information can be collected from a large group of participants.

3.5.2 Qualitative data collection method: Semi-structured interviews

According to Creswell (2009:175) and Flick (2014:2) qualitative data collection is done by examining documents, observing behaviour, or interviewing participants. The choice of the qualitative strategy of inquiry for this study was semi-structured, face-to-face interviews. Interviews are used to ask participants questions in order to learn about their experiences, beliefs, views, and opinions (Nieuwenhuis, 2008b:87). Face-to-face interviews have the advantage of creating a rapport with the participants, which allows the researcher to gain their trust and cooperation (Leedy & Ormrod, 2014:156). A disadvantage is that not all participants will be equally articulate (Creswell, 2009:179). Where necessary, the researcher repeated the questions using simpler language, without changing the meaning of the question. In addition, a decreased pace of speech was applied whenever repeating a question.

According to Nieuwenhuis (2008b:87), interviews can be open-ended interviews (also known as unstructured interviews), semi-structured interviews, and structured interviews. An unstructured interview is often a series of interviews in conversation form with the aim to explore a participant's views, ideas, beliefs, and attitudes about a phenomenon (Leedy & Ormrod, 2015:160; McMillan & Schumacher, 2014:381; Niewenhuis, 2008b:87).

When the researcher asks specific pre-determined questions without allowing follow-up probing, it is known as a structured interview (Leedy & Ormrod, 2015:160; McMillan & Schumacher, 2014:381; Niewenhuis, 2008b:87).

Semi-structured interviews give the researcher opportunity to probe for clarity on the person's understanding and perceptions, while following a pre-determined set of questions (Leedy & Ormrod, 2015:160; McMillan & Schumacher, 2014:381; Niewenhuis, 2008b:87). The researcher chose a semi-structured interview, to give the participants ample opportunity to share their ideas freely, while at the same time having structure to keep the interview in line with the focus of the questions. (Greeff, 2011:351; Leedy & Omrod, 2014:156; Nieuwenhuis, 2008b:87) (*cf*. Appendix H).

The interviews took 30 minutes for each participant and were tape-recorded. The aim of the interview was to follow up on the results found in the quantitative study. This was done to explain the findings that were derived from the questionnaire. Two schools that took part in the research were situated in Evaton and the other two in Boipatong in the Sedibeng West district. The researcher aimed to have an equal distribution of participants between the two areas. Four participants were chosen from each school, thus 16 participants in total. An equal number of male and female participants were chosen for the interviews. Also, the participants were chosen according to their questionnaire averages. The averages of the participants were grouped into two categories, namely average-strong and average-weak (*cf.* 4.7).

The interview questions were personalised according to the individual results of each participant for the quantitative data collection. The participants who partook in the interviews indicated to the researcher that they were comfortable with the interviews being conducted in English. The interviews were conducted at the participants' respective schools, at times arranged with the school principal that did not disrupt class time.

As a novice researcher who has limited experience with conducting interviews, the researcher acquainted herself with the interviewing skills as described in the following sections.

Conducting the interview

The most important thing is to identify and recruit suitable interviewees (Merriam, 2009:105), who will assist the researcher to answer the research question (Leedy & Ormrod, 2015:279). In the context of this study, the researcher recruited 16 Grade 10 mathematics learners who were willing to participate in the interviews. Leedy and Ormrod (2015:281) describe the importance of being objective during the data collection phase, as the researcher's impressions and interpretations may change during the study. The researcher remained objective during the interviews (*cf*. 3.7.3).

The interviews were tape-recorded using a smartphone application and were conducted in June, 2017. Each of the schools set aside an office that could be used for the interviews, which ensured privacy throughout the interview sessions. The interviews took approximately 30 minutes per participant.

Beginning the interview

Prior to the interview, the researcher explained the intention of the interview to the participants, namely to clarify their views as expressed in the questionnaire which addressed the development of their self-regulating skills. The researcher provided clarification regarding the stages of the learning process, to enable the participants to provide meaningful responses. The participants were kindly thanked for their participation. The researcher confirmed the submission of the informed consent forms before she continued with each interview.

Interviewer and participant interaction

The researcher was genuinely interested in what participants had to say and showed interest and compassion to all participants; which created good rapport and trust between the researcher and the participants. The participants had the freedom to express their thoughts, beliefs, and attitudes in their own words. The researcher did not show surprise, agreement, or disapproval towards the responses of the participants, in order to create an atmosphere of openness for the participants to feel free to share information with the researcher. Simple *yes*-or-*no* questions were avoided, and where necessary, the researcher encouraged the participants to elaborate on certain answers. The researcher avoided asking leading questions that would guide the participants to give expected or ideal answers; instead, the researcher remained a good listener who tried to understand the participants objectively. Eye contact was kept during the whole interview process (Creswell, 2009:183; Leedy & Ormrod, 2015:285; Nieuwenhuis, 2008b:88).

The researcher took cognisance of the advantages and limitations of using interviews during research.

Advantages of interviews

- Interviews are flexible and adaptable and large amounts of data can be collected quickly.
- Through probing, more depth can be gained in data.
- Face-to-face interviews give the researcher first-hand experience of non-verbal and verbal communication with the participant.
- The interviewer has an opportunity to motivate the participant, if needs be, when they feel unsure of themselves.
- Interviews produce a higher response rate (Creswell, 2009:179; Greeff, 2003:305; McMillan & Schumacher, 2014:221).

Limitations of interviews

- Participants may be uneasy and unwilling to share information. The researcher welcomed each participant and started off with conversational questions to help put the participant at ease, and created a good rapport with them.
- Hindrances such as poor articulation or perceptiveness of the participants required the researcher to repeat questions in order to avoid misunderstandings.
- Interruptions may distract the participants' thoughts. Unfortunately, interruptions did occur, and often the school environments were noisy during the interview sessions. The researcher often had to repeat questions or wait for the interruptions to subside before continuing with the interview process.
- Researchers must keep in mind they are there only to collect information. The researcher did not give any advice to the participants; she only focused on conducting successful interviews with them.
- The responses may be untruthful. There was a good rapport between the participants and researcher; as such, the researcher is confident that the participants provided honest responses.
- Interviews can be very time consuming. Therefore, the researcher kept the interview sessions to the point, and each participant was involved for only 30 minutes.

- The interviewer may be biased and ask closed questions. The researcher ensured to remain unbiased and allowed the participants to express their feelings.
- Fewer participants take part in the data collection process, in comparison to the questionnaire method. Sixteen participants were involved in the interviews. According to Leedy and Ormrod (2005:101), 15 – 25 participants are sufficient to gather qualitative data for a phenomenological study.
- Anonymity is not possible in face-to-face interviews, to a certain degree, because it requires the researcher to meet and engage with the participants. Confidentiality was however ensured, by not presenting findings linked to names of the participants (Creswell, 2009:179; Greeff, 2003:305; McMillan & Schumacher, 2014:221).

Greeff (2003:299) and Merriam (2009:96) explain that there are different types of questions to be asked during the interview. Some types of questions suggested by Greeff (2003:299) and Merrian (2009:96), were used during the interviews:

- **Main questions:** The researcher prepares main questions beforehand to start and guide the interview. An example of this type of question for this study was: "*From your questionnaire, it seems as though your study environment does not support you. Why is that?"*
- **Probes:** When responses lack clarity or sufficient depth, the interviewer will probe to create more understanding. In the context of this study, an example question was: "*You say you do not have a place where you sit to study by yourself. Where do you study then?"*
- **Follow-up questions**: These questions are used to find the link between the answers and the main question. An example of this type of question used in the context of the study was: *"You say that you receive support to complete your maths tasks. Who supports you to complete the maths tasks?"*
- **Experience and behaviour questions** relate to the interviewee's behaviour or actions (Merriam, 2009:96). These questions were asked during the interview regarding the use of teaching processes in the classroom, for example: *"What do you do if you are not sure how to do the maths?"*

- **Opinion and values questions** refer to the participant's beliefs and opinions (Merriam, 2009:96). These questions were asked in the interview regarding the participants' perceptions about the development of their self-regulating skills, for example: *"From your questionnaire, it seems that you do/do not have the skills to plan before you do a maths task. What do you think is the reason for this?"*
- **Feeling questions** engage the emotional and affective dimensions of the participant (Merriam, 2009:96). Questions were asked about how the participants feel about the way teachers go about nurturing self-regulation in the mathematics classroom: *"Here at school, what does your mathematics teacher do to help you plan, monitor, and evaluate your mathematics learning?"*

Before structuring the interview questions, the researcher first considered what was revealed in the quantitative data that needed to be followed-up in the interviews.

3.6 RELIABILITY AND VALIDITY OF THE QUANTITATIVE STUDY

3.6.1 Reliability of the questionnaire

To ensure reliability, a pilot study was undertaken which involved 65 Grade 10 Mathematics participants who were not part of the actual research sample. This was done to determine the Cronbach alpha coefficients and the inter-item correlations of the questionnaire items before the actual research began. To enhance the reliability of the questionnaire, it was translated from English to Sesotho to accommodate the Sesotho-speaking participants. The first pilot study was repeated, as it revealed unreliable results. The researcher reworked the questionnaire items and after the second pilot study was conducted, reliable Cronbach alpha coefficients were calculated (*cf.* Table 4.1).

The Cronbach alpha coefficient is used to measure the internal reliability or internal consistency. Internal consistency means that there is a high degree of similarity between the questionnaire items. If the items are strongly correlated, the coefficient will be close to one; as opposed to being poorly correlated, where the coefficient will be close to zero. Guidelines for acceptable Cronbach alpha coefficients according to Pietersen and Maree (2016a:239), are:

- 0.9 – high reliability

- 0.8 – moderate reliability
- 0.7 – low reliability

Reliability coefficients of 0.8 are acceptable; coefficients less than 0.6 are unacceptable. The Cronbach alpha coefficients for the pilot study and the actual study are reported in Chapter 4 (*cf.* 4.2.1). Another method to ensure reliability involves an inter-item correlation which establishes how well a set of questions reflect a construct. An acceptable value for an inter-item correlation range between 0.15 and 0.5 (Revelle & Zinbarg, 2009:145). The inter-item correlations for the pilot study and actual study are reported in Chapter 4 (*cf*. 4.2.1, Table 4.2).

3.6.2 Validity of the research design

The validity criteria identified by McMillan and Schumacher (2014:399-401) were taken into consideration to make sure the study complied with validity criteria.

Statistical conclusion validity

The researcher believes that statistical conclusion validity was guaranteed, as appropriate statistical tests and procedures that adhered to the suggestions of the Statistical Consultancy Services of the North-West University, Vaal Triangle Campus, were applied to analyse the data obtained from the questionnaires meaningfully (McMillan & Schumacher, 2006:134).

Internal validity

Leedy and Ormrod (2005:97) explain that internal validity is the extent to which the design and data yielded allow the researcher to draw accurate conclusions about cause and effect along with other relationships within the data. The researcher only controlled for the influence of gender, how many times that Grade 10 were repeated, and the living conditions of the participants as biographical variables that could influence the outcome of the research. Therefore, complete internal validity could not be guaranteed.

External validity

Leedy and Ormrod (2014:99) state that external validity exists when the conclusions of the study can be generalised to other contexts. The study was conducted in a real-life setting that enhanced the possibility of applying the conclusions to other real-world contexts. However, the convenient sample limits the external validity of the research, as the findings cannot be generalised.

Construct validity

Construct validity is the extent to which an instrument measures a characteristic that cannot be directly observed (Leedy & Ormrod, 2014:92). By making use of more than one data collection instrument, i.e., questionnaires and face-to-face semi-structured interviews to measure the perceptions and views of the participants in relation to the development of their self-regulating skills, the researcher ensured construct validity. A questionnaire can be regarded as a suitable instrument to measure perceptions of participants about the development of their self-regulating skills (Leedy & Ormrod, 2005:92). Interviews are regarded as suitable for exploring perceptions of the participants in relation to possible reasons for self-regulating skills to be well-developed or not well-developed.

3.6.3 Validity of the questionnaire

To ensure the validity of the questionnaire, the researcher adhered to the following criteria for validity, as identified by Leedy and Ormrod (2014:91, 92) and Pietersen and Maree (2016a:240).

Face validity

Face validity implies that a data collection instrument should measure what it intends to measure (Leedy & Ormrod, 2014:91). The questionnaire that was used managed to achieve this. The perceptions about the self-regulating skills of the participants related to the stages of learning; planning, monitoring, evaluation, as well as in relation to their study environments, were measured in accordance with the literature (*cf.* 2.3).

Content validity

Content validity refers to the extent that the data collection instrument covers the complete construct that the researcher wants to measure (Pietersen & Maree, 2016a:240). The questionnaire reflected all the various parts of the construct self-regulation in equal proportions, i.e., planning, monitoring, evaluating, and study environment.

Construct validity

The questions in the questionnaire were discussed with the study leader and co-study leader in order to determine whether the questions would aptly measure the self-regulating skills involved during planning, monitoring, and evaluation, as well as in establishing an appropriate study environment. Before the actual research took place, the researcher also conducted a pilot study to determine the reliability of the questionnaire items (Leedy & Ormrod, 2014:92) (*cf.* Table 4.1, Table 4.2). The pilot study results also confirmed the construct validity of the questionnaire.

3.7 TRUSTWORTHINESS OF THE QUALITATIVE STUDY

According to Babbie and Mouton (2002:276), the key criterion or principle of good qualitative research is found in the notion of trustworthiness, which *inter alia* refers to neutrality of the findings that emanate from the study. The researcher guaranteed trustworthiness in this study by adhering to the criteria identified by Lincoln and Guba (1985:301-316) and Babbie and Mouton (2002:276-278).

3.7.1 Credibility

The researcher aimed to achieve credibility by adhering to the following procedures:

- **Prolonged engagement:** The researcher stayed in the field until she was sure that data saturation occurred. Francis, *et al.* (2010:1229) describe data saturation as the point where no new ideas emerge during the interviews. According to the researcher no new ideas emerged after the 16 interviews, and she concluded that data saturation was reached.

- **Referential adequacy:** The researcher used a voice recorder to capture all the detail of the participants' verbal responses accurately. The researcher attached evidence of the verbatim transcripts and coding procedure as an example of an audit trail (*cf.* Appendix I), to indicate how she derived the themes identified from the responses of the participants (*cf.* 4.7.1.1 - 4.7.1.8).
- **Peer debriefing:** The researcher's study leaders provided on-going oversight of the data collection and findings.
- **Member checks:** The researcher consulted the participants again to confirm and check that her verbatim transcripts and interpretations corresponded with what the participants noted during the interview sessions.
- **Thick description:** The findings contained a detailed description of what transpired from all the interviews, and therefore contributed to a rich database.

3.7.2 Transferability

Lincoln and Guba (cited by Babbie & Mouton, 2002:277) assert that a qualitative study cannot be regarded as credible unless it is also transferable. Transferability refers to the extent to which the findings can be applied in other contexts or with other participants. The researcher guaranteed transferability according to the following criterion identified by Babbie and Mouton (2002:277).

In a qualitative study, transferability depends on similarities between the sampled participants and the population from which the participants were selected (Babbie & Mouton, 2002:227). The researcher described, in detail, the biographical variables and context of the participants, so as to allow judgments about transferability to be made by researchers in other contexts with participants who have a similar background.

3.7.3 Dependability

In addressing the issue of dependability, namely to ensure that interpretations really emanate from the data and not own insights (Babbie & Mouton, 2002:278), the researcher adhered to the following criterion according to Lincoln and Guba (1985:316-318):

The researcher’s study leaders did an **inquiry audit**. The inquiry audit involved an examination of the interview transcripts, coding, field notes, and the interpretations in order to verify accuracy, credibility, and acceptability.

3.7.4 Confirmability

Research findings should not be based on the biases of a researcher (Babbie & Mouton, 2002:278) and should have traceable evidence regarding the interpretations and findings of the study (Lincoln & Guba, 1985:318). The example of an audit trail which the researcher included, demonstrates how the researcher’s conclusions, and interpretations, were based on the interview data (*cf*. Appendix I). The researcher also made use of an independent coder who is knowledgeable in the field of self-regulated learning to verify the identification of codes, axial codes, and themes.

A researcher is an instrument in qualitative research which could lead to the validity of research being compromised (Creswell, 2009:177). Therefore, researchers need to clarify their roles upfront, in order to avoid circumstances that could threaten the validity of the data collection and analysis. In the following section, the researcher clarifies how she ensured that her role did not compromise data collection.

3.8 ROLE OF THE RESEARCHER

According to Creswell (2009:177), a qualitative researcher has to consider the following range of ethical and personal issues that could compromise the collection of trustworthy data, namely: **historical, social and cultural experiences, status, race, gender, assumptions, personal connection to the site,** and **sensitive ethical issues.** The researcher explains in the following sections how she considered ethical and personal issues relevant to the research that could have compromised the collection of trustworthy data.

3.8.1 Historical, social, cultural experiences

Although the historical, social, and cultural background of the researcher is very different to the background of the participants, the researcher has many years of teaching experience in the Sebokeng township, which has made the researcher sensitive and empathetic towards people with different backgrounds. The researcher had an excellent rapport with the participants; therefore, she confidently reports that no historical, social, and cultural differences could have had an influence on the data collection.

3.8.2 Assumptions

The researcher's assumptions, which result from her teaching experience, are that the development of self-regulating skills is fragile and deficient among learners in general. To make sure that her assumptions did not cloud her interpretations, extra care was taken not to be biased. Another precautionary measure that was taken was to have her study leaders verify all the data interpretations. The researcher sifted through the data with an open mind, being careful to pick out information objectively; that is, whether it supported or contradicted her own assumptions.

3.8.3 Sensitive ethical issues

The study did not focus on a sensitive ethical issue and to protect the identity of the participants during the analysis of the interview data, numbers were used to identify them. A thorough account of how the participants were sampled for the study follows in Section 3.9.

3.8.4 Personal connection to participants

The researcher had connections with participants at two of the schools that were involved in the research, as she was their teacher who presented the enrichment training at AMSC. She therefore stood in a hierarchical relationship to the participants. She therefore requested an independent person to sit in during the recruitment and interviews to ensure that she adhered to ethical principles during the interviews.

3.9 RESEARCH PARTICIPANTS

3.9.1 Sampling for quantitative study

The population for the study comprised all learners with mathematics as subject in South African secondary schools. Due to time, logistical, and financial constraints, it was not possible for the researcher to do research with all the mathematics learners in South Africa, and a study population was chosen.

The study population comprised all the Grade 10, 11, and 12 learners enrolled for mathematics at the AMSC in Sebokeng, Sedibeng West district, Gauteng Province, where the researcher teaches mathematics to Grade 10, 11 and 12 learners. As the focus of the research was on Grade 10 mathematics, the researcher approached all the Grade 10 learners to become part of the sampled participants for the study.

The sampling strategy for the quantitative part of the study was non-probability, convenient, purposeful sampling (Leedy & Ormrod, 2014:151). The researcher acknowledges that she utilised non-probability sampling, which implies that the sample might be less representative of the population, and that the generalisability of the findings was limited to the participants who took part in the study (McMillan & Schumacher, 2006:125). The participants were readily available and the researcher had easy access to the participants. All the Grade 10 learners were chosen because their academic performance in mathematics could probably still improve if deficiencies in the development of their self-regulating skills as pointed out by the data collection, could be reversed before they reach Grade 12.

AMSC provides enrichment intervention programmes to improve the Grade 12 results in mathematics, physical science, and life sciences. The schools that are part of the AMSC intervention programme are identified from the Boipatong, Bophelong, Evaton, and Sebokeng townships in the Sedibeng West District by the Gauteng Department of Basic Education. During 2017, the Grade 10 mathematics learners who took part in the intervention programmes at AMSC belonged to two township schools in Boipatong and Evaton, respectively. The learners were chosen by the Department of Basic Education based on the results that they achieved after writing an adapted TIMSS test that focused on the subjects offered at AMSC. The top 35 (approximately) Grade 10 learners per school whose subject choices included mathematics, physical science, and life sciences were chosen to become part of the AMSC programme. The goal of the mathematics enrichment programme is to prepare learners for future recruitment opportunities offered by ArcelorMittal (in the form of bursaries), for example in the engineering field.

A homogenous group of Black, mainly Sesotho-speaking, male and female learners between 16 and 18 years old take part in the programme. During 2017, the Grade 10 mathematics learners had class, presented by AMSC teachers, on Tuesdays and Fridays for one hour each, at their respective schools in Boipatong and Evaton. Due to safety reasons, training was not presented at AMSC.

Recruitment of the research participants was done by the researcher at their respective schools using a Power Point representation. The researcher was assisted by a Sesotho-speaking teacher who acted as an independent person during the research. She translated questions and provided explanations in the participants' Home Language about the purpose of the research. Her presence created more freedom for the participants to ask for clarification whenever necessary. The participants were well informed about the research objectives and what their involvement would entail. At the end of the presentation, consent forms were issued to the participants, as well as consent forms for their parents/guardians that had to be taken home. The participants could also take the informed consent forms home to reflect on the information once more and were given a week within which they could return the consent forms. The researcher and a colleague of the researcher, Mr. Mosiane, collected the informed consent forms from the participants at each of the schools.

In summation, the inclusion criteria for the research participants were:

- They could be a girl or a boy.
- They had to have mathematics as a subject.
- They had to be in Grade 10.
- They had to come from a selected AMSC secondary school in Sedibeng West district
- They had to be selected by ArcelorMittal for participation in the intervention programme.

As such, the exclusion criteria for the research participants were:

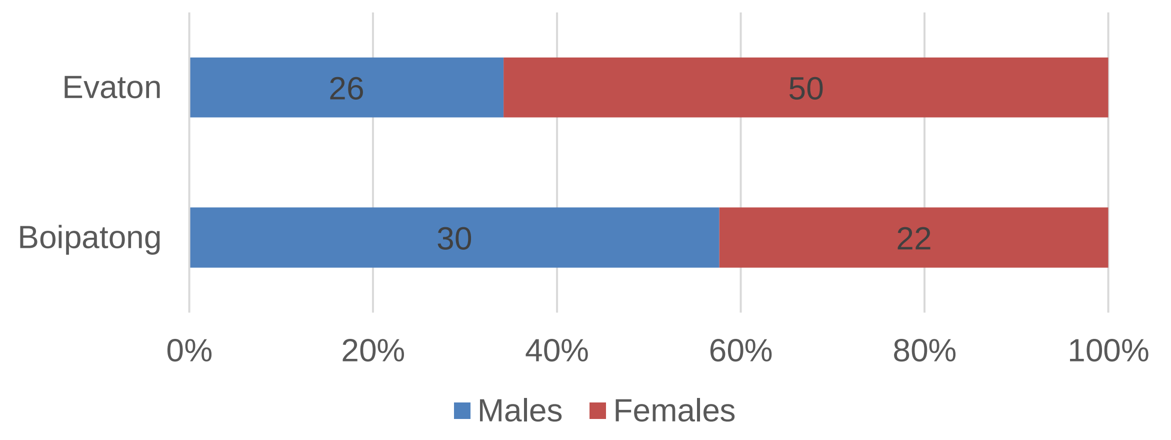
- A learner that was not in Grade 10.
- A learner that did not have mathematics as a subject.
- A learner that did not attend one of the selected AMSC secondary schools in Sedibeng West district.
- A learner that was not selected by ArcelorMittal to receive training at the AMSC.

A limitation of using convenience sampling is that the findings could not be generalised (Leedy & Ormrod, 2014:151) because the selected group of 130 participants was not randomly selected, and therefore, they may not have been representative of the population. However, as the sample was relatively homogenous, it provides some basis for generalising findings to other participants with similar characteristics that were not part of the sample (Boeije, 2002:393).

Table 3.2 summarises the distribution of the participants for the quantitative study.

Table 3.2: Participants: Quantitative study

School	Number of males	Number of females
Boipatong	30	22
Evaton	26	50
Total	56	72



3.9.2 Sampling for qualitative study

Purposive, criterion sampling was used to select the participants for the qualitative part of the study. According to Nieuwenhuis (2008b:79), purposive sampling is appropriate to use when the researcher has a specific purpose in mind. In this study, the purpose was to focus on the development of self-regulating skills according to the perceptions of Grade 10 mathematics learners. Therefore, the researcher only selected participants that qualified to suit the purpose (Nieuwenhuis, 2008b:79). In this study, the participants had to be in Grade 10 and have mathematics as a subject. Criterion sampling implies that the participants need to meet certain criteria in order to participate in the research. Criterion sampling enables the researcher to select those participants most likely to possess the knowledge or experience concerning the research phenomenon (Merriam, 2009:79). From the sample of 130 participants who completed the questionnaire, 16 participants were approached, purposively based on the averages obtained for the questionnaire responses, and invited to take part in the interviews.

The total averages for the four questionnaire sections were calculated on the four-point Likert scale, according to which the participants were grouped into two categories (see Table 3.3 below). The researcher ranked the averages that each of the participants obtained in the four schools from high to low and identified four participants in each school who had the highest averages in the *average-strong* category (Likert scale averages: 2,95 – 4, 1 male and 1 female per school, where possible) and four participants who had the lowest averages in the *average-weak* category (Likert scale averages: 2,94 – 1, 1 male and 1 female per school, where possible). The identified participants indicated their willingness to partake in the interviews

Table 3.3: Grouping of participants for the interviews

Interview number	Questionnaire number	Male/ Female	Average	Strong–Average (AS) Average-Weak (AW)
1	60	M	3.47	AS
2	67	F	1.68	AW
3	71	M	3.32	AS
4	80	F	3.32	AS
5	122	M	2.89	AW
6	94	M	2.95	AS
7	106	F	1.84	AW
8	125	F	2.68	AW
9	56	M	1.95	AW
10	51	M	3.00	AS

Interview number	Questionnaire number	Male/ Female	Average	Strong–Average (AS) Average-Weak (AW)
11	45	F	3.32	AS
12	36	F	2.63	AW
13	24	M	1.89	AW
14	19	M	3.16	AS
15	11	F	3.05	AS
16	7	F	2.95	AS

According to Table 3.3, the participants were grouped as follows:

- Category 1: Participants who appeared to perceive the development of their self-regulating skills as *"strong-average"*, thus being regarded as *skilled* to *expert* in the application of self-regulating skills according to the Likert scale descriptions (Likert scale averages: 2,95 - 4).
- Group 2: Participants who appeared to perceive the development of their self-regulating skills as *"average-weak"*, thus being regarded as *novice* to *able* in the application of self-regulating skills according to the Likert scale descriptions (Likert scale averages: 1 – 2,94).

3.10 DATA ANALYSIS

The data were collected quantitatively and qualitatively, and were therefore analysed in two separate ways. Statistical procedures were used for the analysis of the questionnaire responses and a content analysis was employed for the interview data.

3.10.1 Data analysis and interpretation of the questionnaire

Descriptive statistics were used to analyse the data obtained with the questionnaire. According to Leedy and Ormrod (2014:295), descriptive statistics describe and summarise what the data resemble. The analysis of the completed questionnaire responses reported the frequencies, percentages, means, and standard deviations for each item and each section in the questionnaire.

Inferential statistics were also used to compare the perceptions of the participants in relation to the development of their self-regulating skills for the different sections in the questionnaire (Creswell, 2009:152). To identify any differences between the perceptions of the participants regarding the development of self-regulating skills, a t-test was used (Maree & Pietersen, 2007b:225). If any statistically significant differences were noted ($p < 0.05$), Cohen's *d* was calculated to determine the effect of the differences in practise (McMillan & Schumacher, 2014:337).

A MANOVA was conducted to (i) establish if there were differences in perceptions in relation to the various biographical variable groupings, and (ii) differences in perceptions in relation to the strategies applied during planning, monitoring, evaluation, and securing a study environment. If any statistically significant differences were observed, an ANOVA was conducted to analyse the identified differences among group means in a sample (McMillan & Schumacher, 2006:373). If the ANOVA indicated statistically significant differences between groups, a *post hoc* test was conducted to determine which groupings displayed the differences. To this end, a Tukey HSD (Honestly Significant Difference) test was used (McMillan & Schumacher, 2006:305). If any statistically significant differences were noted ($p < 0.05$) between the comparisons, Cohen's *d* was calculated to determine the effect of the differences in practise (McMillan & Schumacher, 2014:337).

The effect size is a standardised, scale-free measure that indicates the magnitude of the difference being tested between variables (Pietersen & Maree, 2016c:234). Effect sizes ranging from 0 to 0.2 are interpreted as a small effect size, while 0.5 is regarded as a medium effect size, and 0.8 is a large effect size (Pietersen & Maree, 2016b:234).

3.10.2 Data analysis and interpretation of the interviews

Verbatim transcripts of the interviews were compiled immediately after each interview, and thereafter analysed the data using deductive and inductive content analyses (Nieuwenhuis, 2008c:99). A deductive analysis implies that *a-priori* codes based on the literature review were identified, which guided the analysis of the data (Nieuwenhuis, 2008c:99, 107). According to Thomas (2003:2), the primary purpose of an inductive analysis approach is to allow research findings to emerge from the frequent, dominant, or significant themes inherent in raw data, without restraints imposed by structured methodologies which are evident in the text.

The researcher used the following procedures for an inductive analysis of the qualitative data as described by Creswell (2009:183-190).

Step 1*:* Preparation of raw data files for data analysis

The researcher transcribed the interview data verbatim from the voice recordings.

Step 2: Close reading of the data

The researcher obtained a general sense of the information by reading through the transcriptions several times and reflected on the ideas that participants had expressed. Focused perusal of the data were important to obtain an impression of the depth and credibility of the data.

Step 3: Analysis of data by identifying open codes and axial codes

The researcher open-coding segments on the verbatim transcripts that enabled her to answer the interview questions posed to the participants. The researcher highlighted the sections in the responses of the participants that played a part in answering the question asked (*cf.* Appendix I). Thereafter, the researcher described the open codes with more information, called axial codes. The researcher then compiled a list of all the topics reflected in the axial codes across the different interviews, and grouped similar topics together.

Step 4: Identifying categories and themes

By means of axial coding themes were generated from the data. Different colours were used to identify different themes.

Step 5: Presentation and interpretation

The researcher presented the findings of the data analysis in narrative form. The interpretation of the data also involved a comparison of the interview findings with information extracted from the literature review.

Step 6: Visual representation

The researcher structured a visual representation to summarise the findings obtained for the interview questions, and to indicate the major themes that emerged from the interview data (McMillan & Schumacher, 2014:365) (*cf*. Figure 4.1).

Step 7: Writing a composite

Finally, the researcher-constructed a composite that summarised the major findings that emanated from the interview data (*cf*. 4.8)

Throughout the analysis of the interview data, the researcher made use of the constant comparative method to identify conceptual similarities and patterns. Each piece of data that was analysed was compared with other relevant pieces of data (Boeije, 2002:393).

In the final section of this chapter, the ethical principles that were followed in the context of this study will be explained.

3.11 ETHICAL CONSIDERATIONS

3.11.1 Ethical issues in the research problem

Creswell (2009:88) mentions that a researcher should identify an important problem to study that will benefit the participants. The lack of developing self-regulating skills among mathematics learners, appears to be a problem in the South African education scenario (*cf.* 1.1). As the lack of self-regulating skills impact on academic achievement, the researcher regarded the topic of self-regulation to be of importance and worthy of research.

3.11.2 Ethical issues in the purpose and questions

It is of vital importance to state clearly the purpose of the study so that all the participants will understand what the study is about (Creswell, 2009:89). The researcher was assisted by an independent Sesotho-speaking teacher when she addressed the potential participants about the purpose of the study during a recruitment session at various schools. This helped to clarify any questions the participants may have had before the study commenced. During the recruitment session, informed consent forms providing detailed information about the research, were distributed to the participants and their parents. The participants were requested to return the completed informed consent forms by a specified date and time.

3.11.3 Ethical issues in data collection

The information that was provided in the informed consent form (*cf.* Appendix D, E, F) was in line with the suggestions of Creswell (2009:89) and included the following:

- The identification of the researcher.
- An explanation of how the participants were selected.
- The identification of the purpose of the study.
- The benefits and risks of participating.
- The identification of the level and type of participant involvement.
- An explanation of the numbering of the questionnaires and how anonymity and confidentiality would be ensured.
- The role of an independent person in the research (a colleague of the researcher, who also acted as interpreter).
- Reassurance that the participant could withdraw at any time with no penalty implications.
- The researcher's personal details, if participants required further information.

It is important to note that permission to conduct the research was obtained from the participants, their parents/guardians, the principal of AMSC, as well as the Gauteng Department of Basic Education (*cf.* Appendix D, E, F).

3.11.4 Ethical issues in data analysis and interpretation

When a researcher analyses and interprets the data, some issues may emerge that call for respectable ethical decisions to be made (Creswell, 2009:91). The researcher applied the following criteria identified by Creswell (2009:91):

- The anonymity of the participants was protected by using a coding process with numbers to identify participants. To secure confidentiality, the data were only available to the researcher, her study leader, her co-study leader and the Statistical Consultation Services. The researcher signed the North-West University Code of conduct for researchers before attempting the research. The code of conduct has four major principles, namely, upholding honesty in all respects of research; accountability in the conduct of research; professional courtesy and fairness in working with others; and good stewardship of research on behalf of others.

- An account of the information that was interpreted and analysed was given to participants on completion of the study to verify whether it represented a true account of what they shared during the research.
- The data obtained and the consent forms were held in a locked cupboard at AMCS, to which only the researcher had access. A password-protected computer was used for capturing and storing the data in a folder specifically for the research.
- The researcher is responsible for the storage of all research documents for a period of five years, since the first data collection.
- Participants and the Department of Basic Education will receive a written summary of all the relevant and incidental findings after the examination of the dissertation.

3.11.5 Ethical issues in writing and disseminating the research

The research did not use language or words that were biased against participants in terms of gender, sexual orientation, racial or ethnic group, or disability (Creswell, 2009:92). Thus, in no circumstances did the researcher allow herself to draw conclusions based on these presumptions. The researcher also guarded against falsifying or inventing findings to meet her needs (Creswell, 2009:92). Therefore, the findings of this study were based only on the data obtained by the empirical study. Participants were informed that the findings will be reported at relevant conferences and in accredited peer-reviewed science journals.

3.12 CHAPTER SUMMARY

This chapter provided a comprehensive explanation and motivation of the research methodology that was applied within this study.

As quantitative and qualitative data were collected in the context of the study, a pragmatic research paradigm (*cf.* 3.2) was used. The main aim of the study was twofold: firstly, to describe how well-developed the Grade 10 mathematics learners perceived their self-regulating skills to be; secondly, to explore the perceptions of the participants in relation to the reasons for their self-regulating skills to be well-developed or not well-developed. The dual nature of the main aim provided the rationale for collecting data quantitatively and qualitatively (*cf.* 3.3).

In line with the pragmatic research design, a sequential explanatory mixed method design was used (*cf.* 3.4.1). The data was collected in sequence; first the quantitative data collection, followed by the qualitative data collection. Non-experimental descriptive survey research was used for the quantitative data collection that focused on the Grade 10 participants' perceptions about the development of their self-regulating skills (*cf.* 3.4.2.1). A phenomenological study was used for the qualitative part of the study (*cf.* 3.4.2.2), as the researcher wished to obtain a better understanding of the participants' experiences in relation to the reasons for self-regulating skills to be well-developed or not well-developed.

Different data collection methods were used because the study comprised qualitative and quantitative components. A closed, researcher-constructed four-point Likert scale questionnaire (*cf*. 3.5.1) was used to obtain the perceptions of the participants in relation to the development of their self-regulating skills to plan, evaluate, and monitor their learning, as well as to select a suitable study environment. Semi-structured face-to-face interviews (*cf.* 3.5.2) were employed to explore the participants' perceptions in relation to the reasons for self-regulating skills to be well-developed or not well-developed.

Non-probability, convenient sampling was used for the quantitative data collection (*cf*. 3.9.1). The Grade 10 participants were recruited from four schools involved in the AMSC enrichment programme. The research was conducted in the Sedibeng West district, which included two schools in Bophelong and two schools in Evaton, with a homogenous group of 130 male and female participants who took part in the completion of the questionnaire (*cf*. 3.9.1).

Based on the findings obtained with the questionnaire, 16 participants were selected by means of purposeful, criterion sampling (four participants per school (males and females) to take part in the interviews (*cf.* 3.9.2). They were grouped into two categories: Two participants per school who appeared to perceive the development of their self-regulating skills as *"average - strong"* (averages between 2.95 – 4 on the four-point Likert scale, thus regarding themselves as *skilled* to *expert* in applying self-regulating skills), and two participants per school who appeared to perceive the development of their self-regulating skills as *"average-weak"* (averages between 1 – 2.94 on the four-point Likert scale, thus regarding themselves as *able* to *novice* in applying self-regulating skills).

To ensure reliability of the questionnaire, a pilot study was conducted (*cf.* 3.6.1) which confirmed that the questionnaire complied with face validity, content validity, and construct validity. In addition, the criteria for internal, external, construct, and statistical conclusion validity were complied with, to ensure the validity of the quantitative research design (*cf.* 3.6.1, 3.6.2). To ensure trustworthiness of the qualitative data, the research complied with criteria for credibility, transferability, dependability, and confirmability (*cf.* 3.7).

The researcher ensured that her role as researcher did not compromise the collection of data. In order to achieve this, she considered the historical, social, and cultural background of the participants, her connection to the research sites, disregarded her assumptions, and ensured that the research did not focus on sensitive issues (*cf.* 3.8).

Ethical issues were considered during the research by identifying a worthy research problem, describing the purpose of the research in detail; ensuring confidentiality throughout the data collection, analysis, interpretation, and dissemination of the research (*cf.* 3.11).

The next chapter, Chapter 4, focuses on the analysis and interpretation of the data.

CHAPTER 4
DATA ANALYSIS AND INTERPRETATION

4.1 INTRODUCTION

This chapter presents the data analyses and the interpretations for the data collected with the questionnaire and interviews to determine how well-developed participants perceive their self-regulating skills to be, and to explore possible reasons for self-regulating skills to be well-developed or not-well developed. The chapter unfolds in the following sequence:

The next section outlines the reliability data of the pilot study and the actual study that included the calculation of Cronbach alpha coefficients, inter-item correlations.

4.2 RELIABILITY OF THE QUESTIONNAIRE

4.2.1 Cronbach alpha coefficients and inter-item correlations: pilot study and actual study

The Cronbach alpha coefficients that were calculated for the various constructs in the questionnaires for the pilot and actual study are presented in Table 4.1.

Table 4.1: Cronbach alpha coefficients: Pilot study and actual study

Questionnaire constructs	Pilot study	Actual study
Planning	0.727	0.680
Evaluation	0.846	0.614
Monitoring	0.737	0.732
Study environment	0.663	0.666

In order to prove that the questionnaire issued to the participants was reliable, a pilot study was carried out (Leedy & Ormrod, 2005:192). The pilot study was repeated once, as the first pilot study yielded unreliable Cronbach alpha coefficients, after which the questionnaire items were restructured and rephrased.

Cronbach alpha coefficients were calculated to determine the internal consistency of the various questionnaire sections. According to Sekaran (2000), and Simon (2008), the Cronbach alpha reliability coefficients determine the extent to which the items in a questionnaire correlate positively to one another.

In the Social Sciences, a Cronbach alpha of between 0.7 and 0.8 is regarded as acceptable if scale items are used (Simon, 2008). Garson (2008) contends that a value of 0.60 could also be regarded as acceptable when an exploratory study is conducted. Since this study involved a first exploration of how self-regulating skills are nurtured in mathematics, it is evident from Table 4.1 that the questionnaire for the participants complied with the criteria for reliability.

Revelle and Zinbarg (2009:145) mention that inter-item correlations evaluate different questionnaire items to determine how well they measure a construct in question. Table 4.2 presents the inter-item correlations for the pilot and actual study for the learner questionnaires:

Table 4.2: Inter-item correlations: Pilot study and actual study

Questionnaire sections	Pilot study (n = 54)	Actual study (n = 128)
Planning	0.164	0.302
Monitoring	0.319	0.241
Evaluation	0.411	0.354
Study environment	0.330	0.238

An acceptable value for an inter-item correlation is between 0.15 and 0.5 (Revelle & Zinbarg, 2009:35). Both the pilot study and actual study complied with these criteria for acceptable inter-item correlations.

In order to establish whether parametric or non-parametric statistical procedures should be applied in the study, the data obtained during the actual study were examined in relation to skewness and kurtosis.

4.2.2 Skewness and kurtosis

The data related to skewness and kurtosis indicate the symmetry of the distribution of data and provide a guide to the researcher in choosing parametric or non-parametric statistical procedures for the analysis of the data (Pietersen & Maree, 2016d:210, 211).

The skewness of a distribution describes how far the distribution of data deviates from symmetry. Data can be **positively skewed** (longer tail to the right) or **negatively skewed** (longer tail to the left) (Pietersen & Maree, 2016d:210, 211). The following guidelines apply for interpreting values in relation to the skewness of data:

- Skewness smaller than -1 or larger than 1: The distribution of the data is extremely skew
- Skewness between -1 and -0.5 or between 0.5 and 1: The distribution of data is moderately skew

- Skewness between -0.5 and 0.5: The distribution of data is symmetrical (Brown, 2008).

The kurtosis of a distribution describes how peaked or flat the data are distributed around the mean. The “peak” (leptokurtic) or “flatness” (platykurtic) around the mean is directly related to the standard deviation of the distribution (Pietersen & Maree, 2016d:211).

The following guidelines apply for interpreting kurtosis values.

- A normal distribution: Kurtosis is exactly 0 and called **mesokurtic**
- A distribution with short and thin tails and a low and broad central peak: Kurtosis is < 0 and called **platykurtic**
- A distribution with long and fat tails and a high and sharp central peak: Kurtosis is > 0 and called **leptokurtic (**Field, 2012:20, 21)

Table 4.3 reports on the data obtained for skewness and kurtosis.

Table 4.3: Skewness and kurtosis

Constructs	Skewness	Kurtosis
Planning	-.268	-.188
Monitoring	-.177	.183
Evaluation	-.054	.196
Study environment	-.134	-.546

The skewness values for planning, monitoring, evaluation, and study environment indicate a symmetrical dispersion of the data, as data values lie between -0.5 and 0.5 on the graph.

Two kurtosis values (planning and study environment) are negative, implying that the distribution is flat and light-tailed with a low and broad central peak (a platykurtic distribution). The kurtosis values for monitoring and evaluation are positive values, and point to a distribution with a sharp central peak and heavy tails (known as leptokurtic). The further that kurtosis values lie from zero, the more likely it is that the data distribution is not normal (Field, 2012:185).

According to the Statistical Consultation Services that assisted the researcher with the data analysis, parametric statistical procedures could be applied to analyse the data.

The following section deals with the biographical information of the research participants who took part in the actual study. The data are displayed in tables and graphs.

The data in the graphs are rounded off to the nearest integer, and the data in the tables only reflect the actual responses obtained.

Reference made to majority and minority as part of the interpretations, could be understood as follows: Majority = highest frequency and percentage; minority = lowest frequency and percentage.

4.3 BIOGRAPHICAL INFORMATION OF PARTICIPANTS

The researcher distributed 130 questionnaires to research participants. Of the 130 questionnaires distributed, 128 (98.46%) were returned.

4.3.1 Biographical information: Gender

In Table 4.4, the biographical information of the participants related to gender is indicated.

Table 4.4: Gender of participants

Gender	*f*	%
Male	56	43.7
Female	72	56.3
Total	128	100.0

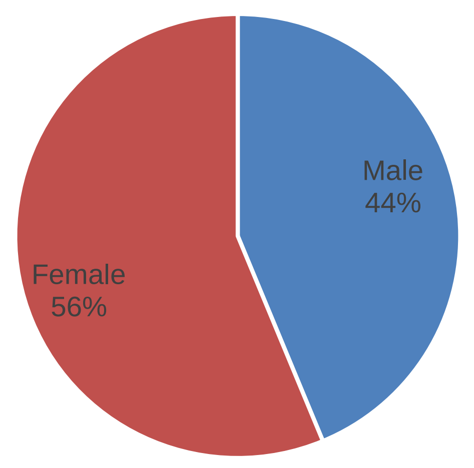


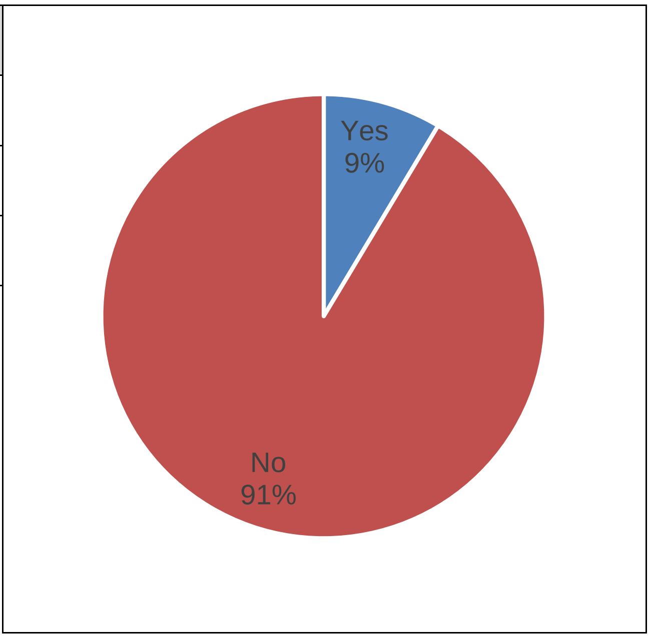
Table 4.4 indicates that more female (n = 72) than male participants (n = 56) took part in the research.

4.3.2 Biographical information: Repetition of Grade 10

In Table 4.5, the biographical information of the participants who have repeated Grade 10 is indicated.

Table 4.5: Repetition of Grade 10

	f	%
Yes	11	8.6
No	117	91.4
Total	128	100.0



According to Table 4.5, only a small percentage of the participants, 8.6%, repeated Grade 10.

4.3.3 Biographical information: Living conditions

In Table 4.6, the biographical information of the participants' living conditions is indicated.

Table 4.6: Living conditions

Living conditions	f	%
Both parents	56	43.8
Single parent	41	32.0
Guardians	28	21.9
Alone with brothers and sisters	3	2.3
Total	128	100.0

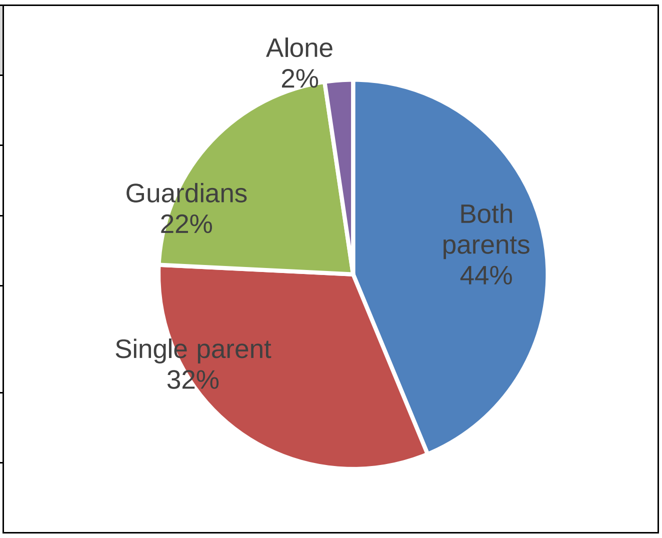


Table 4.6 indicates that only 43.8% of the participants live with both parents. Many of the participants, 32%, live in single parent families, while 21.9% live with guardians, and 2.3% do not have parents or guardians with whom they live.

The following section presents the responses obtained for each of the sections in the questionnaire. Each section focused on a specific construct in relation to the development of self-regulating skills in the mathematics classroom.

4.4 DATA ANALYSIS AND INTERPRETATION: PARTICIPANT RESPONSES

By means of descriptive statistics, data were organised and summarised to promote an understanding of the data characteristics (Pietersen & Maree, 2016d:207). The responses of the participants are classified in a frequency table in order to explore different response patterns between participants (Pietersen & Maree, 2016d:207). The data of the responses are summarised with frequencies and percentages. Graphical representations will serve the purpose of visually highlighting the prominent features that emanated from the responses.

The data are interpreted according to the average percentage scored on the Likert scale. Participants were provided with the following descriptive explanations for the four-point Likert scale, according to which they had to assess the application of their self-regulating skills:

- Novice (1): Someone with no or little experience and knowledge.
- Able (2): Someone with limited experience and knowledge.
- Skilled (3): Someone having experience and knowledge in learning.
- Expert (4): Someone who is a very experienced and knowledgeable learner.

The researcher wishes to state, that during the data analysis she hoped to find that participants would regard themselves as experts, in having knowledge and experience in applying self-regulation strategies.

The data analyses and interpretations obtained for the various constructs in the questionnaire follow in the subsequent sections.

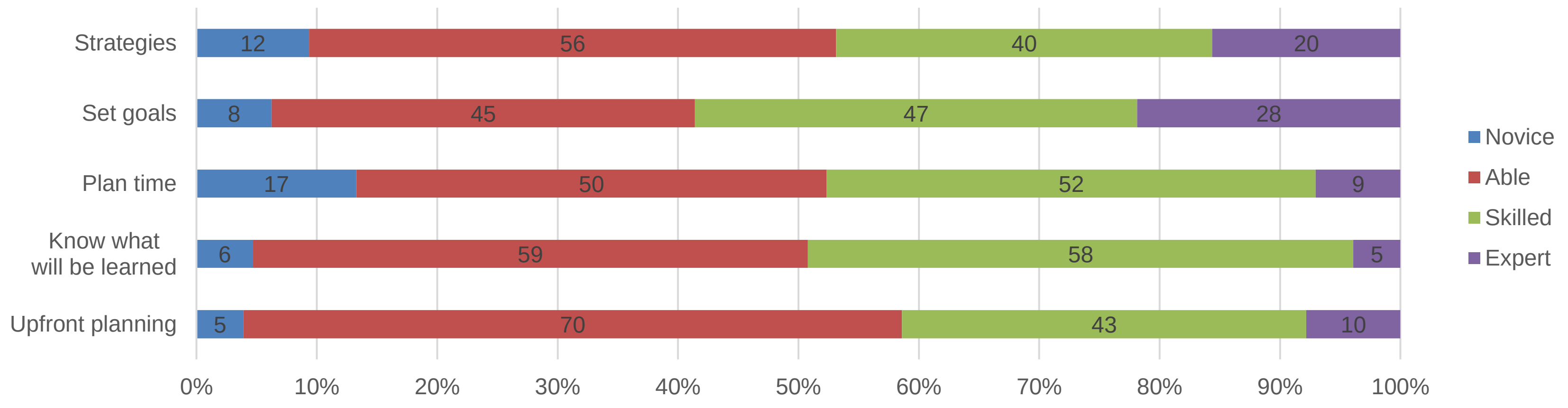
4.4.1 Data analysis and interpretation: Planning

The questions in this section of the questionnaire established how the participants perceive their application of skills in relation to planning, goal-setting, and applying strategies to complete mathematics tasks.

Table 4.7 presents the data obtained for Section B of the questionnaire, related to self-regulating skills for **planning** the completion of mathematics tasks.

Table 4.7: Participant responses: Planning

Question		Novice (1)		Able (2)		Skilled (3)		Expert (4)	
		f	%	f	%	f	%	f	%
1.1	I plan how I am going to do a mathematics task before I begin.	5	3.9	70	54.7	43	33.6	10	7.8
1.2	I make sure that I know what I am going to learn before I start a maths task.	6	4.7	59	46.1	58	45.3	5	3.9
1.3	I plan how much time I will need to complete a mathematics task before I start a task.	17	13.3	50	39.1	52	40.6	9	7.0
1.4	I set goals for myself which I want to achieve before I start a maths task.	8	6.3	45	35.1	47	36.7	28	21.9
1.5	I know what strategies to use to complete maths tasks.	12	9.4	56	43.8	40	31.2	20	15.6



The responses to Question 1.1 indicate that 33.6% of the participants appear to be *skilled* and 7.8% appear to be *experts* in planning how to do a mathematics task before they attempt it. Only 54.7% of the participants feel that they are *able* to plan before they do a maths task, whereas 3.9% seem to be complete *novices* in planning before they do a math task. Based on the data, the researcher concludes that the majority of the participants who took part in the research apparently lack self-regulation strategies (*cf*. 2.3.4.1) to become skilled in planning for the completion of their mathematical tasks. This observation could imply that many of the participants might ultimately not be effective at achieving the goals set out by the mathematics tasks (Bannert & Reimann, 2012:194; Boekaerts, 1996:107; Cazan, 2012; Ertmer & Newby, 1996:10, 11; Pintrich, 1999:461; Schunk, 2005b:86; Zimmerman, 2008:166; Zumbrunn, *et al*., 2011:10) (*cf.* 2.3.4.1).

In response to Question 1.2, only 45.3% of the participants feel that they are *skilled* in ensuring beforehand what they should be learning by completing a mathematics task. Only 3.9%, see themselves as *experts* in knowing beforehand what they should be learning by completing a mathematics task. A high percentage (46.1%) of participants see themselves as *able,* and 4.7% see themselves as *novices* in knowing what they are going to learn before they attempt a maths task. The data concern the researcher, as a deduction can be made that too many of the participants appear to lack self-regulating strategies to make ensure they know what the goals are that they should achieve with a given task (Schraw, *et al.,* 2006:114) (*cf.* 2.3.4.1).

For Question 1.3, the participants who feel they are *novices* in planning the time they are going to need to complete a maths task is 13.3%, while 39.1% feel they are *able* and 40.6% feel they are *skilled* to plan the time they are going to spend on a mathematics task. Only 7% of the participants indicate they are *experts* in planning the time they are going to spend on a mathematics task. The data are disturbing to the researcher because time management is an important self-regulating skill for being successful in completing a task (Pintrich, 2000:455) (*cf.* 2.3.4.1). The researcher concludes that many of the participants who took part in the study might not possess self-regulation strategies to enable them to plan their time effectively, which could result in their attempts to complete mathematics tasks being unsuccessful (Bannert & Reiman, 2012:194) (*cf.* 2.3.4.1).

For Question 1.4, the majority of the participants (36.7%) feel that they are *skilled;* while 21.9% feel they are *experts* in setting goals before they start a maths task. Participants who seem to be *novices* in attempting to set goals are the minority (6.3%), and 35.1% of the participants see themselves as being *able* to set goals before they start a maths task. The researcher concludes that in order to become experts, many of the participants who took part in the study seem to require more support in developing the self-regulating skill of setting goals before attempting a mathematics task. It is important to develop skills to set goals, as this will enable the participants to identify, and be more aware of obstacles on the way to achieve goals, which they may encounter (Bannert & Reimann, 2012:194; Boekaerts, 1996:107; Cazan, 2012; Ertmer & Newby, 1996:10 & 11; Pintrich, 1999:461; Schunk, 2005b:86; Zimmerman, 2008:166; Zumbrunn, *et al*., 2011:10) (*cf.* 2.3.4.1).

The results from Question 1.5 show that 15.6% of participants feel that they are *experts* in selecting strategies they are familiar with in applying and solving a mathematics problem, while 9.4% perceive themselves as *novices.* The majority of the participants (43.8%) perceive themselves as being *able* to select strategies to solve problems, and 31.2% feel they are *skilled* in selecting strategies to solve mathematics problems. Once again, the researcher is disturbed by these results, and draws the conclusion that too many of the participants apparently still need to become experts in knowing which strategies to choose to complete tasks. A lack of strategies to complete tasks could have a negative influence on the participants' ability to select main ideas in information and to apply them to solve problems or complete tasks (Bannert & Reimann, 2012:194) (*cf.* 2.3.4.1).

Based on the perceptions of the participants, it seems that the majority are not skilled experts in any of the aspects that involve the planning of their mathematics learning, as less than half of the participants who took part in the study regarded themselves as being *skilled* or *experts* in possessing effective self-regulating skills to plan their mathematics learning. The implication of the aforementioned observation is that the participants who took part in the study seem to lack meta-cognitive (strategies for goal setting and task completion), and motivational (identifying expectations) strategies (Zimmerman, 2000:17) (*cf.* 2.3.4.1) that are important for the self-regulation of the planning phase of the learning process.

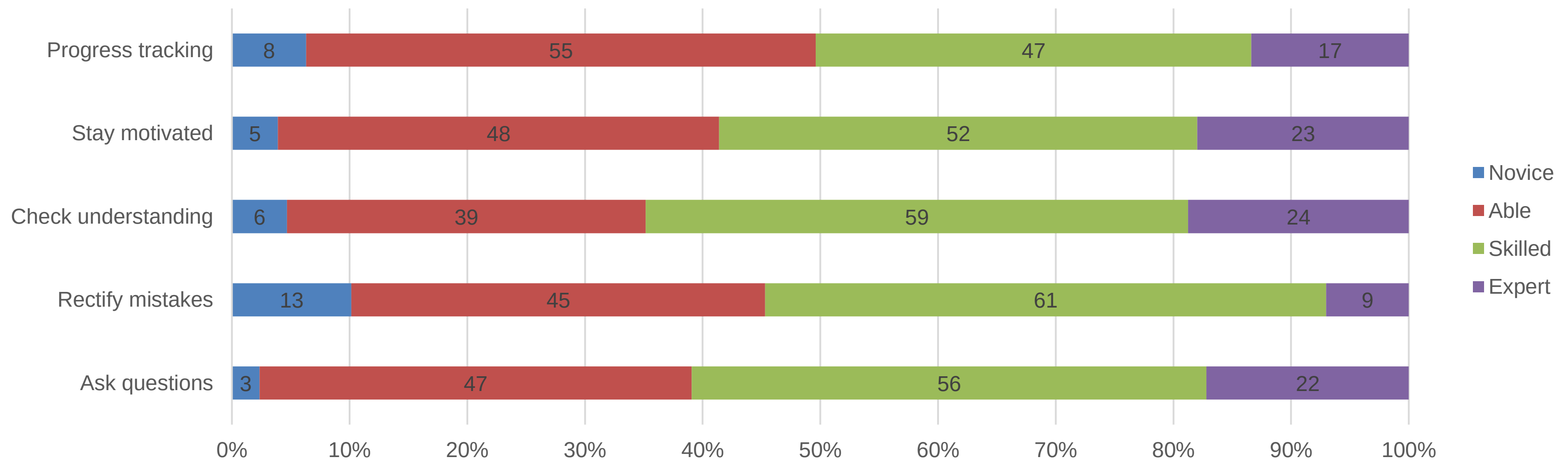
The following section focuses on the data analysis and interpretation for the participants' perceptions in relation to their self-regulating skills for monitoring learning.

4.4.2 Data analysis and interpretation: Monitoring

Table 4.8 represents the data obtained for Section B of the questionnaire, related to self-regulating skills for **monitoring** the completion of mathematics tasks.

Table 4.8: Participant responses: Monitoring

Question		Novice (1)		Able (2)		Skilled (3)		Expert (4)	
		f	%	f	%	f	%	f	%
2.1	When I am busy doing a maths task, I ask myself questions to make sure I understand what I am busy doing.	3	2.3	47	36.7	56	43.8	22	17.2
2.2	When I am doing a maths task, I can rectify my mistakes on my own if I do something wrong.	13	10.1	45	35.2	61	47.7	9	7.0
2.3	When I am doing a maths task, I ask myself continuously if I understand what I am doing.	6	4.7	39	30.4	59	46.1	24	18.8
2.4	When I am doing a maths task, I stay motivated to continue even if I experience problems.	5	3.9	48	37.5	52	40.6	23	18.0
2.5	When doing a maths task, I am able to keep track of my progress.*	8	6.3	55	42.9	47	36.7	17	13.3



From the responses to Question 2.1, it appears that 17.2% of the participants consider themselves to be *experts,* and 43.8% see themselves as being *skilled* at asking questions to ensure that they understand what they are busy doing. The participants who experience themselves as being *novices* make up 2.3%, and 36.7% of them feel they are *able* to ask themselves questions to make sure they know what they are doing in the mathematics task. The researcher concludes that these results could imply a lack of self-regulating skills to monitor mathematics task completion and to adjust aspects that affect the successful completion of a task. Moreover, the lack of monitoring skills could contribute to feelings of poor self-efficacy, helplessness and anxiety (Bandura, 1986:337, Bandura, 1993:123; Schunk, 2005b:87; Zimmerman, 2008:175) (*cf.* 2.3.4.2).

In response to Question 2.2, only 7.0% of the participants indicate that they are *experts* in rectifying their own mistakes. The majority of the participants (47.7%), feel they are *skilled* to rectify their mistakes, while 35.2% think that they are *able* to rectify their own mistakes, and 10.1% perceive themselves to be *novices* in rectifying their own mistakes. The researcher concludes that if learners are not experts in applying self-regulating skills to rectify their mistakes, it could become difficult for them to achieve their set goals successfully. To determine what changes should be made to achieve one's goals is an important mechanism to control learning and ensure its effectiveness (Schraw *et al.,* 2006:114; Schunk, 2005a:173) (*cf.* 2.3.4.2), which many of the participants appear to be lacking.

Continuous self-testing, like asking questions to determine what changes should be made to ensure the successful achievement of goals (Schraw *et al.,* 2006:114; Schunk, 2005a:173) (*cf*. 2.3.4.2), are important in self-regulation. Although 30.4% and 46.1% of the participants perceive themselves as *able* and *skilled*, respectively, the researcher is concerned that only 18.8 % perceive themselves as being *experts* in questioning their progress towards achieving goals. Some of the participants, 4.7%, appear to be complete *novices* in executing self-questioning/self-testing skills. The researcher therefore deduces that the participants who took part in the study may experience difficulty in achieving learning-goals successfully, due to the lack of well-developed self-regulating skills that involve self-testing/self-questioning.

Only 18% of the participants perceive themselves as being *experts* to stay motivated to continue with mathematics tasks, even when faced with problems. In addition, 3.9 %

perceive themselves as *novices,* and 37.5% and 40.6% indicate they are *able* and *skilled,* respectively, to stay motivated when they are doing a mathematics task. The responses alarm the researcher, as previous research studies have shown that motivation will include a willingness to put in an effort to reach goals (Zimmerman, 2008:175) (*cf.* 2.3.4.2) which, in turn, enhances self-efficacy and performance (Finn & Metcalfe, 2013:19; Zimmerman, 2008:175) (*cf.* 2.3.4.2). Only 18.0% of the participants perceive themselves to be *experts* in staying motivated and continuing with a task even if they experience problems with it. The researcher concludes that the participants who took part in the study may need to become more skilled in applying self-regulation strategies to motivate themselves even when they encounter problems with their tasks, in order to increase the chances of bettering their performance and increasing their self-efficacy (Bandura, 1993:131) (*cf.* 2.2.3.3). It is important to possess self-regulating skills to persist through difficult learning tasks, to enable one to find the task more rewarding when one reaches one's goal (Ertmer & Newby, 1996:12; Zimmerman, 2008:168, Zumbrunn, *et al.,* 2011:10) (*cf.* 2.3.4.1).

Only 13.3% of the participants experience themselves as being *experts* in keeping track of their progress when involved in task completion, while 36.7% and 42.9 % feel they are *skilled* and *able* to do so, respectively. It is disconcerting, that 6.3% appear to have no skills to track their progress when involved in task completion. One participant (0.8%) did not respond to the question. The responses are unsettling to the researcher, because keeping track of performance is an important skill to ensure greater performance success, as adjustments can be made in advance to avoid errors and obstacles which influence performance success (Boekaerts, 1996:107; Erlich & Russ-Eft, 2011:7; Ertmer & Newby, 1996:13; Pintrich, 1999:462) (*cf.* 2.3.4.1, 2.3.4.2).

In sum, it seems that the majority of participants who took part in the study also lack effective self-regulating skills to monitor their performance when working towards the completion of mathematics tasks, as the lowest percentages (between 2.3 and 10.1) were obtained for students who perceived themselves to be novices. Although the questionnaire responses indicated that the majority of the participants appeared to be *able* and *skilled* to monitor their work, the percentages obtained in each instance indicated that less than half of the group appeared to be able or skilled in monitoring. Based on the data, the researcher concludes that the participants who took part in the research lack meta-cognitive self-regulation strategies to continuously check their work, in order to correct behaviour and mistakes, and to keep track of progress, as well as motivational self-regulation strategies to become skilled at staying motivated and completing tasks during the monitoring stage of learning (Finn & Metcalfe, 2013:19; Zimmerman, 2008:175) (*cf.* 2.3.4.2).

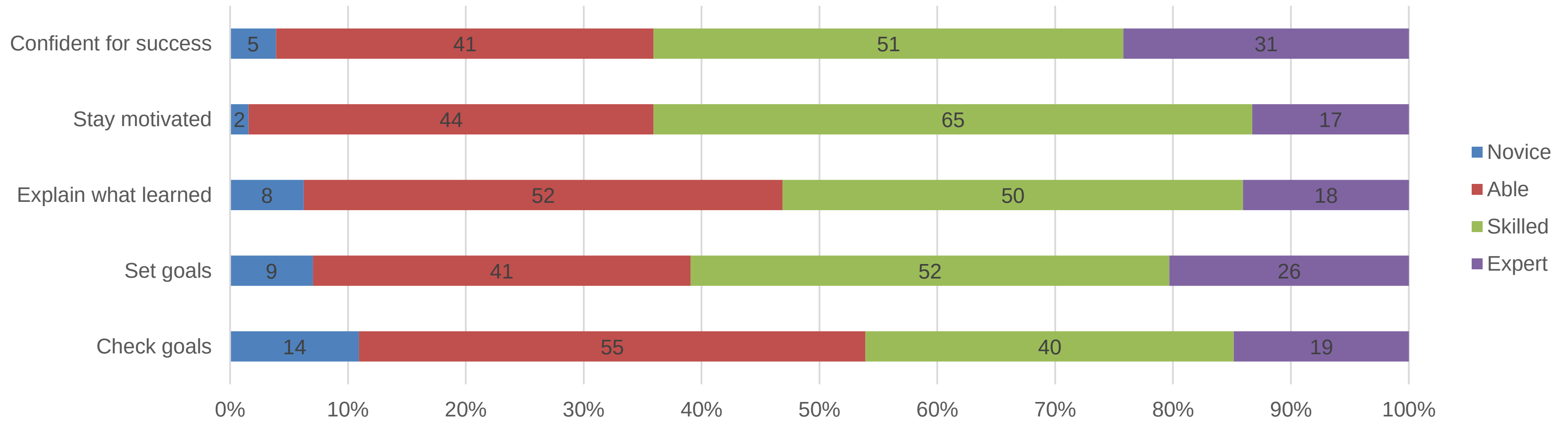
The following section focuses on the data analysis and interpretation for the participants' perceptions in relation to the application of self-regulating skills during the evaluation stage of learning.

4.4.3 Data analysis and interpretation: Evaluation

Table 4.9 below represents the data obtained for Section B of the questionnaire, related to self-regulating skills for evaluating the completion of mathematics tasks.

Table 4.9: Participant responses: Evaluation

Question		Novice (1)		Able (2)		Skilled (3)		Expert (4)	
		f	%	f	%	f	%	f	%
3.1	After completing a maths task, I know how to check if I have achieved the goals of the task.	14	10.9	55	43.0	40	31.3	19	14.8
3.2	After completing a maths task, I set goals that I would like to achieve.	9	7.0	41	32.0	52	40.7	26	20.3
3.3	After completing a maths task, I can explain what I have learned.	8	6.3	52	40.5	50	39.1	18	14.1
3.4	While I am working on a maths task, I stay motivated until I have completed the task.	2	1.6	44	34.4	65	50.7	17	13.3
3.5	When completing a mathematics task, I feel confident that I will succeed.	5	3.9	41	32.0	51	39.8	31	24.3



In the response to Question 3.1, the participants revealed the following: 14.8% indicate that they are *experts* in checking if they achieved the goals of a task, whereas 10.9% indicate they are *novices*. The majority of the participants appeared to be *able* (43%) and *skilled* (31.3%). It is important that learners become experts in checking for goal achievement, because being unsuccessful in checking for goal achievement could have a negative influence on the outcome of the learning process; implying poor achievement (Pajares & Schunk, 2001:246; Pintrich, 2000:460; Schraw, *et al.,* 2006:114; Zimmerman & Schunk, cited by Redmond, 2010) (*cf.* 2.3.4.3*;* 2.2.3.3; 2.3.3.1). It is cautiously assumed that not all of the participants have well-developed self-regulating skills to judge goal achievement according to desired expectations (Pintrich, 2000:460; Schraw, *et al.* 2006:114) (*cf.* 2.3.4.3).

Only 20.3% of the participants see themselves as *experts* in setting new goals they would like to achieve after the completion of a mathematics task (Question 3.2). Additionally, 7.0% perceive themselves as being *novices*, 32% and 40.7% regard themselves as *able* and *skilled* in setting new goals after task completion, respectively. Given the responses, as well as the responses to question 3.1, the researcher is concerned that many participants seemingly do not possess self-regulating skills to set ranking goals for themselves; and might therefore be incapable of identifying new goals to achieve, and tracking their progress towards achieving those goals (Schunk, 2005b:87) (*cf.* 2.3.4.3). In addition, because many of the participants also appear to lack strategies to enable them to become skilled at monitoring their work objectively (*cf.* Table 4.8), it is reasonable to assume that they possibly do not possess strategies to ensure that they become skilled at achieving goals successfully (Marcou & Philippou, 2005:303-304) (*cf.* 2.3.4.3).

The responses to question 3.3 revealed that only 14.1% of the participants indicate that they regard themselves as *experts* in explaining what they have learned after completing a maths task and 39.1% feel they are *skilled* to explain what they have learned. The participants who perceive themselves as being *able* and novices in explaining a maths task after completion were 40.5% and 6.3%, respectively. To be able to assess your understanding through conversation with peers is an important factor in self-regulation (Ertmer & Newby, 1996:5; Schunk, 2005b:87) (*cf.* 2.3.4.3). From the data, the researcher concludes that many of the participants apparently have not been exposed to teaching and learning environments to acquire self-regulation strategies to enable them to become skilled at reflecting on what they have learned (Pintrich, 2000:460; Schunk, 2005a:173) (*cf*. 2.3.4.3).

In response to staying motivated until a task has been completed (Question 3.4), only 13.3% of the participants indicate they feel they are *experts* in this regard. Half of the participants, 50.7%, indicate they regard themselves as *skilled* in doing so; while 34.4% feel *able* and 1.6% perceive themselves as *novices* in staying motivated. The upkeep of self-motivation is an indication of self-efficacy, which ensures persistence, and enhances the adaption of strategies to achieve goals (Marcou & Philippou, 2005:303, 304) (*cf.* 2.3.4.2). Although many of the participants indicated they feel they are able and skilled at staying motivated, there are still some participants who indicated they are not *experts* or *skilled* in feeling motivated. This finding perturbs the researcher because a lack of motivation to complete tasks could be linked to a lack of self-efficacy (not believing in one's own capabilities) (Perry & Steck, 2015:128-129; Tella, 2011:430) *(cf.* 2.2.3.3), or negative self-beliefs (perceptions of own worth) (Pajares & Schunk, 2001:243) (*cf.* 2.2.3.3). Problems in relation to self-efficacy and self-beliefs could result in a lack of perseverance and the amount of time invested in tasks which, in turn, impact the successfulness in mathematics task outcomes (Ertmer & Newby, 1996:20; Finn & Metcalfe, 2013:19) (*cf.* 2.3.4.2). The response to this question, aligns well with the response to question 2.4 in the previous section, where only 18% of the participants perceive themselves as being experts who stay motivated to continue with mathematics tasks when faced with problems.

Question 3.5 explored the feelings of confidence to be successful in mathematics task completion among the participants. In comparison to the other questions pertaining to evaluation, the data revealed that the highest proportion of participants appear to be *experts* (24.3%) who are skilled in regulating their confidence to succeed. Many of the participants also indicate that they perceive themselves as *skilled*, 39.8%, and *able*, 32.0%, to be confident about achieving success. The participants who indicated that they are *novices* and seemingly lack feelings of confidence to succeed, were 3.9%. This response signals some encouragement, because when a learner expresses his confidence in being successful when completing his task, it could be regarded as an indication that he can predict outcomes of his performances, manage his time well (Ertmer & Newby, 1996:20; Finn & Metcalfe, 2013:19) (*cf.* 2.3.4.3), and persist in adapting strategies to achieve goals (Marcou & Philippou, 2005:303, 304) (*cf*. 2.3.4.3). To this extent, Schunk (2005b:87) (*cf.* 2.3.4.2) also argues that a lack of confidence will result in not having the skills to track progress towards goals that need to be achieved.

Comparable to the self-regulating skills for planning and monitoring learning, the data in relation to evaluation of learning, also revealed that most of the participants who took part in the study seem to regard themselves as *able* to *skilled* in evaluating learning. However, only a few participants appear to regard themselves as *experts* in evaluating their mathematics learning. The researcher concludes that the participants require more effective meta-cognitive strategies (checking if goals are achieved) as well as motivational strategies (staying motivated and confident until a task is completed) to self-regulate learning during the evaluation phase of the learning process (Marcou & Philippou, 2005:303-304; Schunk, 2005b:87) (*cf*. 2.3.4.3).

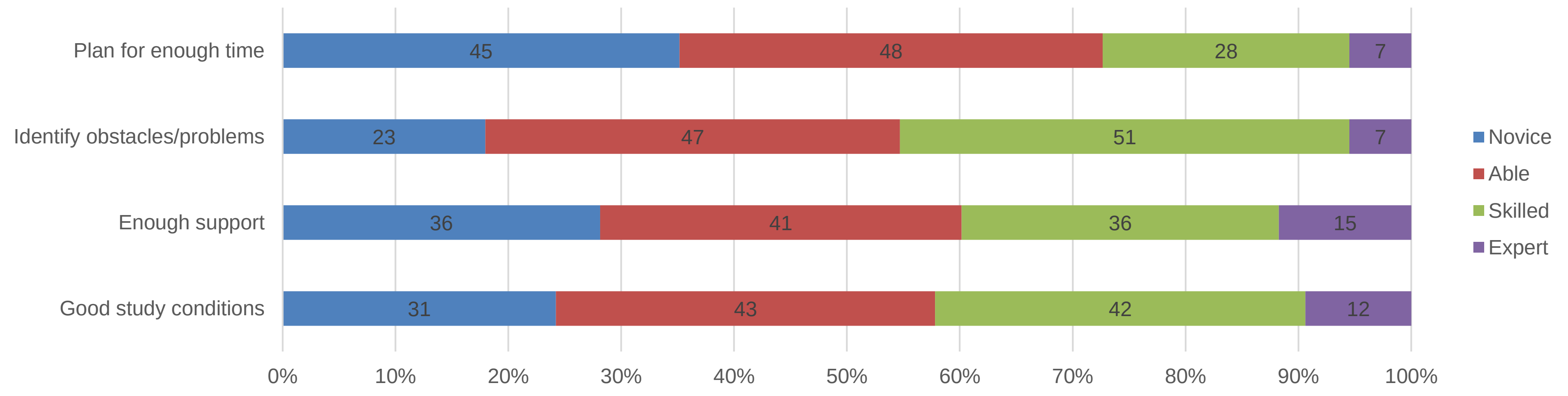
The next section analyses the data obtained for the questions in relation to the study environments of the participants.

4.4.4 Data analysis and interpretation: Study environment

Questions about the participants' study environment aimed to examine how the participants perceive their skills to self-regulate the conduciveness of their study environments. Table 4.10 below presents the data obtained for Section B of the questionnaire, related to self-regulating skills for ensuring conducive study environments.

Table 4.10: Participant responses: Study environment

Question	Novice (1)		Able (2)		Skilled (3)		Expert (4)	
	f	**%**	***f***	**%**	***f***	**%**	***f***	**%**
4.1 I have good study conditions when I want to work on my mathematical tasks.	31	24.2	43	33.6	42	32.8	12	9.4
4.2 I have enough support to assist me in completing my mathematical tasks.	36	28.1	41	32.1	36	28.1	15	11.7
4.3 I can identify the obstacles/problems that hinder me to complete my mathematical tasks.	23	18.1	47	36.7	51	39.8	7	5.4
4.4 When I am doing a maths task, I plan to allow myself enough time to complete the task.	45	35.2	48	37.5	28	21.8	7	5.5



In response to Question 4.1, it seems that only 9.4% of the participants view themselves as *experts* in ensuring that they have good study conditions when working on mathematical tasks. This response could be an indication that only a few participants appear to have skills to enable them to adjust their study environments to ensure optimum learning. In addition, 33.6% and 32.8% appear to be *able* and *skilled*, respectively, to ensure that they have good study environments. Given the participants' township backgrounds, it is not surprising that a staggering 24.2% apparently lack strategies to enable them to ensure good study conditions. The researcher concluded that many participants lack self-regulation strategies to enable them to become skilled experts at adapting or changing their study environments. This could imply that the participants' study environments do not ensure optimal study conditions and may contain many distractions that influence the success of achieving goals (Ertmer & Newby, 1996:3; Pintrich, 1999:462, Zimmerman, 2008:168) (*cf.* 2.3.4.1).

A small proportion, 11.7%, indicated that they regard themselves as *experts* in ensuring there is enough support to assist them in completing mathematical tasks. Many of the participants, 28.1%, consider themselves to be *novices* at ensuring study support. Furthermore, 32.1% and 28.1% rated themselves as *able* and *skilled,* respectively, in securing study support. Given the aforementioned data, the researcher argues that the responses of the majority of the participants create the impression that they possibly do not belong to working support groups and do not have assistance from their teachers or parents to increase their chances of success (Wolters, *et al.*, 2003:54) (*cf.* 2.3.4.1).

The participants' perceptions also show signs of an absence of well-developed self-regulation strategies to become skilled at identifying obstacles/problems that hinder them in completing mathematical tasks. Only 5.4% of the participants indicated that they view themselves as *experts* who can identify the obstacles/problems that hinder them to complete their mathematics tasks. A number of participants indicated that they perceive themselves as *novices* (18.1%), *able* (36.7%), and *skilled* (39.8%) in identifying obstacles/problems that could hinder task completion. Once again, the responses create the impression that many of the participants are not skilled experts, capable of organising their learning environment and eliminating distractions to ensure optimal learning (Maggioni & Parkinson, 2008:445-447) (*cf.* 2.4.1.2). Without eliminating obstacles or problems during learning, learners might feel anxious and helpless; they ultimately do not achieve their goals and miss the opportunity to renegotiate task requirements with their teachers (Bandura, 1986:337; Bandura, 1993:123; Schunk, 2005b:87; Zimmerman, 2008:168, 175) (*cf.* 2.3.4.2-2.3.4.4).

Self-regulation strategies to plan for enough time to complete a mathematics task seems to be the most problematic aspect regarding the creation of a study environment that is conducive to working on mathematical tasks in this section. In comparison to the other questions in this section, the responses to this question yielded the highest percentage of responses (35.2%) who regard themselves as *novices* in planning time properly for task completion. Only 5.5% of the participants considered themselves to be *experts* in planning time for task completion. Furthermore, 37.5% assessed themselves as being *able* and 21.8% as being *skilled* in planning time for competing tasks. The majority of the participants do not seem to be capable of managing their time so that task completion can take place effectively. Learners who are successful in managing their time, are successful in applying environmental self-regulation strategies (Pintrich, 2000:451; Schunk, 2005a:173; Zimmerman, 2008:168) (*cf.* 2.3.3.3), which ensures maximum learning (Zimmerman, 2008:167) (*cf.* 2.3.4.2).

In conclusion, the data only reveal that a few participants could be regarded as experts in ensuring a supportive study environment. The researcher therefore argues that the participants who took part in the study seemingly do not apply effective self-regulation strategies to make them skilled at self-regulating their study time, or to consider ways to enhance the study environment (Finn & Metcalfe, 2013:20; Zimmerman, 2000:21) (*cf.* 2.3.4.3).

The following section pays attention to the analysis of variables that could have influenced the outcomes of the research.

4.5 DATA ANALYSIS: INFLUENCE OF VARIABLES

To establish if there were any statistically significant differences between the learner responses obtained from the questionnaire in relation to the different biographical variables (gender, repetition of Grade 10, and living conditions), the responses were compared by considering the mean scores for each of the questionnaire sections. An

ANOVA was utilised to determine whether differences that occurred between the different biographical variables were statistically significant (Pietersen & Maree, 2016b:255). T-tests were utilised to determine whether differences that occurred were statistically significant (Pietersen & Maree, 2016b:250-253). Statistically significant values for *p* are below 0.05. To determine the effect size of the statistically significant differences, Cohen's *d* was calculated, and the effect sizes were interpreted as follows:

- 0.2: Small effect
- 0.5: Medium effect
- 0.8: Large effect (Pietersen & Maree, 2016c:234)

Means for the various sections in the questionnaire were calculated according to the ordinal scales utilised for classifying the questionnaire responses (1: *Novice*, 2: *Able*, 3: *Skilled*, 4: *Expert;* 1*: Almost always,* 2*: Often,* 3*: Sometimes,* 4*: Almost never*). In interpreting the results, it is important to note that the higher the mean, the more favourable the response, towards indicating perceived competence in the application of self-regulating skills.

The purpose of the Likert scale questionnaire was to examine the performance of individual items in a construct to identify specific deficiencies in relation to the application of self-regulating skills (*cf*. 4.4.1 - 4.4.40), but also to measure overall performance of the items as a group (Harpe, 2015:836-850).

4.5.1 Gender

In Table 4.11, the data are reported for the biographical variable, gender, in relation to the development of self-regulating skills.

Table 4.11: Gender

Section	Gender	n	$\bar{x}$	*s*	F	t	*p*	*d*	Effect size
Section B: Planning	Male	56	2.486	0.582	5.821	-0.753	0.017	0.120	Small
	Female	72	2.556	0.467		-0.733			
Section C: Monitoring	Male	56	2.599	0.489	0.000	-1.458	1.000	-	-
	Female	72	2.727	0.499		-1.462			
Section D: Evaluation	Male	56	2.725	0.609	1.049	0.602	0.308	-	-
	Female	72	2.664	0.536		0.592			
Section: E: Study environment	Male	56	2.334	0.622	0.916	2.227	0.340	-	-
	Female	72	2.100	0.563		2.200			

Statistical significance: $p < 0.05$

The above table indicates that a statistically significant difference between the responses of the male and female participants was only detected in relation to Section B of the questionnaire, pertaining to planning as self-regulation skill. The value of this statistical significance was $p < 0.05$, where $p = 0.017$, with a small effect size, $d = 0.120$. This result can be interpreted as such that the female participants perceive their self-regulating skills in relation to planning to be better than what their male counterparts perceive their skills to be, and that the difference between the males, ($\bar{x}$ = 2.486), and females, ($\bar{x}$ = 2.556), was not due to chance.

In line with the literature and the statistical consultation services, Cohen's *d* and effect sizes are only reported for statistically significant differences. According to Leech, *et al*. (2005:59), if the difference between means was not statistically significant, it would have been best not to make any comment about which mean was higher, because the difference could be due to chance. Likewise, if the difference was not statistically significant, Leech, *et al.* (2005:59) recommend that effect size should not be discussed or interpreted.

The standard deviations of both the male and female groups (*s* = 0.582, *s* = 0.467) were not large, indicating that there was not much variation between the responses of the participants in both gender groups.

4.5.2 Repetition of Grade 10

In Table 4.12, the data for the biographical variable regarding repetition of Grade 10, and perceptions in relation to the development of self-regulating skills are reported. This variable was included in the study as the researcher supports the argument that poor academic achievement could be an indication of poor self-regulating skills (Van der Walt & Maree, 2007:224) (*cf*. 2.3.4.4).

Table 4.12: Repetition of Grade 10

Section	Repetition Gr 10	n	$\bar{x}$	*s*	F	t	*p*	*d*	Effect size
Section B: Planning	Yes	11	2.400	0.447	0.061	-0.833	0.805	-	-
	No	117	2.537	0.526		-0.954			
Section C: Monitoring	Yes	11	2.450	0.455	0.002	-1.553	0.966	-	-
	No	117	2.692	0.497		-1.673			
Section D: Evaluation	Yes	11	2.636	0.650	1.041	-0.330	0.310	-	-
	No	117	2.696	0.563		-0.293			
Section: E: Study environment	Yes	11	2.727	0.467	1.536	0.402	0.217	-	-
	No	117	2.196	0.611		0.502			

Statistical significance: $p < 0.05$

The researcher is aware that the total number of responses needs to be taken into account when making comparisons. The group who did not repeat Grade 10 (n = 117), was much larger than the group who did repeat Grade 10 (n = 11). The smaller numbers could perhaps skew the data, as the group who repeated Grade 10 is underrepresented. The standard deviations however indicated that the responses within both groups were not widely dispersed around the mean.

The results obtained for Section B (planning), Section C (monitoring), Section D (evaluation) and Section E (study environment) indicated that there were no statistically significant differences between the perceptions of participants who repeated Grade 10 and the participants who did not repeat Grade 10, as $p > 0.05$, in all instances.

Based on the data, it seems reasonable to conclude that repetition of Grade 10 did not have an influence on perceptions regarding the application of self-regulating skills among the participants who took part in the research.

4.5.3 Living conditions

In the next table, Table 4.13, the data for the biographical variable living conditions in relation to the development of self-regulating skills are reported. The following living conditions applied: 1 = Living with both parents, 2 = Living alone (single), 3 = Living with a guardian, and 4 = Living with brothers and sisters. It could be argued that participants living alone and/or with brothers and sisters, possibly lack the most support for developing self-regulating skills.

Table 4.13: Living conditions

Section	Living condition	n	$\bar{x}$	S	F	*p*	*d*	Effect size
Section B: Planning	1	56	2.267	0.697	2.190	0.093	-	-
	2	41	2.329	0.652				
	3	28	2.566	0.809				
	4	3	2.607	0.872				
Section C: Monitoring	1	56	2.710	0.761	1.662	0.179	-	-
	2	41	2.682	0.773				
	3	28	2.641	0.800				
	4	3	2.066	0.801				
Section D: Evaluation	1	56	2.729	0.878	1.346	0.263	-	-
	2	41	2.737	0.863				
	3	28	2.607	0.806				

	4	3	2.133	0.696				
Section E: Study environment	1	56	2.160	0.937	0.718	0.543	-	-
	2	41	2.158	0.992				
	3	28	2.348	0.833				
	4	3	2.250	0.891				

Statistical significance: $p < 0.05$

The above table indicates that no statistically significant differences, $p < 0.05$, were noted for the responses of the participants from different types of living conditions, for any of the sections of the questionnaire. This implies that the participants from the different types of living conditions had similar perceptions regarding the development of their self-regulating skills. As no statistically significant differences were noted, there was no need to follow up the ANOVA with a *post hoc* test, Tukey's HSD (Honestly Significant Difference) test (McMillan & Schumacher, 2006:302).

4.6 DATA ANALYSIS AND INTERPRETATION: A COMPARISON BETWEEN THE PARTICIPANTS' RESPONSES FOR THE VARIOUS QUESTIONNAIRE SECTIONS

In order to determine whether there were any statistically significant differences between the responses obtained for the various sections of the questionnaire, the participants' responses were compared by using the mean scores for each of the questionnaire sections. T-tests were utilised to determine whether differences that occurred were statistically significant (Pietersen & Maree, 2016b:250-253). Statistically significant values for p are below 0.05. To determine the effect size of the statistically significant differences, Cohen's d was calculated, and the effect sizes were interpreted as follows:

- 0.2: Small effect
- 0.5: Medium effect
- 0.8: Large effect (Pietersen & Maree, 2016c:234)

The findings for the following data sets are regarded as new findings, as there was no known literature pertaining to comparing the different stages of self-regulation and determining during which stages learners appear to possess better developed self-regulating skills, based on the participants' perceptions.

Table 4.14 reports the means, standard deviations, and the statistical significance of the differences between the responses obtained for the various questionnaire sections.

Table 4:14: Comparison: Means for questionnaire sections

Section	n	$\bar{x}$	*s*	T	Sig *p*	Cohen's *d*	Effect size
B: Planning	128	2.525	0.519	-3.715	0.000	0.281	Small
C: Monitoring	128	2.671	0.497				
B: Planning	128	2.525	0.519	-3.793	0.000	0.292	Small
D: Evaluation	128	2.691	0.568				
B: Planning	128	2.525	0.519	4.306	0.000	0.537	Medium
E: Study environment	128	2.203	0.599				
C: Monitoring	128	2.671	0.497	-0.505	0.615	-	-
D: Evaluation	128	2.691	0.568				
C: Monitoring	128	2.671	0.497	7.030	0.000	0.781	Medium
E: Study environment	128	2.203	0.599				
D: Evaluation	128	2.691	0.568	6.701	0.000	0.814	Large
E: Study environment	128	2.203	0.599				

Table 4.14 indicates that the mean scores obtained for all the questionnaire sections fall between $\bar{x}$ = 2.203 and $\bar{x}$ = 2.691. One of the sections that stand out as having the highest mean score compared to the rest of the sections is Section D (Evaluation), with $\bar{x}$ = 2.691. The lowest mean score is observed for section E (Study environment), at $\bar{x}$ = 2.203. As mentioned previously, mean scores that are closer to 1 (*Novice*), indicate that perceptions indicate that the self-regulating skills appear to be underdeveloped.

A statistically significant difference, not due to chance, was noted for the comparison between the mean values for *planning* ($\bar{x}$ = 2.525) and *monitoring* ($\bar{x}$ = 2.671), with $p < 0.05$, $p = 0.000$, and a small effect size, $d = 0.281$. According to the data, the participants who took part in the study perceive the application of self-regulating skills for planning and monitoring differently. The participants perceive their skills for monitoring their work to be better than the skills for planning their work. However, being good at monitoring without proper planning will not achieve successful learning, because learners can only monitor their achievements according to goals they have set in their planning (Ertmer & Newby, 1996:13) (*cf.* 2.3.4.2). Nevertheless, the advantages of good monitoring skills are beneficial for altering strategies or choosing better strategies to reach desired goals and ultimately be successful in learning. Good monitoring skills will also help learners to manage their time and environment for maximum learning (Bandura, 1986:338; Finn & Metcalfe, 2013:19; Flavell, 1979:908; Schunk, 2005b:87; Zimmerman, 2008:167) (*cf.* 2.3.4.2).

A statistically significant difference was noted for the comparison between mean values for *planning* ($\bar{x}$ = 2.525) and *evaluation* ($\bar{x}$ = 2.691), as $p = < 0.05$, $= 0.000$, with a small size effect size of $d = 0.292$. The participants perceived their self-regulating skills for evaluating their work to be better than the skills for planning their work. During planning, learners should set their goals and during evaluation they should check if they achieved their goals. Without strategies to be skilled at properly planning work, clear goal setting is compromised, and the probability of achieving learning success is reduced (Schunk, 2005b:86; Zimmerman, 2008:166; Zumbrunn, *et al.,* 2011:10) (*cf*. 2.3.4.1). Good self-regulating skills during the evaluation of learning, will give the participants the opportunity to make adjustments to be more successful, where goals are not achieved; they would know how to attempt similar tasks in future, and their self-efficacy would be enhanced which would enable them to persist and complete tasks.

The comparison between the means obtained for *planning* ($\bar{x}$ = 2.525) and the *study environment* ($\bar{x}$ = 2.203) revealed a statistically significant difference, $p < 0.05$, $= 0.000$, with a medium effect size, $d = 0.537$. Thus, according to the data, the participants perceive their self-regulating skills for planning to be better than the self-regulating skills for ensuring a suitable study environment. This observation is disconcerting, as learners can only plan to set goals and manage their time if the study environment is conducive to learning (Zimmerman, 2008:167) (*cf.* 2.3.3.1). It is also justified to question the quality of the participants' planning if their study environments do not support learning.

A statistically insignificant difference was noted for the comparison between the mean values for *monitoring* ($\bar{x}$= 2.671) and *evaluation* ($\bar{x}$ = 2.691), with $p > 0.05$, = 0.615. The participants perceive their effectiveness in applying self-regulating skills for monitoring (keeping track of their progress) and evaluation (checking if they achieved their goals) as being similar. The means obtained for self-regulating skills to *monitor* and *evaluate* were higher than the means obtained for self-regulating skills to plan and secure a suitable study environment.

The comparison between mean values for *monitoring* ($\bar{x}$ = 2.671) and *study environment* ($\bar{x}$ = 2.203) indicated that the participants' perceived their self-regulating skills to *monitor* more favourable than their self-regulating skills to ensure a conducive *study environment*. A statistically significant difference, $p < 0.05$, = 0.000, was noted, with a medium effect size of d = 0.781. This finding could be regarded as an indication that the participants lack self-regulating skills to eliminate distractions in their study environments, and not being able to identify obstacles that might hinder them in maximising their learning and completing mathematics tasks effectively (Zimmerman, 2000:14) (*cf.* 2.3.2).

A statistically significant difference was noted for the comparison between the means of *evaluation* ($\bar{x}$ = 2.691) and *study environment* ($\bar{x}$ = 2.203), p < 0.05, = 0.000, with a large effect size, d = 0.814. The participants perceived the application of their self-regulating skills to evaluate their work more favourably than their self-regulating skills to ensure that their study environments are effective for learning. According to Pintrich (2000:460) and Schunk (2005a:173), if a study environment is not conducive to learning, it will have a negative effect on learners' evaluation processes, because they will not be able to plan their study time or determine whether their time was used efficiently. Furthermore, learners will not have the skills to adjust their study environment to be conducive to learning (*cf.* 2.3.4.3), and they will not be able to evaluate what was successful and unsuccessful in order to improve their future performance (Finn & Metcalf, 2013:20; Zimmerman, 2000:21) (*cf.* 2.3.4.3). The response to this question contradicts the response obtained for the comparison between planning and evaluation, according to which the participants perceive to be better skilled at evaluation than planning. According the literature well-developed self-regulating skills in evaluation enable learners to be more successful in choosing or adapting their learning environments for maximum learning, and in planning their learning time (Ertmer & Newby, 1996:5; Schunk, 2005b:87; Finn & Metcalfe, 2013:20; Zimmerman, 2000:21) (*cf.* 2.3.4.3). This argument does not seem to hold true for the participants who took part in the study, as they seem to have difficulty in ensuring a favourable study environment.

In the following section, the researcher analyses and interprets the responses obtained for the interviews with the participants who took part in the research.

4.7 DATA ANALYSIS AND INTERPRETATION: PARTICIPANTS' INTERVIEW RESPONSES

This qualitative section of the research specifically dealt with the major positive and negative findings obtained from the quantitative data analysis and interpretation. The participants were asked interview questions based on the findings obtained from the questionnaires which they completed. The researcher wanted to explore possible reasons for self-regulating skills that were perceived as *well-developed (skilled to expert)* and *not well-developed (novice to able)*.

In this section, the main themes that were identified from the verbatim transcripts of the interview data are highlighted. The discussion below is structured according to the questions in the interview protocol (*cf.* Appendix H).

Direct quotations from the interview transcripts are used to support the themes that the researcher derived from the responses. The researcher indicates the exact row number, as found in the verbatim transcripts (*cf.* Appendix I), as well as the number identifying a particular participant, e.g. 2:20, where 2 indicates the participant and 20 indicates the row number in the verbatim transcript.

In order to select the participants for the interviews, the mean scores of the individual participants on the four-point Likert scale were scrutinised, for each of the questionnaire sections. Based on the mean scores, two groups of participants were selected. The two groups included participants with perceived *average* to *strong* (skilled – expert) self-regulating skills ($\bar{x}$ = 2.95 – 4), and participants with perceived *weak to average* (able – novice) self-regulating skills ($\bar{x}$ = 1 – 2.94). The analysis and interpretation of the data is structured in two sections, according to the participants who represented the aforementioned groupings.

In the following section, the researcher presents the data analysis and interpretation of the participants who perceived their self-regulating skills not to be well-developed.

4.7.1 Data analysis and interpretation: Participants with apparent average to weak self-regulating skills

Table 4.15 below, indicates the participants with apparent "*average to weak"* self-regulating skills who took part in the interviews and who, according to the questionnaire data, regarded themselves as *able* or *novice* in the application of self-regulating skills.

Table 4.15: Participants with average to weak self-regulating skills

Participant number	Gender	Planning	Monitoring	Evaluation	Study environment	$\bar{x}$
2	F	1.4	2.2	1	2.25	1.68
5	M	3.2	3.2	3.4	1.5	2.89
7	F	2	1.6	2	1.75	1.84
8	F	3.2	3	2	2.5	2.68
9	M	2	2	2	1.75	1.95
12	F	2.4	2.6	3	2.5	2.63
13	M	2	2.2	1.8	1.5	1.89

The themes that were extracted from the verbatim transcripts in relation to each of the questions are discussed in the subsequent sections. The researcher acknowledges that the verbatim transcripts contain language errors, as the exact words of the participants are reported.

During the interviews, the researcher took time to explain the meaning of the different stages of the learning process to the participants, and what they involve, in order to enable them to understand the questions that were posed to them.

The subsequent sections focus on the responses of the participants in relation to the different interview questions.

4.7.1.1 Factors influencing planning when doing mathematics tasks

Question 1 aimed to explore the factors influencing the development of participants' self-regulating skills to plan effectively when doing mathematics.

According to Pajares (2008:111), Zumbrunn, *et al.* (2011:10) (*cf.* 2.5.2.7), learners should be encouraged by their teachers to set long-term goals. In addition, setting short-term goals will help them stay on track (Pajares, 2008:111; Zumbrunn *et al.*, 2011:10) (*cf.* 2.5.2.7). As part of the planning phase of learning, learners should choose the correct strategies or approaches for completing tasks. Planning also includes setting goals and planning the time to be spent on the task (Schraw, *et al*., 2006:114; Schunk, 2005a:173) *(cf*. 2.2.3.1). In addition, learners' motivational beliefs will lead to actions they will take to assess their performance and reflect on whether they have achieved the goals they set for themselves (Boekaerts, 1996:107; Erlich & Russ-Eft, 2011:7; Pintrich, 1999:462) *(cf*. 2.3.4.1).

The following four themes are extracted from the data.

Theme 1: Lack of understanding about what planning implies

Based on the responses of the participants, it is clear that they do not really understand what it implies to plan for the completion of work. Responses such as*: "I don't understand"* (2:34), *"I don't know to make goals…"* (13:54-56), "*I don't set goals really"* (9:35) and *"I don't have many skills…"* (8:41-44), testify to this lack of understanding about what planning implies. This finding supports previous research that reveals that learners in mathematics seemingly do not apply any self-regulation strategies, to become skilled self-regulators during the planning, monitoring, and evaluation of their mathematics work (Van der Walt, 2006:183) (*cf*. 1.1). It could also be argued that the teachers of the participants who took part in the study possibly do not nurture the development self-regulating skills in the mathematics classroom (Van der Walt, 2006:183) (*cf.* 1.1). The participants probably do not get the support they need to learn how to set clear goals, select suitable strategies to complete work, identify obstacles they may encounter, or determine how much time they need to achieve their goals (Boekaerts, 1996:107; Cazan, 2012; Ertmer & Newby, 1996:10 & 11; Pintrich, 1999:461; Schunk, 2005b:86; Zimmerman, 2008:166; Zumbrunn *et al*., 2011:10) (*cf.* 2.3.4.1).

Theme 2: Reliance on teachers to set goals

Unfortunately, it seems that many of the participants do not know how to set goals, and thus lack self-regulating skills to properly plan their task completion. This is deduced from the participants' responses which indicate that they wait for their teachers to set the goals for them. The following responses support the researcher's observation: *"No"* (2:96) [learner does not set goals], *"I don't know to make goals because I just want to write without making goals for myself*" (13:54-56), *"If I maybe have five questions and some of them I don't understand I keep trying*" (5:110-111), *"I wait for my teacher first*" (to set goals) (13:116), *"I wait for the teacher"* [to set goals] (9:113), *"I wait for my teacher to do it*" (12:112), *"Most of the times I wait for the teacher*" [to set goals] (8:138).

Theme 3: Lack of ability to set goals

Boekaerts (1996:107) argue that there are three central skills to apply to be able to achieve one's set of goals: Firstly, to form a clear mental picture of the learning goals to be achieved; secondly, a plan of action must be considered to achieve the goals; and thirdly, behavioural changes to be made to achieve the set goals must be considered *(cf*. 2.3.4.1). From the responses, it appears as if only one participant sets goals: "*I set my goals, eh, before I write the test*... *I want to manage or obtain"* (7:45 - 47), *"I set my goals first, so that when the teacher comes with the lesson, I already know that we are going to do that*" (7:98-100).

Two of the participants indicated that they do not know how to set goals. The following responses support the researcher's observation: *"No"* [learner does not set goals] (2:96), *"I don't know to make goals because I just want to write without making goals for myself*" (13:54-56).

Given the possible absence of skills to plan work in mathematics, those who took part in the study will most probably have difficulty in performing well on mathematics tasks and produce work of poor quality, due to the lack of skills in planning and setting goals (Bannert & Reimann, 2012:194; Cazan, 2012; Schunk, 2005b:86; Zumbrunn, *et al.*, 2011:10) (*cf*. 2.3.4.1).

4.7.1.2 Factors influencing the monitoring of mathematics tasks

Question 2 elicited information from the participants in relation to factors that could impact on the development of self-regulating skills to monitor work effectively. Based on the responses, the researcher identified three themes.

Theme 1: Lack of skills to monitor work

The first theme identified relates to participants' lack of self-regulating skills to monitor their work. Responses such as, "*I don't correct my mistakes"* (5:59), "*If I've writing, I just leave it like that"* (13:63), "*If I do something I tell myself it is fine"* (2:49), "*No"* [learner does not monitor] (9:44), "*I don't correct my mistakes*" (5:59-60), testify to the fact that seemingly the participants do not monitor their mathematics work. This observation aligns with previous research that indicated monitoring work as a weakness among many learners (De Corte, *et al*., 2000:694-695) (*cf.* 2.6.1). The researcher carefully concludes that if the participants fail to monitor their work, they will not be able to alter or improve on their current strategies for task-completion to better their problem solving skills in future (Boekaerts, 1996:107; Darr & Fisher, 2004; Finn & Metcalfe, 2013:19) (*cf.* 2.3.4.2, 2.6.2).

The responses could also point to a possible unwillingness among the participants to put in effort to monitor their work – a practise that would help them to make progress towards reaching their goals (Bandura, 1986:338; Flavell, 1979:908; Schunk, 2005b:87; Zimmerman, 2008:167) (*cf.* 2.3.4.2)

Theme 2: Making use of self-checking

Some participants self-check their work for mistakes as a self-regulation strategy to monitor the completion of their mathematics tasks. The following responses were received: "*Yes, I check but sometimes I get less that that I was hoping to get*" (7:61-63), *"I go back and check my mistakes"* (12:58-59), *"I check from start to finish so that I can* *rectify my mistakes"* (8:57-58). It is disconcerting that self-checking appears to be the only strategy that the participants (who took part in the study) use to monitor their work. Nevertheless, this strategy is helpful, and will enable the participants to pay close attention to their thinking patterns and make changes to the strategies they employ in order to become more successful in achieving their goals (Bandura, 1986:338; Schunk, 2005b:87; Zimmerman, 2008:167) (*cf.* 2.3.4.2).

Theme 3: Limited support from parents and friends during monitoring

Some participants indicated that they make use of support during monitoring: *"I work with my friends, we correct each other's mistakes, we help each other so that we can understand better"* (2:36-37), *"I go to my maths teacher, but when I'm at home I ask my mother for help"* (7:83-84).

According to the Department of Basic Education (2012:5-6), learners must be able to work effectively on their own as well as in a group (*cf.* 2.5.1). This could enhance their critical thinking and accuracy in mathematics (Department of Basic Education, 2012:11) (*cf.* 2.5.1). The responses received, support the view of Zumbrunn, *et al.* (2011:12) (*cf.* 2.6.3), who report that self-regulated learners are willing to seek help from others to achieve their goals, which gives them the opportunity to articulate their own mathematical understanding and enhance their cognitive development and thinking, as well as to create an opportunity for reflection about their progress towards achieving goals (Ertmer & Newby, 2013a:59; Finn & Metcalfe, 2013:19; Zimmerman, 2008:167; Zhou & Brown, 2014).

4.7.1.3 Factors influencing the evaluation of mathematics task outcomes

With Question 3, the researcher gained insight into the participants' perceptions regarding factors that impact the development of their self-regulating skills to evaluate mathematics task outcomes.

The researcher extracted two themes from the responses obtained.

Theme 1: Lack of understanding of what evaluation means

Self-regulated learners will evaluate the outcome of their task completion as well as the procedures and strategies they used to achieve their goals, in order to make adaptations for future task completion (Ertmer & Newby, 1996:13) (*cf.* 2.3.4.3). According to the responses of the participants, they apply the following strategies to evaluate their learning in mathematics: "*I try that in future I can try and memorise it",* (8:79). "*I do something incorrect I do it again* "(2:60), "*I don't understand what they talking with us in the class"* (9:49-51). From the responses, it seems as though the participants do not evaluate their mathematical processes and that they do not understand what is expected with the evaluation of work, and do not have self-regulation strategies to evaluate their work. It seems fair to argue that if the participants do not understand what evaluation of work means, they will also not be equipped to engage in the evaluation of their work. When the participants are not capable of evaluating their mathematics tasks, and if they do not know if they have achieved their goals, it could have a negative influence on their self-efficacy beliefs that could lead to demotivation which, in turn, could lead to avoiding task completion and claiming it being too difficult, without putting in an effort to be successful (Bandura, 1993:133; Pajares & Schunk, 2001:242) (*cf.* 2.3.4.3).

Theme 2: Passive approach to evaluation

Zumbrunn, *et al.* (2011:5) (cf. 2.3.4.3) emphasised that self-regulated learners will evaluate the process that was used to achieve goals to establish how effective goal achievement was. Evaluating the participants' responses indicates that they seem to have a passive approach to their learning, and rely on the teacher's feedback when marking their work. In this regard, the participants said the following: "*When I give someone my papers, so that he* [the teacher] *can rectify, if he* [the teacher] *tells me, if* [the teacher] *tells it is correct then and it is correct*" (13:80-82), "*Like, after my teacher mark my script, ja, I just check what's wrong I did wrong*" (12:68-69), "*Just let my teacher to mark, so that I can see, ok I did mistake here*" (5:60-61), and *"Sometimes I get less that that I was hoping to get, but some, at times I get more than what I had hoped for"* (7:61-63).

The responses of the participants seem to testify to a lack of self-regulating skills to evaluate task outcomes in mathematics. This could imply that the participants lack a personal understanding of what strategies worked or did not work during task completion, thus hampering their ability to consider improvements for future performance (Finn & Metcalfe, 2013:20; Zimmerman, 2000:21) (*cf*. 2.3.4.3).

4.7.1.4 Factors influencing securing a suitable study environment

Question 4 explored the participants' perceptions about securing a supportive study environment, and a description of their study environment.

The following three themes could be extracted from the responses of the participants.

Theme 1: Absence of a suitable study environment

Self-regulated learners control their environment to improve their study time and study space (Ertmer & Newby, 1996:5; Schunk, 2005b:87) (*cf.* 2.3.4.3). In addition, learners who can manage their environments are successful in managing their time and create an environment for maximum learning (Zimmerman, 2008:167) (*cf.* 2.3.3.4). It is disturbing that only two participants seemingly have a suitable study environment. They responded as follows: "*Yes*" [this learner does have place to study; did not indicate where] (2:76) and "*At school and before I leave school, I met my friend here for 80 minutes and at home I work 2 hours*" (7:69-71).

Five participants indicated that their study environments are not conducive for successful learning, implying that they are not able to focus and concentrate on achieving their goals, and possibly also lack materials or resources to be successful in achieving goals (Pintrich, 1999:462; Zimmerman, 2008:167) (*cf*. 2.3.4.1, 2.3.3.4).

Theme 2: Noisy study environments

A study place must preferably be a quiet place where optimal study opportunities exist (Ertmer & Newby, 1996:3; Zimmerman, 2008:168) (*cf.* 2.3.4.1). Self-regulated learners can choose a study environment which is optimal for learning and reflect on ways to change environmental conditions if it is not conducive to learning (Pintrich, 2000:460; Schunk, 2005a:173) (*cf.* 2.3.4.3). It seems as though some of the study environments are not conducive to learning according to the responses of some participants: "*Because every time when I study home, then my environment keeps on making noise, then I can't really study so well"* (13:86-88), "*I can hear music louder musics outside and focus on the song not on my books"* (9:67-69), and *"Like, there is always noise"* (12:76), *"The neighbours are making noise most"* (12:80), and "*The study environment sometimes it's bad because my little sister is making noise and I can't study"* (5:73-76). The responses could imply that the participants do not have the self-regulating skills to make changes to their learning environments.

Theme 3: Crowded households

The study environments of some of the participants seem to be unsuitable to maximise learning, due to crowded households. In this regard, the responses indicated the following: *"Yah, there are and my niece"* (9:74), *"Yah, sometimes she disturbs me in many ways"* (9:83), and *"I don't spend much time practising, cause sometimes, like at home I don't have that time because we are very busy at home, like, there is a large number of people so, even if I try to practise, but I can't because there is a lot of us at home"* (8:42-46).

The researcher is of the opinion, that the study environments described above will not enable the participants to concentrate and focus on their learning due to continuous noise and being crowded, which could influence their academic performance, motivation and self-efficacy beliefs negatively, when they fail to achieve their goals (Bandura, 1999b:23-27; Pintrich, 1999:462; Zimmerman, 2008:168) (*cf.* 2.3.3.4; 2.3.4.1).

4.7.1.5 The role of the mathematics teacher in developing self-regulating skills

With question 5, the researcher aimed to explore whether and how the mathematics teachers contribute to the development of the participants' self-regulating skills.

From the responses, the researcher derived the following theme.

Theme 1: A teacher-centred teaching approach

Conventionally, mathematics learning goals focused on the mastering of facts and procedures, whereas currently, the focus is on making sense of and solving real-life problems (Ocak & Yamaç, 2013:381) (*cf.* 2.5). Subsequently, learners have to become self-regulated and less dependent on their teachers; take responsibility for, and play an active role in their own learning processes (Boekaerts, 1996:100; Dignath & Büttner, 2008:232; Medina, 2011:150; Zimmerman, 1986:307) (*cf.* 2.5). For this purpose, self-regulating skills are important to enable learners to interact with mathematical ideas in an active and constructive way (Darr & Fisher, 2004; Van der Walt & Maree, 2007:223; Sadi & Uyar, 2013:22; Department of Basic Education, 2012:5) (*cf.* 2.5).

Gleaned from the responses, it seems as though the participants do not generally take responsibility for their own learning. Only one learner mentioned something vaguely related to taking responsibility for learning: *"And is for to go home to do the work and understand it, it's up to us*" (9:89-90). The response does however not provide evidence that the participant knows how to take responsibility for learning.

Classroom environments where teaching is learner-centered, project-based, or problem-based and inquiry-driven, tend to influence learners' attitudes positively, promote self-regulated learning, enhance their mathematical insight and increase their performance in mathematics (Ocak & Yamaç, 2013:381; Paris & Paris, 2001:93, 94) (*cf.* 2.5). Derived from the participants' responses, it seems as if their teachers do not enhance the development of self-regulating skills in the mathematics classroom. The following responses were noted: "*He* [the teacher] *always ask us, do you understand"* (2:111), *"He* [the teacher] *makes sure that I understand*. *Even ask me that do I understand"* (8:112-114), *"Sometimes he* [the teacher] *give us after, after extra classes so that we can understand what we don't understand during the lesson"* (7:78-80), *"When he* [the teacher] *gets on the new topic, he* [the teacher] *explain it and give us work* "(9:86-87), and *"No"* [the teacher does not help] (5:81).

In support of the research findings of Van der Walt and Maree (2007:235), the participants who took part in the research seemingly get little support from their teachers to develop and practise self-regulation strategies to become skilled at enhancing the quality of their mathematics task completion. This might also influence the learners' attitudes towards mathematics negatively and could decrease their mathematics achievements (De Corte, *et al.*, 2000:697; DaSilva-Marini & Boruchovitch, 2014:324) (*cf.* 2.7.1).

Given the aforementioned responses indicating limited support from the side of the teacher, the researcher wished to understand if the participants have other sources of support for completing their mathematics tasks.

4.7.1.6 Help-seeking and support when completing mathematics tasks

With Question 6 the researcher wanted to gain insight into the resources that the participants employ for help-seeking in completing mathematics tasks.

Help-seeking is regarded as an important factor in a learner's study environment (Zumbrunn, *et al.,* 2011:12) (*cf.* 2.6.4). Seeking help from their peers and teachers plays an important part in self-regulation, because help-seeking enables a learner to become more motivated, improves their academic achievements, and encourage them to become more independent in their learning (Ryan & Kaplan, cited by Zumbrunn *et al.,* 2011:16) (*cf.* 2.6.3). In particular, collaborative or cooperative learning, where learners work together in small groups toward achieving a common goal, seems to hold merits for advancing self-regulated learning (Hatami, 2015:2164) (*cf.* 2.6.6).

Three themes were extracted from the responses of the participants on seeking help and support, when they complete a maths task.

Theme 1: Seeking help from family and friends

The participants appear to have confidence in asking help from their friends. In this regard, they noted the following: "*Even my mom helps me with my homeworks*" (2:72), "*I am asking my friend*" (2:88), *"Work with my friend so that we can fix each other's mistakes"* (7:36-37), "*I go to my friend which is Charity. She knows maths very well and I ask her some questions"* (13:99-100), *"This cousin of mine he was doing maths and science at school so sometimes I go to see him to help me"* (5:119-121), *"My mother my father my family"* [support me to complete maths tasks] (2:69), and *"My mother is very supportive"* (7:75).

Self-regulation should be demonstrated, taught, and rewarded; and parents should support the development of self-regulation (Zimmerman, 2000:26) (*cf.* 2.6.1). Although the support of parents seems evident, the researcher concludes that this support may refer to support in general, and might not specifically apply to the development of self-regulating skills, as the responses to the questionnaire items pointed to a lack of well-developed self-regulating skills. It would however be necessary to explore whether parents are knowledgeable about how to assist in the development of self-regulating skills, before coming to a final conclusion about the role of parents in supporting the development of self-regulating skills.

Theme 2: Seeking help from the teacher

Although it appeared from the previous question (*cf.* 4.8.1.5) that teachers appear not to enhance self-regulating skills, some participants do approach their teachers for help. The following responses were received: "*Yeh, after school go to my teacher and help me with maths"* (12:94-95), and *"The class teacher and the teachers around the school. Because they are the ones I ask help from"* (8:141-142). Although it seems as if teachers provide support to participants to help them with their mathematics tasks, the participants who took part in the study are not given opportunities to take responsibility for their own learning, and they stay dependent on the teacher. Teachers seemingly do not model self-regulating strategies that the participants could practise and apply to develop problem solving skills.

Theme 3: Inability to seek help

From the responses, it became clear that some participants do not seek help. If learners do not seek help, they might not adapt to their learning environments, or be able to remove obstacles that negatively impact on their learning (Pintrich, 2000:455) (*cf.* 2.3.4.1).

In this regard, the following responses were received: *"There is nowhere I can go and ask for help"* (8:89-90), and "*I leave it just like that*" (9:97). The researcher concludes that lack of help could influence the success of achieving learning goals (Pintrich, 1999:462; Zimmerman, 2008:168) (*cf.* 2.3.4.1).

4.7.1.7 Motivation and mathematics

As motivation plays an important role in self-regulated learning (*cf.* 2.3.3.3), and appeared to be a problematic issue that emanated from the questionnaire responses (*cf*. Table 4.8), Question 7 aimed to explore how motivated participants are to do mathematics.

Motivational strategies play an important role in self-regulation; they ensure willingness to complete a mathematical task and to achieve the set goals (Zimmerman, 2008:175) (*cf.* 2.2.3.2). Strong self-efficacy beliefs will also motivate a learner to persist with task completion. In addition, if learners view a topic as being important and are interested in the topic, they will adapt their strategies to achieve their goals (Marcou & Philippou, 2005:303, 304) (*cf.* 2.3.3.3).

The researcher extracted three themes from the responses to the question.

Theme 1: Life improvement

The participants expressed an eagerness to better their lives by taking mathematics as a subject, as it will provide them with more career opportunities. The participants cited the following: "*Like if I can do it I can learn more things*" (2:93), *"Eh, my work because like, what I see people are in our environment, I feel so depressed because they hurting me. I wonder why they, they are not educated, but me I want to be very educated*" (7:89-92), and *"The career that I have chosen need maths and the people who motivate me, they make me to believe that I can make maths"* (13:105-107).

Theme 2: Mathematics promotes intrinsic motivation

Positive motivational strategies include positive self-talk (e.g. *I can do this*), well-developed self-efficacy and willingness to put in an effort (Bandura, 1986:337; Bandura, 1993:123; Schunk, 2005b:87; Zimmerman, 2008:175) (*cf.* 2.2.3.3). It appears that the participants motivate themselves through positive self-talk and willingness to put an effort into their mathematics to ensure that they pass. Examples of responses supporting the aforementioned are: "*I just want to persist"* (12:106), and "*I motivate myself, yes, I motivate myself that I am going to pass this thing*" (8:131-132).

Theme 3: Absence of motivation

People who lack self-efficacy and motivation will slower their pace when faced with difficulties or perhaps give up totally (Bandura, 1993:131) (*cf.* 2.2.3.3). According to the following statements of the participants, a deduction could be made that they might not be successful in mathematics because they probably lack confidence and could become demotivated, due to a lack of well-developed self-regulating skills. Self-efficacy and motivation are critical parts of being successful in mathematics (Bandura, 1993:133; Pajares & Schunk, 2001:242) (*cf.* 2.2.3.3). The participants indicated the following: "*I sometimes the question and I don't understand it. Sometimes I've been disturbed, so I can't focus*" (9:107-109), "*Thing that I can't understand they make me give up"* (5:97).

4.7.1.8 Exceptions

Three of the participants had overall averages that corresponded with the *weak* to *average* self-regulating skills group, but achieved averages that corresponded with the *average* to *strong* self-regulating skills group for some of the self-regulating skills in relation to the stages of learning.

For these exceptions, questions were formulated to explore the positive responses noted among the participants.

- Participant 12 perceived that he possesses self-regulating skills to evaluate his work. The researcher explored the possible reasons for this. In this regard he mentioned: *"I wrote my task, I prepare myself first*... *After writing what I am writing I go back and check my mistakes"* (12:40-41), and *"Like, after my teacher mark my script, ja, I just check what's wrong I did wrong*" (12:68-69). The response of the participant indicates that he makes use of a self-checking strategy that could enable him to be assess the successfulness of completed work.
- Participant 7 perceived that she possesses self-regulating skills to plan and monitor her work. According to the participant, possible reasons that contribute to this could be the following: *"I set my goals, eh, before I write the test I make an effort at the marks is 100 marks. I want to manage or obtain 70*" (7:45-47), and *"I work with my friends, we correct each other's mistakes, we help each other so that we can understand better"* (2:36-37). Participant 7 seemingly sets goals as part of the

planning phase of learning and employs resources (friends) to enrich her study environment.

- Participant 8 apparently possesses well developed self-regulating skills to plan, monitor, and evaluate his work. He only has a problem related to the study environment that possibly contributed to the poor average noted for his questionnaire average. He mentioned the following about the skills to plan, monitor, and evaluate his work: "*I check from start to finish so that I can rectify my mistakes"* (8:57-58), and *"I try that in future I can try and memorise it, yeh, so that it makes it easy for me to don't forget such, such important things"* (8:79-80). Participant 8 also makes use of self-checking to spot mistakes. However, the strategies employed for planning and evaluation are not very sophisticated to conclusively indicate that the participant could be regarded as an expert in the application of self-regulating skills.

Although it appears that the three participants employ some efforts to benefit their learning, these efforts appear not to be purposively and intentionally acquired through modelling and practise with the aim to become expert self-regulated learners.

In the following section, the researcher explores the responses obtained from the participants who appeared to have average to strong self-regulating skills.

4.7.2 Data analysis and interpretation: Participants with apparent average to strong self-regulating skills

Table 4.16 below, indicates the participants with apparent *average* to *strong* self-regulating skills who took part in the interviews.

Table 4.16: Participants with average to strong self-regulating skills

Participant number	Gender	Planning	Monitoring	Evaluation	Study environment	$\bar{x}$
1	M	3.6	3	3.8	3.5	3.47
3	M	2.8	3.4	3.6	3.5	3.32
4	F	3.4	3.8	3.6	2.25	3.32
6	M	3.2	3.4	3	2	2.95

10	M	3.2	3.6	3.4	1.5	3.00
11	F	3.6	3.4	3.4	2.75	3.32
14	M	2.8	3.4	3.8	2.5	3.16
15	F	2.8	3.6	3	2.75	3.05
16	F	3	2.6	3.8	2.25	2.95

The themes that were extracted from the verbatim transcripts in relation to each of the questions are discussed in the subsequent sections.

4.7.2.1 Factors influencing planning when doing mathematics tasks

Question 1 aimed to explore the factors contributing to the development of participants' self-regulating skills to plan effectively when doing mathematics.

Based on the participants' responses, the researcher extracted two themes in relation to planning.

Theme 1: Lack of understanding what planning entails

According to Boekaerts (1996:107) (*cf.* 2.6.8), there are three important skills when setting goals and achieving the set goals. Firstly, a clear mental picture should be formed of the goals that they want to achieve; secondly, a plan of action must be set to achieve these goals; and thirdly, the plan of action should be monitored.

Even though this group of participants appeared to have self-regulating skills to plan their mathematics task completion, their responses in relation to what assists them to be effective in planning indicated otherwise. During planning, clear goals should be set and strategies selected to achieve those goals. In addition, the time required in order to achieve goals should be planned (Ertmer & Newby, 1996:11-13; Paris & Paris, 2001:89) (*cf.* 2.3.4.1). There is no evidence in the participants' responses that indicates that they know how to set clear goals, or how to manage their time to achieve set goals. Responses indicated the following: "*I started planning on things that I don't know*" (16:55-57), "*So after maybe I see that I have a problem or something I just go on my book again and revise it and revise it. After I see maybe this ain't working for me tomorrow when we get in class I firstly ask my teacher*" (6:42-48), *"I haven't set my time properly"* (10:35), *"I'm* *not good at planning because I study everything that I am about to write a day before writing the test"* (15:28-30), and *"I don't write my goals Ma'am. So, I put them in my mind"* (4:36-37).

It also appears that the participants are not encouraged to set their own goals, as indicated by two of the participants: "*[I] wait for the teacher*" (to set goals) (10:119), *"No*" [participant does not set goals] (11:47).

Although some participants claim that they set goals, they were very vague in clarifying what it means to set goals and what strategies they employ to ensure that they achieve the goals. Their responses included statements such as: "*I set new goals 'cause when you wait for someone, eish, it's a waste of time sometimes*" (16:144-145), "*Ye I do based on what, like, what I've saw and what I write. I do. And then I make sure that they are balancing* "(6:129-131), "*I do set my own goals"* (15:70), "*Yah, I do"* (3:124) "*I look at what I did wrong and what I did right that I can so actually approve my marks"* (3:126-127), *"I know how to manage my time I know how to balance my hobbies and my school* work" (1:104-106), and *"My goal like is to pass like mathematics at least 60% by half year"* (14:123-124).

Theme 2: Limited strategies to plan

Some of the participants' responses indicated that they have limited strategies to benefit the planning of their work: "*I have a study timetable where I check, like, which subjects that I am less, am less able to do*" (3: 38-39), *"I use my books and my previous tasks that my teacher gives to me, so that I can set my goals" (*1:32-34), *"I set like the time like how long should I do it"* (14:39-40).

It seems as if acknowledging the importance of time management is a strategy used by two of the participants as part of planning (Zimmerman, 2008:167) (*cf.* 2.3.4.2). The researcher assumes, with caution, that strategies to plan work are not taught explicitly in schools. In the absence of self-regulation strategies to plan, the participants might not achieve satisfactory mathematics academic performance (Zimmerman, 2000:27) (*cf.* 2.7.1).

The conclusion drawn from the interviews is that if the participants do not understand what planning entails, it is unlikely that they will be skilled in planning, and possibly overestimated their skills to plan during the completion of the questionnaire. The participants might stay dependent on their teachers, which might also result in unfinished mathematics tasks and the quality of the tasks not being on par (De Corte, *et al.,* 2000:697; DaSilva-Marini & Boruchovitch, 2014:324) (*cf.* 2.7.1).

In essence, this group of participants seem to be no different to the *weak* to *average* group of participants, and also appear to lack self-regulation strategies that would enhance the skilful planning of their learning (Pintrich, 1999:461; Schunk, 2005b:86; Wolters, *et al*., 2003:9; Zimmerman, 2000:17) (*cf.* 2.3.4.1).

4.7.2.2 Factors influencing the monitoring of mathematics tasks

Question 2 elicited information from the participants in relation to factors that possibly contributed to the development of their self-regulating skills to monitor work effectively.

During the monitoring stage of the learning or task completion process, self-regulated learners will check whether they are on track to reach the goals they set (Ertmer & Newby, 1996:11-13; Paris & Paris, 2001:89) (*cf.* 2.3.4.2).

From the participants' responses, two themes are apparent.

Theme 1: Self-checking as a monitoring strategy

Participants cited examples of the types of strategies they use to monitor their work. The following strategies were mentioned: *"Yes"* [participant can monitor to identify mistakes] (6: 67), *"I am naturally gifted*" [to track progress when doing mathematics] (6:67), *"I check everything that I have written to see that there are no mistakes"* (15:35-37), *"Yes, I check my mistakes and I just go back and see like, yes, like the progress"* (14:50-51), *"Well, I actually double check. I start again and see how did I get that answer and if it's the correct answer or not*" (3:54-56), and *"I studied for days, practise my maths"* (1:42-43).

Some of the participants indicate that they check for correctness of a mathematical task and put in an effort to be successful in obtaining the correct answer (Bandura, 1986:338; Finn & Metcalfe, 2013:19; Flavell, 1979:908; Schunk, 2005b:87; Zimmerman, 2008:167) (*cf*. 2.3.4.2). However, it appears that self-checking is the only strategy applied for monitoring work, implying that the participants seem to have a limited repertoire of strategies to become skilled at monitoring the quality of their work.

Theme 2: Ignoring monitoring procedures

According to the following responses, the participants indicated that they do not monitor at all.

"No. I can't see because I don't like to go back and check on that I failed, maybe" (16:65-66), *"I'm not doing it right. I must submit it to someone to check it for me, then show me the mistakes, yes"* (11:65-66), and *"I didn't monitor at all" (4:44), "I just I just do when I can Ma'am. I don't force to do it, when I can't"* (4:48-49). The response obtained from participant 10 appeared to be irrelevant, and referred to giftedness in relation to monitoring effectively: "*Well I am naturally gifted"* (10:42).

Zimmerman (2008:175) (*cf.* 2.3.4.2) indicated that employing motivational strategies for monitoring means that there is a willingness from learners to put in an effort to reach a planned goal. In support of the literature, the researcher concludes that the apparent ignoring of monitoring procedures, could be linked to a lack of confidence to complete a task (Ertmer & Newby, 1996:20; Finn & Metcalfe, 2013:19) (*cf.* 2.3.4.2). Although the questionnaire responses revealed that the participants perceived their self-regulating skills to monitor their work, similar to planning, as *skilled to expert*, it seems as if they are under a false impression about the quality of the self-regulation strategies they possess to be skilled in monitoring the completion of their work.

4.7.2.3 Factors influencing the evaluation of mathematics task outcomes

With Question 3, the researcher gained insight into the participants' perceptions regarding factors that possibly influenced the effective development of their self-regulating skills to evaluate mathematics task outcomes

During the evaluation phase of learning, a self-regulated learner assesses how successful he was in attaining set goals (Ertmer & Newby, 1996:11-13; Paris & Paris, 2001:89) (*cf.*1.1).

Participants shared their views about what contributes to their being able to evaluate the outcomes of their work in mathematics. The researcher identified two themes from the interview data.

Theme 1: A lack of strategies to evaluate work

Although this group of participants was classified as perceiving their evaluation strategies to be *average* to *strong*, it was disturbing that during the interviews it became clear that they actually do not have strategies to evaluate their learning. The following responses were received: "*When I get a report and I see my marks, are my you know my achievement for mathematics. So that is where I see where my weakness"* (16:75-77), "*I'll see by my marks like did I achieved this thing or not"* (6:76-77), "*I'm not doing it right. I must submit it to someone to check it for me, then show me the mistakes"* (11:65-66), "*I don't, I don't check, Ma'am, when I done it or not"* (4:53), and "*I'm like I check with my previous reports and my previous tasks" (*1:55-57).

Given the responses, it seems unlikely that the participants possess sophisticated strategies to evaluate the outcomes of their work and may, therefore, not be capable to make changes in their behaviour to improve their future performance (Zumbrunn, *et al.,* 2011:5) (*cf.* 2.3.4.3).

Theme 2: Willingness to evaluate and improve

Some of the participants indicated a willingness to change their behaviour to create a better outcome in future when doing similar tasks (Pintrich, 2000:460; Schraw, *et al.,* 2006:114) (*cf.* 2.3.3.3). The following responses support the observation made: "*The next test I'm gonna do much better because although I see what I'm struggling with and I make sure that I know everything that I am struggling with"* (15:43-45), *"Yes, I do, but always you won't see all the mistakes you've done"* (14:61-63), *"I mean you actually go back to that question and evaluate and like, redo that that question"* (3:66-68), and "*I check twice after I have written and then if I written wrong I write I ask someone"* (10:58-59).

Although the willingness to improve seems to be present, the strategies that are used to be skilled at evaluating learning, appear to be under-developed. It seems fair to argue that the participants do not possess effective strategies to evaluate work or to improve on efforts. Strategies to evaluate work should first be acquired and practised, before participants can become skilled at evaluating learning.

4.7.2.4 Factors influencing a suitable study environment

Question 4 probed the participants' perceptions about possible factors contributing to a supportive study environment, and a description of their study environments.

In relation to establishing a suitable study environment, learners should be able to apply self-regulation strategies that would ensure maximum learning, that the environment is quiet, and will help them to focus. Self-regulated learners will create a special time and place for studying and change the environment if it is unsuitable for learning (Ertmer & Newby, 1996:3; Pintrich, 1999:462; Zimmerman, 2008:168) (*cf.* 2.3.3.4).

It is disturbing that none of the responses indicate that the participants' study environments contribute to enhancing learning in mathematics. Bandura (1999b:23) explained that the environment and a person's behaviour continuously interact with one another (*cf.* 2.3.3.4). Given the responses, the researcher concludes that the study environments of the participants could lead to worrying and withdrawing behaviour when tasks must be done (Abdalla, *et al.,* 2000:189) (*cf.* 2.3.3.4).

The researcher identified two themes from the responses of the participants.

Theme 1: Unsupportive study environments

According to Bandura (1999b:24-26) (*cf.* 2.3.2.4), learners have to choose their study environments. If the environment is negative and forced upon them, learners still have a choice on how to react to the environment and remove obstacles. From the participants' responses it appears they simply accept their environments. It also seems that they lack motivation to study, as reflected in the following responses: "*I party when study with my friends playing instead of practising*" (16:91-92), "*There is so many things I do home, don't study"* (10:36-38), "*Not at home*" [studying] (11:90), and "*I study just when I'm bored I don't study at home"* (4: 66-67), "*Like my dad doesn't support me to study 'cause my dad is a traditional man. He just sees no future for me after matric. He just sees me being nobody. Ja. And that's all"* (1:63-65).

Theme 2: Noisy and crowded environments

Literature reveals that the environments that learners use for studying should allow them to maintain their attention and focus on their work. Distractions that will influence the success of achieving one's goals must be removed (Pintrich, 1999:462; Zimmerman, 2008:168) (*cf.* 2.3.4.1). The study environment should guarantee ideal study conditions, such as being a quiet study space (Ertmer & Newby, 1996:3; Zimmerman, 2008:168) (*cf.* 2.3.3.4). This is obviously not the case, as the following transpired from the responses: "*Because there's many little kids in the house so the noise and the focus, yes Ma'am it disturbs me"* (10:68-70), "*I study inside my bedroom"* (6:100), "*And sometimes it's hard because I can't lock the door and then they do up and down something else*" (6:102-104), "*I have two sisters and they most of the time they disturb me with studying. So, I cannot study well when they are around*" (15:51-53), "*There is five of us in the house so like in the afternoon there's no like there's so much noise 'cause the kids are out playing so us like in the evening they come back they do a noises and all that. Ok. That's a lot of noise"* (14:69-74), "*There is always people around you know and they are talking and singing"* (3:76-77), and "*Actually in my room, yah, but sometimes you know the people are coming in and go loud*" (3:86-88).

It seems from the responses that some of the participants are not capable to remove distractions and do not know how to change their actions to adjust their study environments.

Only two participants indicated that they try to solve the noise problem by studying elsewhere: by stating: "*So, I prefer working at school Saturdays"* (10:68-70), and "*Sometimes I go to the studios and do music, at the same time I study"* (10:36-38).

4.7.2.5 The role of the mathematics teacher in developing self-regulating skills

With question 5, the researcher aimed to explore whether and how the mathematics teachers contribute to the development of the participants' self-regulating skills.

The following theme was derived from the responses.

Theme 1: Teachers do not nurture self-regulating skills

The CAPS for mathematics (Department of Basic Education, 2012:6) gives specific guidelines for teaching mathematics, for example, to encourage learners to be active and critical participants in their learning process in order to avoid rote learning (*cf.* 2.5.4.1). Although it is clearly stated in the CAPS document that learners should take responsibility for their own learning, it does not seem to happen in the school environments, following the participants' responses where the following is indicated: "*He* [the teacher]) *ask that, like, do we are understand that previous lesson he taught us"* (16:110-112), *"The male teacher he keeps on telling me to write a previous test, so he can mark them... Then the female teacher just go there for question, setting questions that I don't understand"* (10:80-83), *"He doesn't really help me, but if I have questions or if I need help with anything that I am not good at, I go to her and he helps me"* (15:80-83), *"Like he teaches and then he ask us if we understand the things"* (14: 82-83), "*Like, yes, how to do it and be able to do it"* (11:105-106), "*But our teacher doesn't actually do that. We have tutors who do that so that if we don't understand him at least we can understand the tutors better*" (3: 94-101), and *"She* [the teacher] *help me with the previous task and previous last year papers so that we can revise with them"* (1:78-80).

From the participants' responses, it seems as though the teachers do not encourage the participants to use self-regulation strategies in the mathematics classroom, which correlates with research done by Van der Walt (2006). Van der Walt (2006:183) (*cf.* 1.1) determined that learners do not apply self-regulating skills through reflection and that teachers do not encourage the development of self-regulating skill in their mathematics classrooms.

The teachers of the participants who took part in the study, tend to mainly ask the participants whether they understand the work, which will not promote the development of self-regulating skills. In this regard, De Boer, *et al.* (2012:507) and Donker, *et al.* (2014:2) (*cf.* 2.7.2) contend that learners will not spontaneously develop self-regulating skills; they need to be taught strategies to self-regulate their actions. It also seems sensible to conclude that teacher training possibly does not equip teachers with knowledge and skills to develop self-regulating skills among learners (DaSilva-Marini & Boruchovitch, 2014:328) (*cf.* 2.7.1).

Theme 2: Tutor assistance

Although the participants' responses indicated that they receive assistance from tutors, their responses did not provide evidence that self-regulation strategies are taught by the tutors, or that they are guided to take responsibility for their own learning (Boekaerts, 1996:100; Schunk, 2005a:173) (*cf*. 2.3.2). The participants indicated the following: *"Well we have Saturday classes*" (3:92), "*They actually have with tutors who help us the maths and then we revise the work... We have tutors who do that so that if we don't understand him* [the teacher] *at least we can understand the tutors better"* (3:94-101), and "*He bring teachers, Ma'am, on Saturdays so they go help us full out*" (4:77-78).

Given the limited support indicated from the side of the teacher, the researcher wished to understand if the participants have other sources of support for completing their mathematics tasks.

4.7.2.6 Help-seeking and support when completing mathematics tasks

With Question 6 the researcher wanted to gain insight into the resources that the participants employ for help-seeking in completing mathematics tasks.

The researcher extracted two themes from the participants' responses.

Theme 1: Support from teachers and peers

Receiving support from teachers and peers, increases learners' chances of success towards achieving learning goals (Ryan & Kaplan, cited by Zumbrunn, *et al.,* 2011:16) (*cf.* 2.6.4). In this regard the participants indicated the following sources of support: "*My peers 'cause they the people I understand"* (16:124), "*I just ask my teacher*" (6:115), "*I have a tutor not permanent*" (10:91), "*I go to my teacher someone like I know that is good at mathematics and might cope and beg for help"* (14:97-98), "*I ask my classmate and my teacher"* (11:116), "*I usually ask my friends or my sister friends yah"* (3:111), and "*My maths teacher is very helpful, like she help me with the previous task"* (1:77-78).

According to the responses, the participants seem to seek help from their peers to enable them to complete mathematics tasks. Seeking help from peers could be beneficial to the participants, as according to Ertmer and Newby (1996:5) and Schunk (2005b:87), discussing mathematics with their peers could enable learners to test themselves and assess their understanding through conversation (*cf.* 2.3.4.3). Learners can also intentionally learn self-regulation strategies by observing their peers modelling solutions to problems (Zimmerman, 2000:29) (*cf.* 2.6.2).

From the responses, some participants apparently do not seek help: *"I do write, and I'm not sure, I just write it anyway"* (15:61), *"I am shy to ask someone to help me"* (11:82-83), and "*I just write what comes in my head*" (4:86).

To become self-regulated and enable learners to take responsibility for their own learning process, a classroom should be arranged in such a way that learners can take part in group discussions (Prideaux, 2007:11) (*cf.* 2.6.4). It seems that the teachers do not give the participants who took part in the study opportunities to develop self-regulation strategies by engaging in group discussions. Self-regulation strategies should be modelled and their application by learners rewarded, ideally by parents, too (Zimmerman 2000:27) (*cf.* 2.7.1).

When asked about support, many participants indicated support from their family members and the teacher: *"My guardian they encourage me"* (14:136, 141), "*Mom and my teacher"* (15:73), "*My teacher"* (16:151), "*My teachers"* (6:134), "*It's my brother and my sister"* (11:94), "*Yes, Ma'am and my teacher*" (11:147), and "*My mom*... *You see she tries to give me all the support that I need and that motivation"* (3:132, 135-137). The researcher however concludes, that the support the participants receive, might be general and/or moral in nature, but does not necessarily focus on enhancing the development of self-regulating skills.

Theme 2: Restricted support at home

From many responses, it seems that the participants do not have support at home. That might have an influence on their motivation and it will possibly influence their academic achievement (Ryan & Kaplan cited by Zumbrunn, *et al.,* 2011:16) (*cf.* 2.6.4). The participants cited the following:

"Like if you ask (parents) for support it may be hard because they they wanna do their things (6:91-93), *"And at home nobody you know helps me and try to be there for me"*

(16:92-93), *“Mostly my friends because my parents don’t sit down with me and talk such things”* [learner speaking about: planning, monitoring and evaluating work] (10:123-124), *“I don’t have any support coming from home”* (4:72-73), *“Mother is so supporting, she tries by all means but, just that she has no say against my father cause, mens are the ones who leads the house traditionally”* (1:69-72), and *“Dad doesn’t support me to study cause my dad is a traditional man, so like he doesn’t support me to study. He just sees no future for me after matric. He just sees me just being nobody”* (1:63-67).

To have no support at home is a great concern to the researcher, because it is reasonable to conclude that support in developing self-regulating skills will also be absent.

4.7.2.7 Motivation and mathematics

Question 7 aimed to explore how motivated the participants are to do mathematics.

Motivation is an important factor for all facets of self-regulation (Pintrich cited by Schunk, 2005b:87) (*cf.* 2.3.3.3). Motivation is linked to self-efficacy; a person’s personal belief about how successful he/she is going to be in the learning process (Zimmerman, 2000:17) (*cf.*1.1).

The following responses were received from the participants, and two themes were identified.

Theme 1: Lack of motivation

From the responses, the researcher observed a lack of motivation among the participants: *“I can’t I can’t always think about something that is hard”* (10:106-107), *“My problem is when I’m in class I can listen but someone when I want to ask, eish, I don’t Ma’am”* (11:81-83), *“This I don’t understand”* (3:117), (and) *“I’m not motivated”* (4:91). The responses could indicate that the participants lack self-efficacy, and will probably not be motivated to put much effort and time into completing mathematical tasks (Bandura, 1993:135; Pajares & Schunk, 2001:241) (*cf*. 2.2.3.3). In addition, the participants might not be able to handle the challenges that studying mathematics bring; and therefore, also possibly lack confidence, which is a crucial component for success (Bandura, 1993:133; Pajares & Schunk, 2001:242) (*cf*. 2.2.3.3).

Theme 2: Eagerness and passion as motivational factors

In the following responses, it appears that some participants are motivated: *"I think about, I think about my goals and things I want to achieve before I do the maths" (*16:136-137*),* *"I make sure I understand every question"* (6:121-122), "*I have passion, ja. I make sure that I finish that task"* (14:113-114), and *"My eager to learn helps me, it really does"* (1:92).

The aforementioned responses are encouraging, as motivational factors such as eagerness and passion mentioned by the participants, can influence peoples' lives and choices and give them more career opportunities. They will also be more willing to persevere in difficult situations, enabling them to master a difficult subject like mathematics (Bandura, 1993:135; Pajares & Schunk, 2001:241) (*cf.* 2.3.3.3).

4.7.2.8 Exceptions

Four of the participants had mean averages that corresponded with the *average* to *strong* self-regulating skills group, but some of their responses corresponded with the *weak to average* self-regulating skills group. The researcher formulated additional questions for these participants, to explore the negative responses noted.

- Participant 7 indicated that she does not possess well-developed self-regulation kills to monitor her work (*cf*. Table 4.16). In this regard she stated, *"Yes, I check but sometimes I get less that that I was hoping to get, but some, at times I get more than what I had hoped for"* (7: 61-63).
- Participant 11 indicated that she does not possess well-developed self-regulating skills to plan her work (*cf.* Table 4.16). She reported the following, "*Eish Ma'am. Like understanding*" [learner refers to her problem with mathematics] (11: 81-83).
- Participant 14 indicated that he does not possess well-developed self-regulating skills to plan his work (*cf*. Table 4.16). However, the interview responses pointed to some skills for time management to plan properly for work completion: "*I set like the time like how long should I do it*" (14:39-40).
- Participant 3 (*cf.* Table 4.16) indicated that he does not possess well-developed self-regulating skills to plan his work. He however indicated during the interviews that he

makes use of a time table to plan properly when studying: "*I have a study timetable where I check, like, which subjects that I am less, am less able to do"* (3:38-39).

It is interesting to note that only participant 1 in this group, appeared to have a suitable study environment for completing mathematics tasks (*cf.* Table 4.16). Similar to the group who indicated that they had self-regulating skills that could be regarded as *weak to average*, the group who apparently had *average* to *strong* self-regulating skills, also seem to struggle to apply self-regulation strategies that would enable them to become skilled at reducing obstacles and problems in their study environment.

The researcher does not think that the participants deliberately gave dishonest answers during the completion of the questionnaire. The researcher takes into cognisance the fact that questionnaire completion could lead to participants wanting to appear better than they are, impress the researcher, or give responses based on their beliefs about what they think the researcher needs (Mc Millan & Schumacher, 2006:211).

In the following section, the researcher visually summarises the initial findings that emanated from the interview data.

4.8 SUMMARY: INTERVIEW FINDINGS

A visual summary of the findings with regard to the interviews of the two groups appears in Figure 4.1 and Figure 4.2, respectively.

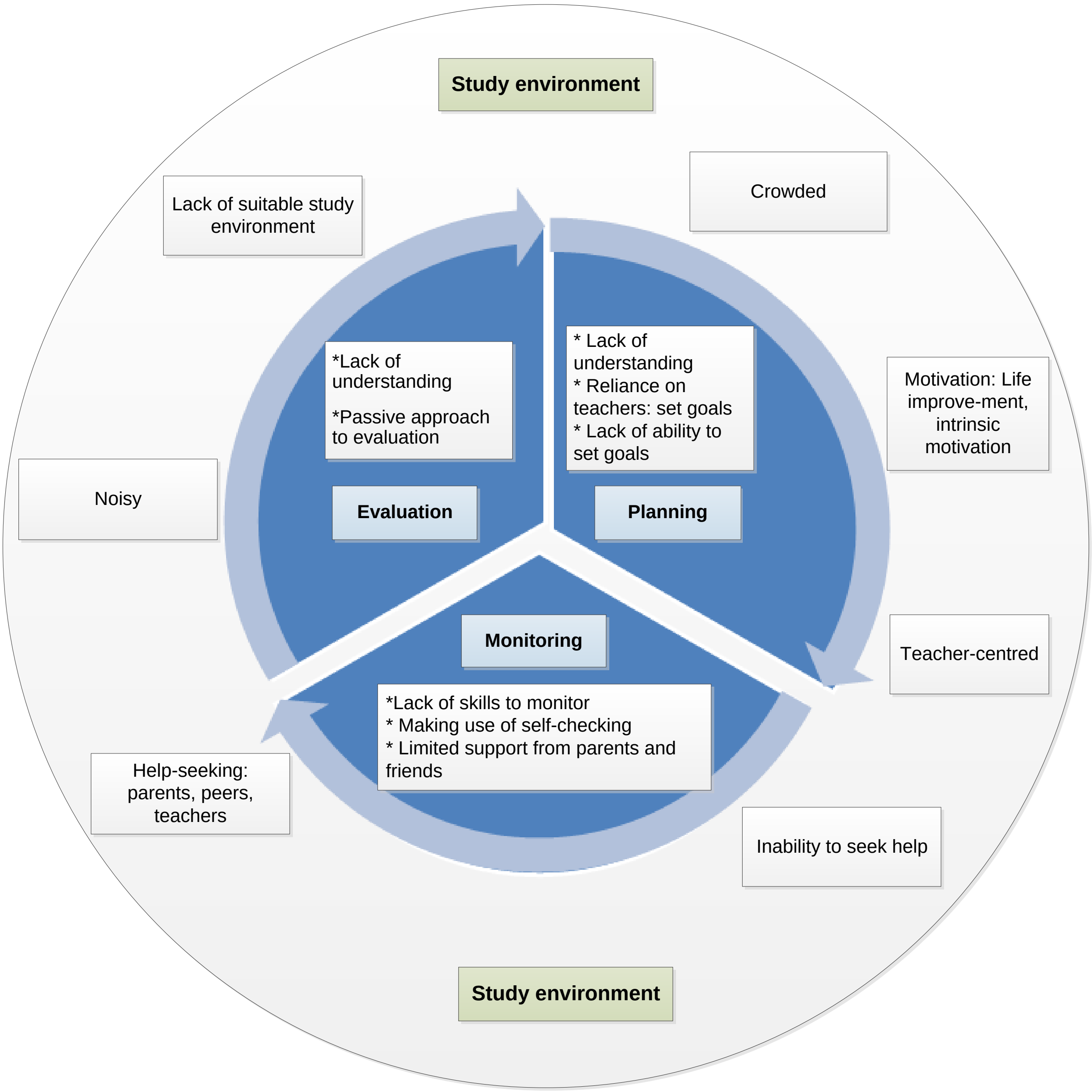


Figure 4.1: Interview themes: Participants with weak to average developed self-regulating skills

According to Figure 4.1, the participants who perceived their self-regulating skills to be *weak to average* indicated that they lack a repertoire of strategies to successfully self-regulate their learning during all the phases of the learning process (planning, monitoring, and evaluation). They tend to rely on teachers to set goals, as they are incapable of setting goals for themselves. Although strategies to monitor learning also seem to be absent, it is commendable that self-checking, which is a valuable strategy to monitor work, is being employed. The participants also lack an understanding of what is implied by *evaluation of learning*; and also do not have effective strategies to self-regulate the evaluation phase of learning and appear to be passive in this regard.

In the context of the interpretation of the data, the researcher viewed the role of motivation, seeking help, availability of resources and support, as important supportive elements in a learner's study environment. The study environments of the participants seem to obstruct learning, as these environments appear to be noisy and crowded at home, and fairly teacher-centred in the classroom, thus not providing opportunities to independently take control of their own learning.

From the responses, encouraging aspects that could contribute to supportive learning environments were noted. The participants reported that they are intrinsically motivated to work on mathematics tasks, as mathematics is regarded as a subject that would lead to opportunities that would enable them to improve their lives when they finish school. Help-seeking is an important strategy in becoming self-regulated. It is inspiring that some of the participants seem to acknowledge help-seeking and support from family, friends, and their teachers. The responses, however, do not clearly point to the fact that family, friends, and teachers are resources that model the application of self-regulation strategies, from which the participants could learn.

The following figure, Figure 4.2, summarises the themes obtained from the responses for the participants who perceived their self-regulating skills to be *average* to *strong*.

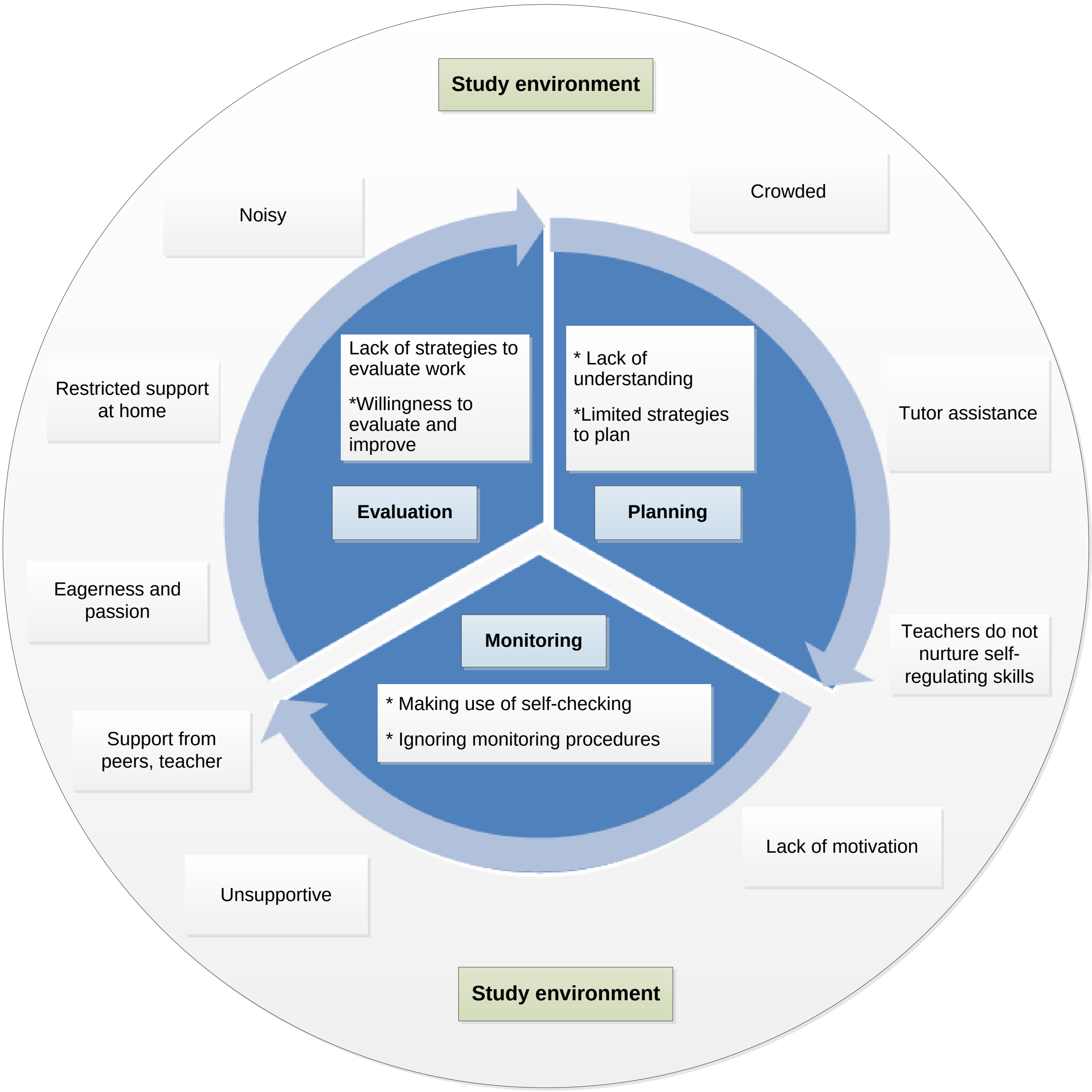


Figure 4.2: Interview themes: Participants with average to strong self-regulating skills

According to Figure 4.2, the group of participants who, based on their perceptions, seemed to possess *average* to *strong* self-regulating skills, also appeared to be novices in applying self-regulating skills during the planning, monitoring, and evaluation phases of the learning process. The only prominent strategy for monitoring task completion appears to be that of self-checking. The study environments of this group of participants also appear to display the same characteristics as the study environments of the group of participants who perceived the application of their self-regulating skills to be *weak to* *average*. Noisiness and crowdedness are factors that could negatively affect the effectiveness of the learning taking place in these environments, which could lead to a lack of motivation that was reported by the participants. Although it appears that the teachers do not nurture the development of self-regulating skills that are required for independent learning, the participants are eager, willing, and passionate about their mathematics learning. In addition, the tutor assistance that the participants receive also mainly relates to a better understanding of the work, and does not testify to evidence that development of self-regulating skills are developed. The participants also receive restricted support from home, implying that self-regulating skills are also not developed at home.

In the following section, the researcher triangulates the findings obtained from the questionnaire and the interviews.

4.9 TRIANGULATION OF QUESTIONNAIRE AND INTERVIEW DATA

This section aims to triangulate the quantitative and qualitative data sets for the group of participants who took part in the research. In line with the purpose of a sequential explanatory mixed method research design, the researcher sets out to explain the quantitative data with the qualitative data.

The interpretation below centres around the questionnaire responses obtained, which indicated expertise in the application of skills to self-regulate learning.

4.9.1 Planning

According to the questionnaire data in relation to apply self-regulating skills to plan learning, very few of the participants regarded themselves as *experts* (being very experienced and knowledgeable) in:

- Planning properly for the execution of a mathematics task before starting the task (7.8%) (*cf.* Table 4.7).
- Ensuring that they know what they will be learning (what the goals are) before starting a mathematics task (3.9%) (*cf.* Table 4.7).
- Managing their time effectively for mathematics task completion (7%) (*cf.* Table 4.7).

- Setting goals for themselves before they start a mathematics task (21.9%) (*cf*. Table 4.7).
- Know what strategies to use to complete a maths task (15.6%) (*cf.* Table 4.7).

Although many of the participants perceived themselves to be *able* (ranging between 35.1% - 54.7%) and *skilled* (ranging between 31.2% - 45.3%) in the application of strategies to plan the aforementioned activities, the qualitative data revealed a different picture, and one could conclude that the participants could rather be regarded as *novices* who have little knowledge about, and experience in, applying strategies that would enhance the skilful planning of their work. In relation to planning properly, the qualitative data explored possible reasons for this observation and revealed the following:

- A lack of understanding what planning implies (*cf.* 4.7.1.1) (*cf.* 4.7.2.1).
- Teachers seemingly do not enhance the development of self-regulating skills (*cf.* 4.7.1.1; 4.7.1.5; 4.7.2.5).
- Participants lack the ability to set goals and do not understand what is meant by setting goals (*cf.* 4.7.1.1).
- Linked to the aforementioned, is an overreliance on the teacher to set goals (*cf*. 4.7.1.1) and possessing limited strategies to identify goals (*cf.* 4.7.2.1).
- Self-regulation strategies are not taught at school, and might be the reason that the participants do not have strategies available to complete mathematics tasks (*cf.* 4.7.2.1; 4.7.2.3).

It is clear that both groups of participants, those who perceived their self-regulating skills to be *weak to average* and those with self-proclaimed *average to strong* self-regulating skills, have problems with planning. Both groups lack understanding about what proper planning entails, and do not know how to set goals (*cf.* 4.7.1.1; 4.7.2.1).

4.9.2 Monitoring

According to the questionnaire, the data revealed limited *expert* application of strategies to be skilled at monitoring learning. The following observations were made from the data:

- Only 17.2% of the participants seemed to be *experts* being skilled to make sure they understand the mathematics task they are engaged in (*cf.* Table 4.8).
- Only 7% regarded themselves as *experts* in setting goals and tracking progress (*cf.* Table 4.8).
- In relation to strategies that could enhance confidence to independently solve problems, only 18.8% of the participants viewed themselves as *experts* (*cf.* Table 4.8).
- The *experts* amongst the participants in applying strategies to ensure a supportive learning environment also appear to be limited (18%) (*cf.* Table 4.8).
- Only 13.3% regard themselves as *experts* who are able to learn from their mistakes (*cf.* Table 4.8).

Many of the participants perceived themselves to be *able* (ranging between 30.4% - 42.9%) and *skilled* (ranging between 36.7% - 47.7%) in the application of strategies to monitor their learning, thus being able to make changes to correct behaviour and develop positive motivational strategies to control their persistence when completing a task. Despite this, one could conclude that these participants should be viewed as *novices* in relation to monitoring. They lack knowledge about, and experience in, applying appropriate strategies to be effective at monitoring task completion in mathematics. Possible reasons for the lack of monitoring skills that emanated from the qualitative data, which support the above-mentioned findings could be:

- A lack of skills to monitor work and ignoring monitoring procedures (*cf*. 4.7.1.1, 4.7.2.2).
- A lack of motivation and finding mathematics difficult (*cf.* 4.7.1.8; 4.7.2.7).
- Participants seemingly do not make the connection between monitoring and achieving goals, therefore do not monitor their work at all (*cf.* 4.7.2.2).
- Limited strategies for monitoring work seem to be available, as only self-checking and seeking help from friends to mark work were cited as monitoring strategies by the participants (*cf.* 4.7.1.2; 4.7.2.2).

Both interview groups, the group with *weak* to *average* and the group with *average* to *strong s*elf-regulating skills have problems with monitoring their work and making adjustments to achieve their goals, which classifies their application of self-regulation strategies to monitor task completion as *novice*; having no or little knowledge and experience.

4.9.3 Evaluation

The questionnaire data revealed that:

- Only 14.8% of the participants are *experts* who seem to be skilled at achieving their goals in mathematics (*cf.* Table 4.9).
- Strategies to deal with negative emotions and feelings when goals are not achieved seem to be expertly employed by only 20.3% of the participants (*cf*. Table 4.9).
- In relation to learning from mistakes, only 14.1% of the participants viewed themselves as *experts* (*cf.* Table 4.9).
- A mere 13.3% of the participants apparently regards themselves as experts in applying strategies to deal with obstacles/problems during the completion of tasks (*cf*. Table 4.9).
- Only 24.2% were of the opinion that they are experts at solving problems on their own (*cf.* Table 4.9).

Possible reasons for the lack of self-regulating skills to evaluate the learning process derived from the qualitative data may be:

- Participants lack a thorough understanding of what is expected during the evaluation of learning (*cf*. 4.7.1.3).
- Participants wait for their teachers to set goals; they do not set goals themselves, therefore adopt a passive approach to evaluation (*cf.* 4.7.1.3)
- Participants lack self-regulating strategies to properly evaluate their work (*cf.* 4.7.1.3, 4.7.2.3), and therefore possibly adopts a passive approach to evaluation (*cf*. 4.7.1.3)

Since both interview groups, the group with *weak to average* as well as the group with *average to strong* self-regulating skills, indicated having problems to evaluate the outcomes of their mathematical tasks, both groups could be regarded as *novices* who lack understanding of what the process to evaluate task outcomes entails. Moreover, they also seem to lack strategies that could enable them to evaluate task outcomes.

4.9.4 Study environment

The quantitative data showed that:

- The participants seemingly do not have self-regulation strategies to enable them to ensure good conditions to study, as only 9.4% regarded themselves as *experts* (*cf.* Table 4.10).
- Only 11.7% tend to be *experts* in securing support and assistance when completing a mathematics task (*cf.* Table 4.10)
- Merely 5.4%viewed themselves as *experts* in identifying obstacles or problems that could hinder task completion (*cf.* Table 4.10)
- Only 5.5% claimed to be *experts* at time management to ensure that they have sufficient time to complete tasks (*cf.* Table 4.10)

Information from the qualitative data may shed light on the reasons for the absence of self-regulation strategies to ensure a suitable study environment, such as:

- Noisy environments could be the greatest contributor to poor study conditions (*cf.* 4.7.1.4; 4.7.2.4).
- Family support is evident in some cases, but the support does not necessarily indicate contribution to the development and application of self-regulating skills (*cf.* 4.7.1.6). In some cases, the participants indicated that they have no family support at all (*cf.* 4.7.2.6).
- The participants share homes with many occupants (*cf.* 4.7.1.4; 4.7.2.4) and they often do not have a specific place of their own to study (*cf.* 4.7.1.4)
- Apparently, teachers do not give support in enhancing the development of self-regulating skills that possibly contribute to participants not being able to make changes to their study conditions (*cf.* 4.7.1.5; 4.7.2.5)

Although it is observed that many participants perceived themselves to be *able* and *skilled* at applying strategies to secure a conducive study environment, their responses revealed that they are actually *novices* who lack understanding of what the process entails to secure a proper study environment, and seemingly do not have strategies to make changes to their study environments.

Based on the interpretations of the quantitative and qualitative data, the researcher derives the following preliminary findings as set out in the following section.

4.10 THE RESULTS OF THE COMBINED QUANTITATIVE AND QUALITATIVE FINDINGS

Based on the combined quantitative and qualitative findings, the researcher concludes that the participants who took part in the study could be regarded as *novices* in terms of applying self-regulation strategies to enable them to become skilled at self-regulation. The participants appeared to have little experience and knowledge in self-regulating their mathematics learning during the phases of the learning process (planning, monitoring, and evaluation). In addition, strategies to control the negative influence of study environments also appeared to be absent.

The findings revealed that more female participants viewed themselves to be good in the application of self-regulating skills in relation to planning than their male counterparts (*cf.* 4.5.1). In addition, the repetition of Grade 10 did not seem to have any influence on the perceptions of the participants and how they viewed the development of any of their self-regulating skills (*cf.* 4.5.2). Similarly, the participants' living conditions also did not bear any influence on the way they perceived the development of any of their self-regulating skills (*cf*. 4.5.3).

The participants appeared to hold similar perceptions in relation to not linking monitoring and evaluation to achieving goals, but viewed the application of self-regulation strategies to monitor and evaluate learning to be better than the self-regulation strategies to plan learning (*cf*. Table 4.14).

The behaviourist learning theory opposes self-regulated learning, as learners are not encouraged to take responsibility for, and are not actively involved in, their own learning.

As such, the teacher gives a stimulus and the learners respond to it (Ertmer & Newby, 2013a:48) (*cf.* 2.2.1). The present research indicated that the participants who took part in the study, are seemingly still exposed to stimulus-response teaching methods at school, and do not have the opportunity to become self-regulated learners who are critical about their learning (Cox, 2011:15; Zhou & Brown, 2014) (*cf*. 2.2.1). The teachers of the participants who took part in the research, seemingly do not model strategies to the participants that could enhance the development of their self-regulating skills to regulate their learning (Kozulin, 2003:15-18; Nel, *et al.,* 2012:63) (*cf.* 2.2.3, 2.2.3.1). The researcher argues that it seems that the teaching and learning that takes place in the participants' mathematics classes at school level, do not support cognitive and constructivist teaching and learning (*cf.* 2.2.2; 2.2.3, 2.6.1). Learners who are exposed to cognitive and constructivist teaching and learning will be active participants during their learning, and take responsibility for constructing their own knowledge, and solve problems while interacting with the environment (Dignath & Büttner, 2008:232; Kay & Kibble, 2016:24) (*cf.* 2.2.3.1). In addition, the participants need to become more self-organised, pro-active, self-reflecting, and self-regulated; not being products of their circumstances but making contributions to their circumstances (Banks & Mhunpiew, 2012:1002) (*cf*. 2.2.3.3). In this regard, the researcher argues that the participants might not possess high levels of self-efficacy to enable them to be more self-regulated (Perry & Steck, 2015:128-129; Tella, 2011:430) (*cf*. 2.2.3.3), and motivated to achieve their goals even when faced with obstacles (Bandura, 1993:131) (*cf.* 2.3.2.3).

The five main personality traits identified by McCrae and Costa (1996:54) have a relationship with self-regulation (*cf.* 2.2.4.2). According to the questionnaire data, the participants seem to lack *openness* - a trait which links up with individuals who have high levels of self-efficacy and take responsibility for their own learning (Bidjerano & Dai, 2007:71) (*cf*. 2.2.4.2). The findings also indicate a possible lack of *conscientiousness* - a trait which relates to being able to plan, set goals, and monitor the achievement of set goals (Bandura, 1991:248; Bidjerano & Dai, 2007:70; Boekaerts, 1996:101) (*cf.* 2.2.4.2; 2.3.4.1). *Agreeableness* is a trait related to academic persistence and motivation. When learners manage their time and procrastinate less they employ more self-regulation strategies. Agreeableness also appears to be a problematic trait, as the participants who took part in the study seem to have problems with proper time-management to complete tasks, as well as being demotivated (Bidjerano & Dai, 2007:71-72) (*cf.* 2.2.4.2).

The research findings indicated that the participants may be experiencing difficulties in applying meta-cognitive, motivational, and environmental strategies to become skilled at self-regulating their learning during the planning, monitoring, and evaluation phases of the learning process (*cf.* 4.7.1.1; 4.7.2.1). At a *meta-cognitive* level, the participants seem to have difficulty in setting goals and choosing strategies to achieve goals (Zimmerman, 2000:17) (*cf.* 2.3.4.1); determining if chosen strategies are working and if they are progressing with a task (Finn & Metcalfe, 2013:19) (*cf*. 2.3.4.2); and therefore will also experience difficulty in establishing what changes they should make to reach set goals (Schraw, *et al.,* 2006:114; Schunk, 2005a:173) (*cf.* 2.3.4.2). Moreover, the participants seem unable to evaluate if a specific approach to task completion was successful and enabled them to achieve their goals (Ertmer & Newby, 1996:5; Schraw *et al.*, 2006:114) (*cf*. 2.3.4.3). Positive motivational strategies that could contribute to enhanced self-efficacy and motivation to persist and adapt their strategies to achieve goals, could greatly benefit the participants' chances of improving their future performance (Finn & Metcalfe, 2013:20; Marcou & Philippou, 2005:303, 304) (*cf.* 2.3.4.3). Becoming more skilled at applying *motivational strategies* (*cf*. 2.3.3.3), would also enable the participants to control the amount of time and effort they put into a task, as well as their willingness to continue when faced with obstacles or problems (Erlich & Russ-Eft, 2011:7; Loynachan, 2018; Marcou & Philippou, 2005:303, 304; Schunk, 2005b:87) (*cf*. 2.3.2, 2.3.4.1; 2.3.4.2; 2.3.4.3). Well-developed *environmental strategies* for planning, monitoring, and evaluation could assist the participants to better manage their study environments and time to maximise learning, remove obstacles and encourage help-seeking in order to increase their chances at achieving success in learning (Pintrich, 2000:455; Schunk, 2005b:87; Zimmerman, 2008:167) (*cf.* 2.3.4.1; 2.3.4.2; 2.3.4.3). Bandura (1999b:23) argues that a person's behaviour is influenced by their environment. If the environment is not conducive to learning, a person does have a choice to change the environment (*cf.* 2.3.3.4). The participants who took part in the study do not seem to have strategies to help them to skilfully adapt or change their environments, implying that the distractions noted in the interview responses (noisiness and crowdedness) could influence the successful achievement of learning goals (Pintrich, 1999:462; Zimmerman, 2008:168) (*cf*.

2.3.4.1). The data indicate that the participants who took part in the study possibly do not acknowledge the importance of *reflection* during learning, which involves self-evaluation and judgements about their learning efforts (Paris & Paris, 2001:89; Pintrich, 2000:461; Schunk, 2005a:173) (*cf*. 2.3.4.4), managing their time to successfully complete tasks, becoming efficient in taking more control in monitoring their learning process, and evaluating the outcomes of their own learning (Dignath & Büttner, 2008:233) (*cf*. 2.3.2). The participants appear to be in need of more conditional knowledge or strategy knowledge (Flavell, 1985:15) (*cf*. 2.3.2) that would enable them to know when to employ certain learning strategies to complete tasks or solve problems effectively. The researcher concludes that the participants do not yet acknowledge the importance of taking ownership of their learning processes and the tasks they have to complete (Prideaux, 2007:11) (*cf*. 2.6.1), and tend to still rely on others to regulate their actions for successful learning (Loyens, *et al.*, 2008:417; Ryan & Deci, 2000:68-70) (*cf.* 2.4.1.1). The use of questions that prompt learners to reflect on their learning (Kistner, *et al.,* 2015:176) (*cf.* Table 2.3), therefore does not seem to have a prominent place in the classrooms of the participants who took part in the research.

The researcher deduces that the research participants do not get the opportunity to interact with mathematical ideas constructively in order for self-regulation to be promoted (Darr & Fisher, 2004) (*cf*. 2.6.1), and to take ownership of their learning (Prideaux, 2007:11) (*cf.* 2.6.1). The implementation of teaching strategies, such as cooperative learning and problem-based learning, would allow learners to plan their own learning, process information, reflect on their actions, and learn from observing their peers modelling solutions to problems (Darr & Fisher, 2004; Flemming, 2014; Hatami, 2015:2164) (*cf.* 2.6.6, 2.5.7); however, these seem limited in the current mathematics classrooms, as no responses in relation to any of the mentioned strategies were received. Teachers do not seem to model and verbalise the application of self-regulation strategies and allow learners to observe and practise the application of self-regulation strategies (Darr & Fisher, 2004; De Boer, *et al*., 2012:507; De Corte, *et al*., 2000:692; Donker, *et al.,* 2014:2; Dignath-Van Ewijk, *et al.,* 2013:339, Mason, 2013:124, 125; Montague, 2008:37-39; Peeters, *et al.,* 2014:1966; Spruce & Bol, 2015:247; Van der Walt & Maree, 2007:235; Zimmerman, 2000:29) (*cf.* 2.3.3.3, 2.6.2, 2.6.8, 2.7.2).

Although the development of self-regulating skills stands central to the objectives of the CAPS for mathematics, the present research findings concur with the research findings of Van der Walt and Maree (2007:235) that revealed that teachers do not create sufficient opportunities for the research participants to practise self-regulation procedures (*cf*. 2.7.2).

An interesting finding, that is not supported by the literature review, relates to the fact that although many of the participants who took part in the study seem to be willing and motivated to learn mathematics, their willingness and motivation do not prompt the action that would lead them to plan, monitor, and evaluate their learning, or control their study environments. According to Dignath and Büttner (2008:233) (*cf*. 2.3.2) and Erlich and Russ-Eft (2011:7) (*cf.* 2.3.4.1), self-efficacy, which comprises willingness and motivation to achieve goals (Loynachan, 2018; Perry & Steck, 2015;128-130; Tella, 2011:430) (*cf.* 2.3.2*,* 2.3.3.3.), could be regarded as a pre-requisite for self-regulated learning in terms of becoming less dependent on teachers, evaluating performance, and reflecting on the achievement of goals; all of which was not observed among the participants who took part in the study. It however seems appropriate to argue that if the participants do not possess self-regulation strategies to apply that will make them skilled at self-regulation, willingness and motivation might not be sufficient prerequisites to enable them to become skilled at self-regulation.

4.11 CHAPTER SUMMARY

This chapter focused on analysing and interpreting the data obtained with the questionnaire and the interviews, and to present the preliminary findings that resulted from the data analysis.

In summary, based on the perceptions of the Grade 10 participants gathered during the research, they could be regarded as *novices* in the application of self-regulating skills to plan, monitor, and evaluate their learning, and do not seem capable of structuring their study environments so that conditions are created that would support their learning. The participants seem unsure about what is meant by planning their learning and how to set goals. They also find it difficult to monitor their learning, to check if they are making progress, and to evaluate whether they have reached their goals. All the participants also appear unable to establish study environments that would contribute to successful learning (*cf*. 4.7.1.1, 4.7.1.2).

The main reasons cited for the unsettling absence of well-developed self-regulating skills among the participants, are summarised as follows:

- A lack of understanding of what the *planning, monitoring*, and *evaluation* phases of the learning process entail (*cf*. 4.7.1.1 – 4.7.1.3; 4.7.2.1 – 4.7.2.3)
- A limited repertoire of available strategies to engage in the independent *planning, monitoring,* and *evaluation* of learning, and to remove obstacles from the study environment (*cf*. 4.7.1.1 – 4.7.1.4; 4.7.2.1 – 4.7.2.4)
- Limited opportunities to develop self-regulating skills at school, thus promoting an over-reliance on the teacher to regulate learning (*cf*. 4.7.1.5, 4.7.2.5)

The final chapter, Chapter 5, presents the summary and findings for the study as well as recommendations flowing from the research findings.

CHAPTER 5
SUMMARY, FINDINGS, AND RECOMMENDATIONS

5.1 INTRODUCTION

The study was aimed at describing the nature of self-regulating skills among Grade 10 mathematics learners, according to the perceptions of the learners, and to explore possible reasons for self-regulating skills to be well-developed or not well-developed. The main aims and objectives that were formulated at the beginning of the study are re-assessed in this chapter, in order to determine whether they were achieved

It is important that the literature study and the data gathered, by means of questionnaires and interviews, have answered the primary and secondary questions which drove the study. This chapter addresses the following aspects.

5.2 AN OVERVIEW OF THE STUDY
5.3 FINDINGS FROM THE LITERATURE REVIEW
5.4 FINDINGS OF THE EMPIRICAL STUDY
5.5 FINDINGS IN RELATION TO THE AIM AND OBJECTIVES OF THE STUDY
5.6 RECOMMENDATIONS
5.7 LIMITATIONS OF THE STUDY
5.8 SUGGESTIONS FOR FUTHER RESEARCH
5.9 CONTRIBUTION OF THE STUDY
5.10 CONCLUSION

5.2 AN OVERVIEW OF THE STUDY

A brief summary of the essence of each previous chapter is provided in this section.

Chapter 1

The main aim of Chapter 1 was to enlighten the reader regarding the problem that the researcher wished to address, and to clarify the purpose of the study. Well-developed self-regulating skills which are imperative to academic performance, are apparently not modelled and taught in the mathematics classroom (Van der Walt & Maree 2007:223-241) (*cf.* 1.1, 2.7.2).

The present research addressed the following gaps in relation to research in the field of self-regulation and mathematics. To the best knowledge of the researcher (i) no investigations with Grade 10 mathematics learners have previously been done in South-Africa in the Sedibeng West district, one of the districts with the poorest overall achievement in South Africa, and (ii) research has not previously been done to determine learners' perspectives in relation to the development of their self-regulating skills. This study also addressed a methodological gap by employing mixed method research to identify learner perceptions in relation to the development of their self-regulating skills, and to qualitatively explore possible reasons for self-regulating skills to be well-developed or not well-developed.

The purpose of the study was twofold: Firstly, to describe **how** well-developed Grade 10 mathematics learners perceive the development of their self-regulating skills. Secondly, the study **explored** possible reasons for self-regulating skills to be well-developed or not well-developed. (*cf.*1.1).

Chapter 1 also presented a brief clarification of the conceptual framework of the study, which is clarified in the summary of Chapter 2 below. In addition, the empirical research design was also explained, which is described and motivated in detail in the summary of Chapter 3, that follows the summary of Chapter 2 below.

Chapter 2

Chapter 2 focused on a conceptualisation of concept central to the study, namely the development of self-regulated learning. According to the researcher, self-regulated learning is enhanced, when learners acquire and apply self-regulation strategies, which enable them to become skilled at taking control of their own learning processes, thus developing self-regulating skills to plan, monitor and evaluate the learning process, and to secure a suitable study environment.

Developing self-regulating skills during teaching is rooted in the constructivist theories of learning (*cf.* 2.2.3). Constructivists believe that learning is an active process where learners take control of their own learning by constructing their own understanding through reflection on immediate and past experiences (Fosnot & Perry, 2015:10) (*cf.* 2.2.3).

A number of processes play a role in self-regulation, namely self-observation, self-evaluation, self-reaction, and self-beliefs (Bandura, 2003:87-89) (*cf.* 2.2.3.3). As such, learners need to observe their own learning processes in order to motivate behavioural changes; constantly compare their current performance to goals that need to be achieved; believe in their own capabilities, stay motivated and persist in order to achieve goals; and have positive perceptions of their own worth to achieve success (Perry & Steck, 2015:128-129; Tella, 2011:430) (*cf.* 2.2.3.3). Self-efficacy increases learner's self-regulation because it determines the extent to which learners will participate in a difficult task, if they will persevere in completing the task, and which goals they want to achieve (Pajares & Schunk, 2001:246) (*cf.* 2.3.2).

A number of personality traits have strong links with self-regulation. A relationship between self-regulation and perceptual control theory exists (Powers, 2016:147) (cf. 2.2.4.1). Goal achievement is important in self-regulation, which includes maintaining perceptions towards reaching a goal, and taking control over the environment to ensure successful goal achievement. According to the big five personality theory, three personality traits have an association with self-regulation. Openness has a strong link with self-efficacy and academic achievement which, in turn, links to self-regulation. Learners with high levels of openness take responsibility for achieving their goals (Boekaerts, *et al.,* 2000:17; Sadi & Uyar, 2012:21; Wolters, *et al.,* 2003:4) (*cf*. 2.2.4.2). Conscientiousness includes characteristics such as being responsible, being able to plan, organise, and persist in achieving good results (Bandura, 1991:248; Bidjerano & Dai, 2007:70) (*cf.* 2.2.4.2). Agreeableness links to self-regulation because agreeable individuals combine learning and the regulation of study habits. It also links with time management and how much effort learners are prepared to put into their learning, as well as managing their study environment (Bidjerano & Dai, 2007:71-72) (*cf.* 2.2.4.2).

The study was based on the conceptualisation of self-regulation according to Pintrich (1999:461), who defines self-regulated learning as a process where learners take responsibility for their own learning. Self-regulated learners can apply meta-cognitive, emotional, and environmental strategies that promote the development of skills to self-regulate the planning, monitoring, and evaluation phases of the learning process (Bandura, 2015:1026; Bandura & Locke, 2003:87; Karpicke, *et al.,* 2009:473; Ocak & Yamaç, 2013:381; Pintrich, 1999:462) (*cf.* 2.3.4). During the planning phase of learning, learners need to be able to set goals and select suitable strategies to complete tasks that would enable them to achieve their set goals. Furthermore, they also need to assess their expectations, interests, and levels of motivation to work on a task and establish whether their study environment would promote successful learning or task completion (Boekaerts, 1996:107, Pintrich, 1999:461, 462; Schunk, 2005b:86; Zimmerman, 2008:166; Zumbrunn, *et al*., 2011:10) (*cf.* 2.3.4.1).

Learners also need to acquire self-regulation strategies that would enable them to develop self-regulating skills to monitor the successful completion of learning tasks towards achieving goals, assess whether they remain motivated and willing to continue with a task, and ensure that their study environments maximise and support their learning or task completion (Finn & Metcalfe, 2013:19; Zimmerman, 2008:167, 175) (*cf*. 2.3.4.2).

In order to evaluate learning, learners have to possess self-regulation strategies that would enable them to assess how effective they were at achieving learning goals, if at all; how feelings of self-efficacy motivated them to persist in completing a task; as well as reflect on how suitable the study environment was for ensuring the successful completion of a task (Finn & Metcalfe, 2013:20; Marcou & Phlippou, 2005:203-304; Zimmerman, 2000:21) (*cf.* 2.3.4.3). Meta-cognition, self-regulation and self-regulated learning can all be regarded as sub-types of self-regulated action (Kaplan, 2008:479) (*cf.* Table 2.1) (*cf.* 2.4). Self-regulation integrates individual cognition and behavioural regulation as a result of interacting with the environment.

The chapter clarified the importance of self-regulation in the context of the objectives of the CAPS for mathematics which point to, among others, learners gaining and applying knowledge and skills in such a way that it will be meaningful in their own lives. Rote learning and uncritical learning must be avoided, and learners encouraged to take an active and critical role in their learning, thus becoming self-regulated learners (Department of Basic Education, 2012:5, 6) (*cf.* 2.5.1).

The literature, regarding the learning and teaching of mathematics where self-regulation is nurtured, highlights the importance of establishing classrooms where teaching is learner-centered. Learners need to be involved in interactive and constructive learning that promotes the development of self-regulation (Darr & Fisher, 2004) (*cf.* 2.6.1). Learner-centered classrooms have a tendency to influence learners' intrinsic motivation that will promote self-regulated learning (Paris & Paris, 2001:93, 94) (*cf.* 2.6). Self-regulation should be taught through direct instruction and modelling (Zimmerman, 2000:29), using guided and independent practise (Zumbrunn, *et al.,* 2011:14), social support and feedback, (Zumbrunn, *et al*., 2011:16), through reflection (Ertmer & Newby, 1996:19), during collaborative/cooperative learning activities (Hatami, 2015:2164), and through problem solving that involves discussions as a strategy to monitor progress (Du Toit & Kotze, 2009:61; Flemming, 2014; Shinde & Kolmos, 2011) (*cf.* 2.6.1 – 2.6.8). Teachers should explicitly and purposefully teach strategies that would facilitate the development of self-regulating skills for goal-setting, planning, attention control, self-monitoring, help-seeking, and self-evaluation (Du Toit & Kotze, 2009:58; Klieme & Vieluf, 2009:89; Kramarski, *et al*., 2013; Montague, 2008:37; Pajares, 2008:110, 111; Pandero, *et al.,* 2017:74, 76; Roth *et al.,* 2016:229; Zumbrunn, *et al*., 2011:11, 12) (*cf.* 2.6.1, 2.6.8).

A number of dysfunctions and challenges in relation to developing self-regulating skills were identified. Personal problems relating to a lack of social experiences, a lack of interest, disorders such as depression, and learning disabilities involving poor concentration and remembering can lead to poor self-regulation (Zimmerman, 2000:27) (*cf.* 2.7.1). The majority of mathematics learners do not plan, monitor, or reflect when solving mathematical problems (De Corte, *et al.,* 2000:695). According to Khul (cited by De Corte, *et al.,* 2000:696), self-regulation strategies to control the environment and time management also need attention since learners do not apply them (*cf.* 2.7). Teacher training does not purposefully aim to prepare teachers how to apply self-regulating skills or how to teach learners to become self-regulated (DaSilva-Marini & Boruchovitch, 2014:328) (*cf.* 2.7.1).

Challenges in South-African schools that could negatively affect the creation of adequate opportunities for developing self-regulating skills among learners are among others, teacher absenteeism, discipline problems, learning environments that do not promote the development of self-regulation, improper feedback about the learning process, and the reality of limited teaching time to complete the curriculum which leads to neglecting the development of self-regulating skills (Zumbrunn, *et al*., 2011:17; Josberger, *et al.*, 2010:27, 28) (*cf.* 2.7.2).

Chapter 3

This chapter explained and motivated the choice of the research methodology that was employed in the study. Pragmatism was selected as the research framework for the study, as both quantitative and qualitative research designs were used in a sequential explanatory mixed-method design. The qualitative research findings were used to explain the quantitative research findings (*cf.* 3.4).

Quantitative, descriptive survey research was employed, and a researcher-designed four-point Likert scale questionnaire was used to gather descriptive data in relation to participants' perceptions about the development of their self-regulating skills (*cf.* 3.5.1). The questionnaire consisted of four sections that corresponded with the stages of learning, namely planning, monitoring, evaluation, as well as ensuring a favourable study environment, for which well-developed self-regulating skills are required (*cf.* 3.5.1).

Qualitative, phenomenological research was used to gather data from participants by means of semi-structured interviews to explore the reasons for their perceptions in relation to the development of their self-regulating skills (*cf.* 3.5.2).

The questionnaire complied with criteria for face validity, content validity and construct validity (Leedy & Ormrod, 2014:91, 92; Maree & Pietersen, 2007b:217) (*cf.* 3.6.2; 3.6.3). Trustworthiness of the qualitative research was ensured by adhering to criteria for credibility, transferability, dependability, and confirmability (Lincoln & Guba, 1985:301-316; Babbie & Mouton, 2002:276-278).

During 2017, sampling took place by approaching the Grade 10 learners who took part in the mathematics enrichment intervention programmes at AMSC. The participants were purposively and conveniently chosen from four township schools situated in the regions of Boipatong and Evaton in the Sedibeng West District of the Gauteng Department of Basic Education (*cf.* 3.9.1). The schools that take part in the enrichment programme are identified by the Gauteng Department of Basic Education. Black, Sesotho-speaking male and female learners between 16 and 18 years old took part in the enrichment programme. During 2017, 130 Grade 10 mathematics learners were chosen to take part in the enrichment programme attended classes presented by AMSC teachers on Tuesdays and Fridays, for one hour each day at their respective schools, in addition to their normal school time table.

The questionnaire was completed by 130 participants, however, two learners decided to withdraw from the research, leaving the researcher with 128 questionnaires from which data were collected. For the qualitative research, 16 of the 128 participants were selected by means of purposeful criterion sampling (*cf.* 3.9.2), based on the results obtained from the questionnaire, to take part in the semi-structured, face-to-face interviews.

During the data analysis, descriptive and inferential statistics were used to analyse the data obtained for the quantitative study. A descriptive analysis was used to describe and summarise the data by using frequencies, percentages, means, and standard deviations for each item in the questionnaire, as well as for each questionnaire section (*cf.* 3.10.1). Inferential statistical procedures were used to compare the perceptions of the participants regarding the development of their self-regulating skills in relation to the different questionnaire constructs. T-tests were used for this purpose. If the comparisons revealed statistically significant differences, Cohen's *d* was calculated to determine the effect of the differences in practise (*cf.* 3.10.1). An ANOVA was used to establish the influence of the biographical variables on the data obtained (*cf*. 3.10.1).

The qualitative interview data were analysed by employing deductive and inductive content analyses. The deductive analysis involved the identification of *a priori* codes based on the literature review against which the data obtained were compared. The inductive analysis was done by compiling verbatim transcripts of the voice recordings made during the interviews, and subsequently open-coding the parts in the responses that contributed to answering the interview questions. The researcher then labelled the information with axial codes, made a list of all the topics and then clustered the similar topics together under themes, and presented the links between the themes visually (*cf.* Figures 4.1, 4.2). Finally, the researcher-constructed a composite that summarised the major findings of the qualitative research.

The researcher upheld ethical principles during the execution of the research (*cf.* 3.11) by ensuring that she addressed a problem that would be beneficial to the research participants. Furthermore, she obtained informed consent from all relevant stakeholders (*cf.* Appendix B, D, E, F), and ensured confidentiality and anonymity by using numbers to identify participants during the analysis and interpretation of data. Taking part in the study was voluntary and all data were kept confidential. The data were only available to NWU Statistical Services, the researcher, her study leader, and study co-leader. The North-West University's code of conduct for researchers was signed before commencing the research (*cf.* 3.11.5).

Chapter 4

In this chapter the data obtained from the questionnaire and the interviews were analysed and interpreted.

The Cronbach alpha coefficients and inter-item correlations for the questionnaire (*cf.* Tables 4.1, 4.2) indicated that the questionnaire was reliable (*cf.* 4.2). The researcher issued 130 questionnaires to participants, of which 128 were returned (*cf.* 4.3). The data also complied with acceptable criteria for skewness and kurtosis (*cf.* 4.2.2).

Gender, repeating Grade 10, and the participants' living conditions were observed as biographical variables in the study. The following was found:

- More female participants (n = 72) than male participants (n = 56) took part in the research (*cf.* Table 4.4) (*cf.* 4.3.1).
- Only a small percentage of participants (8.6%) were repeating Grade 10 (*cf.* Table 4.5) (*cf.* 4.3.2).
- About 43.8% of the participants live with both parents, 32%, live in single-parent families, 21.9% live with guardians, and 2.3% do not have parents or guardians with whom they live (*cf.* Table 4.6) (*cf.* 4.3.3)

The participants' perceptions were determined by using two four-point Likert scales. Participants were provided with the following descriptive explanations of the four-point scales, according to which they had to describe the development of their self-regulating skills:

- 1 = Novice: Someone with no or little experience and knowledge.
- 2 = Able: Someone with limited experience and knowledge.
- 3 = Skilled: Someone having experience and knowledge to do something well.
- 4 = Expert = Someone who is a very experienced and knowledgeable learner.

and

- 1 = Almost always: On a daily basis
- 2 = Often: Three to four times a week
- 3 = Sometimes: Twice a week
- 4 = Almost never: Once a week

Each section of the questionnaire focused on a specific aspect, namely the application of self-regulating skills during the planning, monitoring, and evaluation of learning in mathematics, as well as the application of self-regulating skills to ensure that the study environment supports successful task completion (*cf*. 4.4).

Based on the questionnaire and interview data the following findings can be deduced. The participants apparently lack meta-cognitive self-regulation strategies for becoming skilled at setting goals and selecting strategies for task completion. Moreover, motivational self-regulation strategies to become skilled at identifying expectations (*cf.* Table 4.7, 4.4.1), seem absent.

Given the few participants who regarded themselves as experts in monitoring learning, it could be argued that the participants lack meta-cognitive self-regulation strategies to enable them to become skilled at correcting their behaviour and mistakes, and keeping track of progress, as well as motivational self-regulation strategies to stay motivated and complete tasks (*cf.* Table 4.8, 4.4.2).

Only a few participants appear to regard themselves as experts in evaluating their mathematics learning. The participants' perceptions revealed that they need more effective meta-cognitive self-regulation strategies to become skilled experts at checking if their goals were achieved, as well as motivational self-regulation strategies for staying motivated and confident until a task is completed (*cf.* Table 4.9, 4.4.3).

The data also revealed that the participants' seemingly lack self-regulating skills to ensure that their study environments are favourable to ensure optimal success during task completion and studying. Self-regulation strategies to be experts at reversing the constraints that their study environments pose to learning, appear to be absent among the participants (*cf.* Table 4.10, 4.4.4).

According to the perceptions of the participants, it could also be concluded that the mathematics teachers of the participants apparently do not explicitly teach or model self-regulation strategies to participants that would facilitate the development of self-regulating skills.

The quantitative data indicated that the female participants perceive their self-regulating skills for planning to be better than what their male counterparts perceived their own self-regulating skills for planning (*cf.* 4.5.1, Table 4.11). No statistically significant differences were noted between the male and female participants regarding their perceptions about their self-regulating skills to monitor and plan their work, and to secure a suitable study environment. In addition, no statistically significant differences were noted between the perceptions of participants who repeated Grade 10 and the participants who did not repeat Grade 10 regarding their self-regulating skills to plan, monitor and evaluate their work, and for ensuring a suitable study environment (*cf.* 4.5.2, Table 4.12). Participants from different types of living conditions had similar perceptions regarding the development of their self-regulating skills for planning, monitoring, evaluating their work, and ensuring a suitable study environment (*cf.* 4.5.3, Table 4.13).

Similar perceptions were noted among the participants around their self-regulating skills for monitoring and evaluating their learning. However, their perceptions about the application of skills to monitor and evaluate learning indicated that they regarded themselves better skilled at monitoring and evaluating learning, than at planning their learning. Well-developed self-regulating skills to control the negative influence of study environments appeared to be absent among all the participants (*cf*. Table 4.14).

The qualitative research aimed to understand possible factors that contributed to the development of participants' self-regulating skills (*cf.* 4.8.1). The interview data revealed that the participants appear to be novices who have little knowledge about, and experience in, applying self-regulation strategies that would enable them to become skilled at the planning, monitoring and evaluation of their work. Possible reasons for the absence of self-regulation strategies to plan could be linked to a lack of understanding about what planning and goal setting implies (*cf.* 4.8.1.1) (*cf.* 4.8.2.1). In addition, teachers who do not enhance the development of self-regulating skills are, in effect, promoting an overreliance on the teacher to set goals for the participants (*cf.* 4.8.1.1; 4.8.1.5; 4.8.2.1; 4.8.2.5).

Possible reasons for the lack of self-regulating monitoring skills point to the following: A possible lack of motivation and finding mathematics difficult (*cf.* 4.8.1.8, 4.8.2.7); failing to link monitoring to the successful achievement of goals (*cf.* 4.8.2.2); and possessing limited strategies for monitoring work (*cf.* 4.8.1.2, 4.8.2.2).

The possible reasons for participants not being able to successfully engage in the evaluation process of learning could be linked to the following: Lacking a thorough understanding of what is expected during the evaluation of learning (*cf*. 4.8.1.3); relying on teachers to set goals (*cf.* 4.8.1.3); and a lack of skills to properly evaluate work (*cf*. 4.8.1.3).

The apparent absence of self-regulating skills to ensure a suitable study environment could be linked to the following: Noisy environments (*cf.* 4.8.1.4, 4.8.2.4); a lack of support from parents and teachers (*cf.* 4.8.1.5, 4.8.1.6, 4.8.2.5, 4.8.2.6); and crowded homes with no specific study place (*cf.* 4.8.1.4).

The next section will report the major findings derived from the literature review.

5.3 FINDINGS FROM THE LITERATURE REVIEW

The main findings that transpired from the literature review that guided the construction of the questionnaire and the interpretation of the data revealed the following.

- Teaching and learning underpinned by cognitive constructivist learning theory and socio-cognitive theory (Bandura, 1999b:23, 25) (*cf*. 2.2.3.3) seems to hold the greatest benefits for developing self-regulation among learners. Mental planning, goal construction, reflecting on experiences, social learning, and the development of cognitive functions to enhance learning are important cognitive and constructivist components that play a role in the development of self-regulation (Fosnot & Perry, 2015:10, Zhou & Brown, 2014) (*cf*. 2.2.2 – 2.2.3). According to socio-cognitive theory, learning takes place by observing the behaviour of others and through a continuous interaction between cognitive influences, behavioural influences, and environmental influences (Bandura, 1999b:23). The observation and interaction processes involve self-regulation to monitor, adjust, and correct problems or obstacles that hamper success (Bandura, 1999b:26) (*cf*. 2.2.3.3).

- Self-efficacy and self-concept beliefs play an important role in motivation (Bandura, 1993:131) (*cf.* 2.2.3.3, 2.3.2.3), which is regarded as an important prerequisite for self-regulation (Pajares & Schunk, 2001:239-240) (*cf.* 2.3.2). Self-efficacy has an influence on the level of goals a person will select along with the amount of effort that will be put into achieving them and whether they will persist in achieving goals when confronted with challenges.
- A number of personality traits (openness, conscientiousness, and agreeableness) link well with self-regulation. Openness links with taking responsibility for achieving goals (Boekaerts, *et al.*, 2000:17; Sadi & Uyar, 2013:21; Wolters, *et al.*, 2003:4) (*cf.* 2.2.4.2). Conscientiousness can be associated with being responsible, able to plan, organise, and persist in achieving good results (Bandura, 1991:248; Bidjerano & Dai, 2007:70) (*cf.* 2.2.4). Agreeableness links to time-management, the willingness to put in effort to complete tasks, as well as managing the study environment to optimise conditions that would enhance successful learning or task completion (Bidjerano & Dai, 2007:71-72) (*cf.* 2.2.4.2). Powers (1994) indicated that people normally want to control their behaviour; a fundamental feature of perceptual control theory, which relates to self-regulation. Attaining a goal is very important in self-regulated learning, and includes maintaining a particular perception towards reaching a goal by taking control over the influences in the environment that might obstruct success (*cf.* 2.2.4.1).
- Self-regulated action involves the regulation of one's thinking and behaviour during learning or task involvement (Kaplan, 2008:479) (*cf.* 2.4). Cognitive, meta-cognitive,

motivational, and environmental strategies are required for the development of self-regulating skills during the stages of learning, namely planning, monitoring, and evaluation (*cf.* 2.3.4). Planning is done before attempting a task through setting achievement goals, planning strategies to achieve those goals, and managing time to achieve goals successfully. Monitoring involves observing the progress made towards achieving set goals and removing obstacles that could obstruct goal achievement. It also comprises being skilled at remaining motivated and willing to complete a task, even when faced with challenges. Evaluation takes place at the end of task completion to determine if goals were achieved successfully and if adjustments to applied self-regulation strategies will be required when completing similar tasks in the future. Planning, monitoring, and evaluation involve reflecting about the suitability of self-regulation strategies that enable one to become skilled at completing tasks, and making changes in the choice of self-regulation strategies for future task completion. Learners also reflect on their past experiences to alter their approach to complete similar tasks in the future (Ertmer & Newby, 1996:14; Pintrich, 1999:461; Schraw, *et al.,* 2006:114; Zimmerman, 2000:14). (*cf.* 2.3.4.1 - 2.3.4.4).

- The literature review emphasised the importance of self-regulation in the context of the CAPS objectives for mathematics, which point to, among others, gaining and applying knowledge and skills in such a way that it will be meaningful in the learners' own lives. Studies on self-regulation have confirmed that it enhances mathematics achievement (Perels, *et al.,* 2009:27) (*cf.* 2.5). Rote and uncritical learning should be emphasised less, and learners provided with opportunities to become actively and critically involved in their learning, thus becoming self-regulated learners (Department of Basic Education, 2012:5,6) (*cf.* 2.5.1). The CAPS for mathematics (Department of Basic Education, 2012:5,6) support the development of self-regulating skills by emphasising the development of problem solving skills, creative and critical thinking, and working independently and also with others (*cf.* 2.5.1; Table 2.2).
- Darr and Fisher (2004), Van der Walt and Maree (2007:223), Sadi and Uyar (2013:22), and the Department of Basic Education (2012:5) emphasise the importance of developing self-regulating skills in the mathematics classroom. Teaching should become learner-centered, thus involving learners in an interactive and constructive learning environment that promotes the development of self-

regulation (Darr & Fisher, 2004; Klieme & Vieluf, 2009:89) (*cf.* 2.6.1). Self-regulation should be taught in various ways (*cf*. 2.6.1 - 2.6.7); namely, through direct instruction and modelling (Zimmerman, 2000:29) where learners observe the teacher and receive guidance from the teacher while independently imitating the application of the strategy (Zumbrunn, *et al.,* 2011:14). Social support from teachers and peers that comprises feedback about what was done well, what needs to improve, and suggesting ways to address improvements, also promote the development of self-regulation (Zumbrunn, *et al*., 2011:16). Collaborative or cooperative learning activities are beneficial for developing self-regulated learning (Hatami, 2015:2164), as learners have to plan their task completion and reflect on how well they are achieving their goals. Problem solving is regarded as effective for developing self-regulating skills in mathematics (Flemming, 2014; Shinde & Kolmos, 2011). Problem solving expects of learners to analyse problems, plan how to approach the solutions to problems, and reflect on the suitability of the strategies applied to solve the problems. Discussions during problem solving will help learners to monitor their progress toward achieving goals (Du Toit & Kotze, 2009:61).

- Teachers should explicitly and purposefully teach strategies that would facilitate the development of self-regulating skills for goal-setting, planning, attention control, self-monitoring, help-seeking, and self-evaluation (Du Toit & Kotze, 2009:58; Kramarski, *et al.* 2013; Montague, 2008:37; Pajares, 2008:110-111; Pandero, *et al*., 2017:74, 76; Roth, *et al.*, 2016:229; Zumbrunn, *et al*., 2011:11-12) (*cf.* 2.6.8).
- A number of dysfunctions and challenges in relation to developing self-regulating skills exist. Learners can experience personal problems that refer to among others, a lack of social experiences, a lack of interest, disorders such as depression, and learning disabilities involving poor concentration (Zimmerman, 2000:27) (*cf.* 2.7.1). The research findings of Van der Walt and Maree (2007:224) confirm that the development of self-regulation does not play a role in the South African school curriculum (*cf.* 2.5, 2.6.1). Many mathematics learners do not plan, monitor, or reflect when solving mathematical problems (De Corte, *et al.,* 2000:695); they also do not apply strategies to control their study environment and plan time for learning or task completion (Khul, cited by De Corte *et al.,* 2000:696) (*cf.* 2.7.1). Learners' beliefs about mathematics are naïve and incorrect which influences their self-regulation.

Learners believe mathematics is a fixed body of knowledge that has to be acquired through listening and practise, and does not involve one taking control and responsibility for one's own learning (De Corte, *et al.,* 2000:699) (*cf*. 2.7.1). Teacher training also neglects to equip teachers with knowledge and skills about how to assist learners to become self-regulated (DaSilva-Marini & Boruchovitch, 2014:328) (*cf.* 2.7.1).

- A number of current challenges in South-African schools could negatively affect opportunities to develop self-regulating skills among learners. These challenges refer *inter alia* to teacher absenteeism, discipline problems, learning environments that do not promote the development of self-regulation, improper feedback about the learning process, and the reality of limited teaching time to complete the curriculum which leads to neglecting the development of self-regulating skills (Chisholm, 2011:52; Govender, 2016; Josberger, *et al*., 2010:27, 28; Malan, *et al.,* 2014:1; Van der Walt & Maree, 2007:236); Zumbrunn, *et al.,* 2011:17) (*cf.* 2.7.2).

The subsequent section summarises the findings obtained from the empirical research.

5.4 FINDINGS OF THE EMPIRICAL STUDY

The qualitative data were used to clarify the results from the quantitative data. The essence of what transpired from the preliminary findings, as reported in Chapter 4 (*cf.* 4.10), is summarised below.

- The participants who took part in the study could be regarded as novices in terms of applying self-regulating skills, to plan, monitor, and evaluate their mathematics learning, and to ensure that their study environments maximise their chances of being successful (*cf.* 4.4.1 – 4.4.4). Difficulties were observed in the application of meta-cognitive, motivational, and environmental self-regulation strategies amongst the participants (*cf.* 4.8.1.1, 4.8.2.1), which possibly contributed to the lack of skills to self-regulate learning. At a meta-cognitive level, difficulties manifested in relation to setting goals and choosing strategies to achieve goals (Zimmerman, 2000:17) (*cf.* 2.3.4.1), to judge whether strategies are working for a specific task and enabling task progression (Finn & Metcalfe, 2013:19) (*cf*. 2.3.4.2), as well as to establish what changes should be made to reach set goals (Schraw, *et al.,* 2006:114; Schunk, 2005a:173) (*cf.* 2.3.4.2). Moreover, participants seem unable to evaluate whether a specific approach to task completion was successful and enabled them to achieve their goals (Ertmer & Newby, 1996:5; Schraw, *et al.*, 2006:114) (*cf*. 2.3.4.3). Although some participants indicated that they are motivated to do their mathematics tasks, more exposure to positive motivational strategies could contribute to enhanced self-efficacy and motivation to persist and adapt their strategies to achieve goals, as well as greatly benefit the participants' chances of improving future performance (Finn & Metcalfe, 2013:20; Marcou & Philippou, 2005:303, 304) (*cf.* 2.3.4.3). Well-developed environmental strategies for planning, monitoring, and evaluation could assist the participants to better manage their study environments to maximise learning, remove obstacles, and encourage help-seeking in order to increase their chances at achieving learning success (Zimmerman, 2008:167) (*cf.* 2.3.4.1, 2.3.4.2, 2.3.4.3).

- The findings revealed that the female participants viewed themselves to be better skilled at the application of self-regulating skills in relation to planning, than what their male counterparts viewed their own self-regulating skills to plan work (*cf.* 4.5.1).
- The repetition of Grade 10 did not seem to have any influence on the perceptions of the participants regarding their views in relation to the development of any of their self-regulating skills (*cf.* 4.5.2).
- The participants' living conditions also could not be regarded as influential in terms of how they perceived the development of any of the self-regulating skills (*cf*. 4.5.3).
- It was noted that participants viewed themselves to be better skilled at self-regulating the monitoring and evaluation stages of learning, than planning learning (*cf*. Table 4.14).
- A teaching approach that does not enhance the development of active learning, encourage learners to take responsibility for their learning, and to become critical about their learning seems to prevail in the mathematics classrooms of the participants who took part in the study (Cox, 2011:15; Zhou & Brown, 2014) (*cf*. 2.2.1; 2.2.3; 4.8.1.5; 4.8.2.5). Subsequently, the participants tend to rely on their teachers to direct their learning.
- It could be argued that the participants who took part in the study do not display personality traits that have strong links with self-regulation, such as openness,

conscientiousness, and agreeableness as they appeared to be novices in working independently, planning their work, setting goals to be achieved, and controlling their study environments by removing obstacles that hamper their success (Bandura, 1991:248; Bidjerano & Dai, 2007:70; Boekaerts, 1996:101) (*cf.* 2.2.2.2; 4.4.1- 4.4.4; 4.8.1.4; 4.8.2.4). The participants do not seem to have self-regulation strategies to help them make changes to their environments; as such, factors like noisiness and crowdedness could continue to hamper their success (Bandura, 1999b:23, 27; Pintrich, 1999:451, 457; Zimmerman, 2008:168) (*cf*. 2.2.3.3, 2.3.4, 2.3.4.1) (*cf*. 4.8.1.4, 4.8.2.4).

- The role of reflection seems to be underestimated in the mathematics classrooms of the participants who took part in the research, as the data indicated that the participants are not able to make judgements about their learning (Paris & Paris, 2001:89; Zimmerman, 2000:14) (*cf*. 2.3.4.4). In this regard, the researcher argues that the use of purposeful question during teaching, could encourage participants to reflect on their learning (Kistner, *et al.,* 2015:176) (*cf.* Table 2.3). Reflective questioning does not seem to be have an important place in the classrooms of the participants who took part in the research. The researcher concludes that the participants who took part in the research are not exposed to active and constructive learning that allows them to take ownership of their learning (Darr & Fisher, 2004; Prideaux, 2007:11) (*cf.* 2.6.1). It could be argued that teaching strategies that are regarded as effective for developing self-motivation and self-regulating skills, such as cooperative learning and problem solving, are not implemented frequently enough. Implementing these strategies frequently would contribute to better planning of learning and promote reflection on learning progress and the outcome of learning (Darr & Fisher, 2004; Flemming, 2014; Hatami, 2015:2164; Vula, *et al.,* 2017:56) (*cf.* 2.5.7, 2.6.6, 2.6.7), which was not evident from the data obtained. In particular, the use of discussions during problem solving that could help learners to monitor their progress toward achieving goals (Du Toit & Kotze, 2009:61) (*cf*. 2.6.8), appear to be underutilised during mathematics teaching.
- Teachers seemingly do not model or verbalise the application of self-regulation strategies that would facilitate the development of self-regulating skills for goal-setting, planning, attention control, self-monitoring, self-motivation, help-seeking, and

self-evaluation (Du Toit & Kotze, 2009:58; Kramarski, *et al*., 2013; Montague, 2008:37; Pajares, 2008:110, 111; Pandero, *et al.,* 2017:74, 76; Roth, *et al.,* 2016:229; Zumbrunn, *et al*., 2011:11, 12) (*cf.* 2.6.8). Subsequently, participants are not exposed to observing the application of self-regulation strategies and to practise the strategies to become skilled at self-regulation (Peeters, *et al.,* 2014:1966; Zimmerman, 2000:29) (*cf.* 2.3.3.3, 2.6.2).

- The findings of the research indicate that the development of self-regulating skills, as advocated by the objectives of the CAPS for mathematics, seemingly have not become a reality in the classrooms of the participants who took part in the research. This finding concurs with the research findings of Van der Walt and Maree (2007:235), pointing to teachers that do not create sufficient opportunities for the participants to practise self-regulation procedures (*cf*. 2.7.2).
- Most of the findings align well with the present literature on self-regulation, however, one of the findings could be regarded as interesting and surprising. Although many of the participants appeared to be willing and motivated to learn and do mathematics, they could not be regarded as experts in planning, monitoring, or evaluating their learning, and they also seem to have difficulty in ensuring that they have a suitable study environment. This finding does not align well with the literature where it is argued that self-efficacy comprises willingness and motivation to achieve goals (Perry & Steck, 2015;128-130; Tella, 2011:430) (*cf.* 2.3.3.3.). These traits could be regarded as pre-requisites for self-regulated learning, enabling learners to become less dependent on teachers for evaluating their performance, and reflecting on the achievement of their goals; all of which were not observed among the learners who took part in the study. This observation could be linked to the literature where it is stated that a learner will not acquire self-regulation strategies automatically, and need support (Blair, *et al.,* 2015:459) (*cf*. 2.6.8). Teachers should model learning strategies by thinking aloud (Sabornie & de Bettencourt, 2009:56) (*cf.* 2.6.1), and through guided practise teachers should observe how learners apply the self-regulation strategies (Zumbrunn, *et al*., 2011:14) (*cf.* 2.6.2). Guided practise increases the development of self-regulating skills and motivates learners. Due to the apparent lack of self-regulation strategies, the researcher is concerned that the participants probably do not yet acknowledge the personal importance of self-regulating skills (Ryan & Deci,

2006:68) (*cf.* 2.4.1.1) to attain goals and control their study environments (Abdalla, *et al*., 2000:189) (*cf.* 2.2.4.1).

- The researcher contends that the following conclusions could be applicable in relation to the development of the self-regulating skills of the participants who took part in the study: (i) the self-regulating skills might not have yet developed due to a lack of exposure to self-regulation strategies, and therefore do not manifest during learning, or (ii) the self-regulating skills might be developing, require more practise and therefore are fragile (Feuerstein *et al.,* 2002:271).
- Finally, reasons for the apparent, alarming absence of well-developed self-regulating skills comprised the following: The absence of a clear understanding of what the planning, monitoring, and evaluation phases of the learning process entail (*cf*. 4.8.1.1 – 4.8.1.3; 4.8.2.1 – 4.8.2.3); a restricted set of strategies to self-regulate learning and establish conducive study environments (*cf*. 4.8.1.1 – 4.8.1.4; 4.8.2.1 – 4.8.2.4), and limited opportunities at school and at home that support the development of self-regulating skills (*cf*. 4.8.1.5; 4.8.2.5).

In the following section, the researcher reflects on the extent to which she achieved the aim and objectives set out at the beginning of the research.

5.5 FINDINGS IN RELATION TO THE AIM AND OBJECTIVES OF THE STUDY

The main aim of the study was to **describe** how well-developed Grade 10 mathematics learners perceive the development of their self-regulating skills to be; and to **explore** the possible reasons for self-regulating skills to be well-developed or not-well-developed.

In order to achieve the main aim, the following objectives were formulated.

Objective 1: To determine how self-regulating skills should be conceptualised

This objective was achieved by conducting an extensive literature review (*cf.* 2.2 – 2.7).

This study conceptualised self-regulated learning according to the framework of Pintrich (2000:451-502), who argues that self-regulation during learning comprises three interactive, cyclical phases: planning, monitoring, and evaluation (where self-regulation strategies are applied to facilitate the development of self-regulating skills towards achieving learning goals). Reflection links the three phases and serves the purpose of making conclusions about, and adjustments to behaviour in order to optimise the learning process (Bandura, 1991:248; Dignath-Van Ewijk, *et al.,* 2013:339; Ertmer & Newby, 1996:10; Fosnot & Perry, 2005:34; Karpicke, *et al.,* 2009:479; Ocak & Yamaç, 2013:380; Pandero, *et al.,* 2017:75; Pintrich, 2000:459; Schunk, 2005a:173; Zimmerman, 1986:308; Zimmerman, 2008:169) (*cf.* 2.4.1.3). Meta-cognitive, motivational and environmental self-regulation strategies are applied and adjusted during self-regulated learning to regulate and control thinking and learning (Bandura, 2015:1028; Ertmer & Newby, 1996:10, Zimmerman, 1986:308, 167; Zimmerman, 2008:169) (*cf.* 2.3.4.1 - 2.3.4.4).

During planning, meta-cognitive strategies are required to develop skills for setting goals and selecting strategies for task completion and motivational strategies are required for identifying expectations (*cf.* 4.4.1). Motivational strategies also influence the effort learners put into a task, how much time they will spend on the task, and how well they will cope with stress factors during learning (Boekaerts, 1996:107; Erlich & Russ-Eft, 2011:7; Pintrich, 1999:462) (*cf*. 4.4.1). Environmental strategies applied during planning include managing time and the study environment, as well as help-seeking to support learning (Pintrich, 2000:455) (*cf.* 4.4.1).

As part of monitoring, the learner will assess on a meta-cognitive level if the strategies that were chosen for task completion are working and if learning is progressing towards achieving goals (Bandura, 1986:338; Finn & Metcalfe, 2013:19; Flavell, 1979:908; Schunk, 2005b:87; Zimmerman, 2008:167) (*cf*. 4.4.2). Motivationally speaking, self-regulated learners will monitor whether a task manages to hold their attention; establish what their feelings towards a task are; how confident and willing they feel to put in effort to complete a task; and if their time management will enable them to complete a task in time (Ertmer & Newby, 1996:20; Finn & Metcalfe, 2013:19; Zimmerman, 2008:175) (*cf.* 4.4.2). Self-regulated learners will also determine whether the study environment supports their learning throughout task completion, and if more materials or resources are required to achieve goals successfully (Zimmerman, 2008:167) (*cf*. 4.4.2).

On completion of a learning task, self-regulated learners will meta-cognitively evaluate whether they were successful in achieving their goal and if they should implement new strategies to be more effective in task completion (Ertmer & Newby, 1996:5; Marcou & Philippou, 2005:303, 304). In addition, self-regulated learners will evaluate their emotions towards the outcomes of the task (Marcou & Philippou, 2005:303-304), as well as how well they managed their time and study environment for optimal learning. Learners will also reflect on ways to change their study environments for future tasks (Pintrich, 2000:460; Schunk, 2005a:173). The main purpose of self-regulation during the evaluation phase is to achieve a greater personal understanding of what worked or not, and give consideration to improvements that would benefit future performance (Finn & Metcalfe, 2013:20; Zimmerman, 2000:21) (*cf.* 4.4.3).

Objective 2: To determine what contributes to the development of self-regulating skills

Objective 2 was achieved by means of a literature review.

Learners with well-developed self-regulating skills will have the capability to take responsibility for their own learning (Boekaerts, 1996:100; Schunk, 2005a:173). For this purpose, teachers need to create learning environments where learners can take control of their own learning (Darr & Fisher, 2004; Sadi & Uyar, 2013:22).

Teaching should become learner-centered, thus involving learners in interactive and constructive learning strategies that promote the development of self-regulation (Darr & Fisher, 2004) (*cf.* 2.6.1). Self-regulation should be taught in various ways (*cf*. 2.6.1-2.6.7); through direct instruction and modelling (Zimmerman, 2000:29) where learners observe the teacher and receives guidance from the teacher when independently imitating the application of the strategy (Zumbrunn, *et al.,* 2011:14). Social support from teachers and peers comprises feedback about what was done well, what needs to improve, and suggesting ways to address improvements for promoting the development of self-regulation (Zumbrunn, *et al*., 2011:16). Collaborative or cooperative learning activities are beneficial for developing self-regulated learning (Hatami, 2015:2164). During collaborative learning, learners have to plan their task completion and reflect on how well they are achieving their goals. Problem solving is highly recommended for developing self-regulation in mathematics (Flemming, 2014; Shinde & Kolmos, 2011). Problem solving expects of learners to analyse problems, plan how to approach the solutions to problems, and reflect on the suitability of the strategies applied to solve the problems. Discussions during problem solving will help learners to monitor their progress towards achieving goals (Du Toit & Kotze, 2009:61; Vula, *et al.,* 2017:56,57) (*cf.* 2.6.7, 2.6.8).

Teachers should explicitly and purposefully teach strategies that facilitate the development of self-regulating skills for goal-setting, planning, attention control, self-monitoring, help-seeking, and self-evaluation (Du Toit & Kotze, 2009:58; Kramarski, *et al.,* 2013; Montague, 2008:37; Pajares, 2008:110, 111, Pandero, *et al.,* 2017:74, 76; Roth, *et al.,* 2016:229; Zumbrunn, *et al*., 2011:11, 12) (*cf.* 2.6.8).

Objective 3: To investigate why self-regulating skills are important for learning mathematics

The literature review enabled the researcher to achieve objective 3.

Studies on self-regulation have been steadfast in testifying that mathematics achievement increases noticeably when learners self-regulate their learning (Ertmer & Newby, 1996:19; Loynachan, 2018; Perels, *et al.* 2009:27; Zumbrunn, *et al.,* 2011:16) (*cf.* 2.6.5, 2.3.2, 2.6). According to CAPS, the development of self-regulation is implied in a number of objectives to be achieved during the teaching of mathematics (Department of Basic Education, 2012:11). In this regard, teachers need to replace rote learning and uncritical learning with an active and constructive approach to learning. This will allow learners to take responsibility for their own learning and enable them to develop critical thinking that enhances decision making and accuracy, especially during problem solving. Furthermore, active learning will enable learners to solve problems, make decisions, and be creative in their thinking; acquire skills to work effectively on their own as well as in a group; and to critically evaluate information after collecting, analysing, and organising it (Department of Basic Education, 2012:5). Teacher dependence should be replaced with the development of self-regulating skills that could increase learners' self-motivation and their academic achievements (Boekaerts, 1996:100; Dignath & Büttner, 2008:232; Medina, 2011:150; Zimmerman, 1986:307) (*cf.* 2.5). Problem solving stands central to the mathematics curriculum. Ocak and Yamaç (2013:381) and Vula, *et al.* (2017:56) indicate that well-developed self-regulating skills are of particular importance for effective problem solving (*cf.* 2.5.3). The researcher also argues that self-regulated learners will be equipped with skills that contribute to their self-fulfilment and meaningful participation in society as citizens of a free country (Department of Basic Education, 2012:5, 6) (*cf.* 2.5.4.1).

Objective 4: To determine the perceptions/opinions of Grade 10 mathematics learners about how well their self-regulating skills are developed

This objective was achieved by surveying Grade 10 mathematics learners; perceptions, using a researcher-constructed, closed, four-point Likert scale questionnaire (*cf.* Appendix G).

Perceptions about planning

Based on the perceptions of the participants, it seems that the majority of the participants who took part in the research do not excel in any of the aspects that involve the planning of their mathematics learning. Less than half of the participants who took part in the study regarded themselves as being *skilled* or *expert* in possessing effective skills to plan their mathematics learning (*cf*. Table 4.7).

The questionnaire data indicate to the researcher that the participants who took part in the study seem to lack meta-cognitive (strategies to set goals and identity strategies for task completion), and motivational strategies (identifying expectations and determining emotions, willingness and interests) (Zimmerman, 2000:17) (*cf.* 2.3.4.1) that are important for the planning phase of the learning process; and could be regarded as *novices,* with little knowledge or experience in relation to skills that could enhance the planning phase of learning (*cf.* 4.4.1). It could also be argued that the skills to plan may only be emerging and fragile, implying that the skills are beginning to develop but more practise is required by the participants to apply the skills appropriately (Feuerstein *et al.,* 2002:271).

Based on the data, the researcher concludes that due to a lack of well-developed skills to plan, the participants who took part in the research may:

- not achieve the learning goals set with mathematics tasks (Bannert & Reimann, 2012:194; Boekaerts, 1996:107; Cazan, 2012; Ertmer & Newby, 1996:10 & 11;

Pintrich, 1999:461; Schunk, 2005b:86; Zimmerman, 2008:166; Zumbrunn *et al*., 2011:10) (*cf.* 2.3.4.1);

- be unsure about task expectations or what they have to achieve before starting their learning or completing a task (Schraw, *et al.,* 2006:114) (*cf.* 2.3.4.1);
- find it problematic to plan their time in order to successfully complete a task with great success (Bannert & Reiman, 2012:194) (*cf.* 2.3.4.1); and
- not be aware of and able to identify obstacles that could hamper their success towards achieving goals (Bannert & Reimann, 2012:194; Boekaerts, 1996:107; Cazan, 2012; Ertmer & Newby, 1996:10 & 11; Pintrich, 1999:461; Schunk, 2005b:86; Zimmerman, 2008:166; Zumbrunn, *et al*., 2011:10) (*cf.* 2.3.4.1).

Perceptions about monitoring

The participants who took part in the study also seem to lack effective self-regulating skills to monitor their performance when working towards the completion of mathematics tasks (*cf.* Table 4.8). Although the questionnaire responses to the individual questionnaire items indicated that the majority of the participants appeared to be *able* and *skilled* to monitor their work, the percentages obtained for each question in relation to monitoring indicated that less than half of the group appeared to be able or skilled in monitoring; implying that the skills to monitor could be fragile or still emerging. Based on the data, the researcher concludes that the participants who took part in the research lack well-developed meta-cognitive strategies (to correct behaviour and mistakes, keep track of progress) and motivational strategies (to stay motivated and complete tasks) to self-regulate the monitoring phase of learning (Finn & Metcalfe, 2013:19; Zimmerman, 2008:175) (*cf.* 2.3.4.2).

The findings emanating from the abovementioned observation (*cf.* Table 4.8), refer to the following:

- Participants seem to lack skills to ask questions during learning that would enable them to understand what they are busy doing. This could propel poor self-efficacy beliefs and experiencing feelings of helplessness and anxiety that could make it difficult for the participants to achieve learning goals successfully (Bandura, 1986:337; Bandura, 1993:123; Schunk, 2005b:87; Zimmerman, 2008:175) (*cf.* 2.3.4.2).

- The achievement of goals might not be successful as the participants noted that they lack the self-regulating skills required to rectify mistakes. Being able to rectify one's own mistakes is an important technique to ensure learning effectiveness (Schraw, *et al.,* 2006:114; Schunk, 2005a:173) (*cf.* 2.3.4.2).
- The participants seem to find it difficult to stay motivated when working on mathematics tasks, possibly implying a lack of self-regulation strategies to regulate motivation, interest and willingness during learning. If the participants cannot apply self-regulating skills to persist and stay motivated during learning, they might not find the task rewarding when they ultimately reach their goals (Ertmer & Newby, 1996:12; Zimmerman, 2008:168; Zumbrunn, *et al.,* 2011:10) (*cf.* 2.3.4.1).
- Keeping track of performance ensures greater performance success as adjustments can be made in advance to avoid errors and obstacles that influence performance success (Boekaerts, 1996:107; Erlich & Russ-Eft, 2011:7; Ertmer & Newby, 1996:13; Pintrich, 1999:462) (*cf.* 2.3.4.1, 2.3.4.2). In the context of the study, the responses of the participants seem to indicate that they do not possess well-developed self-regulating skills to keep track of their performance to eliminate obstacles that could maximise their success on the way to achieving goals.

Perceptions about evaluation

Based on the data, the researcher concluded that the participants who took part in the study require well-developed self-regulation strategies that would enable them to develop self-regulating skills to become experts in evaluating their mathematics learning. Although the majority of the participants indicated that they perceive themselves to be *able* and *skilled* in evaluating their learning, only a small percentage of the participants viewed themselves as experts in evaluation. Based on the aforementioned response, the researcher concludes that the participants who took part in the study require more effective meta-cognitive strategies (checking if goals were achieved) and motivational strategies (staying motivated and confident until a task is completed) to self-regulate learning in order to become skilled at evaluating their learning (Marcou & Philippou, 2005:303-304; Schunk, 2005b:87) (*cf*. 2.3.4.3) (*cf.* Table 4.9). The current skills to evaluate could also be deficient; implying that they are not yet developed, therefore do not materialise in environments where they should. In addition, it could also be argued that the skills are either emerging or fragile; that is, having developed but lack practise (Feuerstein *et al.,* 2002:271).

The researcher presents the following findings in relation to the participants' skills for evaluating learning:

- If participants are unsuccessful in checking if goals were achieved, the outcome of the learning process could be influenced negatively, as they might not achieve their goals (Pintrich, 2000:460, Schraw, *et al.,* 2006:114; Zimmerman & Schunk, cited by Redmond, 2010; Pajares & Schunk, 2001:246) (*cf.* 2.3.4.3), (*cf.*2.2.3.3) (*cf.* 2.3.3.1).
- Many participants have seemingly not been exposed to teaching and learning environments where they are expected to discuss or reflect on what they have learned (Pintrich, 2000:460; Schunk, 2005a:173) (*cf*. 2.3.4.3).
- A lack of self-regulation strategies to stay motivated and confident until a task is completed, could pose problems in relation to persevere and reduce the amount of time invested in a task, which impacts on the level of successfulness of mathematics task outcomes (Ertmer & Newby, 1996:20; Finn & Metcalfe, 2013:19) (*cf.* 2.3.4.2). Moreover, a lack of confidence could result in not having the skills to compare progress towards goals that need to be achieved (Schunk, 2005b:87) (*cf*. 2.3.4.2).

Perceptions about study environment

Well-developed self-regulation strategies that would enable the participants to develop the skills to become experts in establishing a suitable study environment seem few and far between. The participants appeared to have divided opinions circling around their being novices, able or skilled in establishing a suitable study environment. The researcher concludes that the participants who took part in the study require more effective meta-cognitive strategies (checking if goals were achieved) and motivational strategies (staying motivated and confident until a task is completed) to self-regulate the establishment of a study environment that would maximise their learning (Marcou & Philippou, 2005:303-304; Schunk, 2005b:87) (*cf*. 2.3.4.3) (*cf.* Table 4.9). The strategies that the participants have to establish suitable study environments for themselves seem to be only emerging or fragile; not practised and applied appropriately (Feuerstein *et al.,* 2002:271).

The following findings could be derived from the data:

- The participants appear to be in need of well-developed strategies to adapt or change their study environments, namely to plan a suitable place for studying, self-regulate their study time, reflect whether their time was used effectively, and consider ways to enhance the environment for future tasks (Finn & Metcalfe, 2013:20; Zimmerman, 2000:21) (*cf.* 2.3.4.3), in order to ensure that they achieve their goals successfully (Ertmer & Newby, 1996:3; Pintrich, 1999:451, Vula, *et al.,* 2017:56; Zimmerman, 2008:168) (*cf.* 2.3.4.1, 2.6.7).
- The participants create the impression that they do not belong to working support groups and do not have strong assistance from teachers, peers or parents to develop self-regulating skills that would increase their chances for success (Wolters, *et al.*, 2003) (*cf.* 2.3.4.1).
- It seems that the participants are struggling to organise their study environments and eliminate distractions for optimal learning (Maggioni & Parkinson, 2008:445-461) (*cf.* 2.4.1.2). If distractions are not eliminated, feelings of anxiety and helplessness could arise and, in turn, the participants might not achieve their goals (Bandura, 1986:337; Bandura, 1993:123; Schunk, 2005b:87; Zimmerman, 2008:168, 175) (*cf.* 2.3.4.2 - 2.3.4.4).

Objective 5: To determine which of the self-regulating skills appeared to be the best developed among Grade 10 mathematics learners

This objective was achieved by means of the empirical study (*cf.* 4.7; Table 4.14).

In order to determine whether there were any statistically significant differences between the responses obtained for the various sections of the questionnaire, the participants' responses were compared on the mean scores for each of the questionnaire sections. T-tests were utilised to determine whether or not the differences that occurred were statistically significant (Pietersen & Maree, 2016b:250). *P*-values below 0.05 were regarded as statistically significant. To determine the effect size of the statistically significant differences, Cohen's *d* was calculated. The mean scores obtained for all the questionnaire sections fell between $\bar{x}$ = 2.203 and $\bar{x}$ = 2.691, implying that the participants rated themselves between *able* and *skilled* in the application of self-regulating skills. One of the sections that stand out, with the highest mean score compared to the rest of the sections, is Section D (*evaluation*), with a mean score of $\bar{x}$ = 2.691. The lowest mean score was obtained for section E (*study environment*), which was $\bar{x}$ = 2.203. Mean scores that are closer to 1 (*novice*), indicate that the self-regulating skills of the participants seem to be underdeveloped (*cf.* Table 4.14).

A comparison between the mean scores for the participants' perceptions in relation to their self-regulating skills for planning, monitoring, evaluation, and establishing a suitable study environment, revealed the following statistically significant differences.

The following comparisons were made:

- A comparison between *planning* ($\bar{x}$ = 2.525) and *monitoring* ($\bar{x}$ = 2.671) revealed a statistically significant difference: $p < 0.05$, $p = 0.000$, and a small effect size, d = 0.281. Participants perceive the quality of the development of their self-regulating skills to monitor their work, to be better than their self-regulating skills to plan their work.
- A comparison between *planning* ($\bar{x}$ = 2.525) and *evaluation* ($\bar{x}$ = 2.691) revealed a statistically significant difference: $p < 0.05$, $p = 0.000$, and a small size effect size, d = 0.292 Participants perceive the quality of the development of their self-regulating skills to evaluate their work, to be better than their self-regulating skills to plan their work.
- A comparison between *planning* ($\bar{x}$ = 2.525) and the *study environment* ($\bar{x}$ = 2.203) revealed a statistically significant difference: $p < 0.05$, $p = 0.000$, with a medium effect size, d = 0.537. Participants perceive the quality of the development of their self-regulating skills for planning their work, to be better than their self-regulating skills for ensuring a suitable study environment.
- A statistical, non-significant difference was noted for the comparison between *monitoring* ($\bar{x}$ = 2.671) and *evaluation* ($\bar{x}$ = 2.691), with $p > 0.05$, p = 0.615.

Participants perceive the quality of the development of their self-regulating skills to monitor their work and to evaluate if they achieved their goals, as more or less similar.

- A comparison between *monitoring* ($\bar{x}$ = 2.671) and *study environment* ($\bar{x}$ = 2.203) indicated that the participants perceive the quality of the development of their self-regulating skills to monitor work, to be better than their self-regulating skills to ensure a suitable study environment. A statistically significant difference, $p < 0.05$, $p = 0.000$ was noted, with a medium effect size of $d = 0.781$.
- A comparison between *evaluation* ($\bar{x}$ = 2.691) and *study environment* ($\bar{x}$ = 2.203) revealed a statistically significant difference, with $p < 0.05$, $p = 0.000$, with a large effect size of $d = 0.814$. Participants perceive the development of their self-regulating skills to evaluate their work to be better than their self-regulating skills to ensure that their study environments maximise learning.

In summary, the participants hold similar perceptions about their self-regulating skills to monitor and evaluate their learning, but view the development of their self-regulating skills to monitor and evaluate learning better than the self-regulating skills to plan learning (*cf*. Table 4.14).

Objective 6: To establish if there is a relationship between biographical variables such as gender, repetition of Grade 10 and living conditions and the perceptions of Grade 10 learners in relation to how well their self-regulating skills are developed?

This objective was achieved by means of the empirical research (*cf*. 4.5).

Gender

A comparison of the means obtained for the development of self-regulating skills to *plan* for the male participants ($\bar{x}$ = 2.486) and the female participants ($\bar{x}$ = 2.556) revealed a statistically significant difference, $p < 0.05$, $p = 0.017$, and a small effect size of $d = 0.120$. The researcher concludes that the female participants perceive the development of their self-regulating skills in relation to planning to be better than the perceptions that the male counterparts hold of their own skills to plan. The difference noted between the males and females, was not due to chance. No statistically significant differences were observed between the male and female participants in relation to their perceptions about the development of their self-regulating skills to monitor and evaluate their work, or to ensure that their study environments maximise learning (*cf.* 4.5.1, Table 4.11).

Given the abovementioned finding, the researcher accepts the alternative hypothesis, Ha^1 (*cf*. 3.3.2.1), which was formulated at the onset of the study, namely, that there is a statistically significant relationship ($p < 0.05$, $p = 0.017$) between gender and the perceptions regarding the development of self-regulating skills in relation to the planning of learning.

Repetition of Grade 10

No statistically significant differences were found between the perceptions of participants who repeated Grade 10 and those of the participants who did not repeat Grade 10 regarding their skills to *plan* ($p > 0.05$, $p = 0.805$) *monitor* ($p > 0.05$, $p = 0.966$) and *evaluate* ($p > 0.05$, $p = 0.310$) their work, as well as to ensure a suitable study environment ($p > 0.05$, $p = 0.217$) (*cf.*4.5.2, Table 4.12).

Based on this finding, the researcher accepts the null hypothesis (Ho^2), and rejects the alternative hypothesis (Ha^2) formulated at the onset of the study (*cf.* 3.3.2.1), namely: There is no statistically significant relationship between the perceptions of mathematics learners who have repeated Grade 10 and those that have not repeated Grade 10, as $p > 0.05$, $p = 0.805$ (*planning*), $p > 0.05$, $p = 0.966$ (*monitoring*), and $p > 0.05$, $p = 0.310$ (*evaluation*), and $p > 0.05$, $p = 0.217$ (*suitable study environments*).

Living conditions

The following living conditions were taken into consideration to determine if the living conditions have an influence on the participant's perceptions in relation to the development of their self-regulating skills: 1 = Living with both parents, 2 = Living alone (single), 3 = Living with a guardian, and 4 = Living with brothers and sisters.

The comparisons between the different living conditions indicated no statistically significant differences between the perceptions of the participants across all types of living conditions were similar in relation to the development of their self-regulating skills for planning, monitoring, and evaluation, as well as for ensuring suitable study environments (*cf.* 4.5.3, Table 4.13): $p > 0.05$, $p = 0.093$ (*planning*); $p > 0.05$, $p = 0.179$ (*monitoring*); $p > 0.05$ $p = 0.263$ (*evaluation*); and $p > 0.05$, $p = 0.543$ (suitable *study environments*).

Taking the aforementioned into consideration, the researcher accepts the null hypothesis (Ho^3), and rejects the alternative hypothesis (Ha^3) as per the onset of the study, namely: There is no statistically significant relationship between the living conditions of Grade 10 mathematics learners and their perceptions in relation to the development of their self-regulating skills, as $p > 0.05$, p = 0.093 (*planning*), $p > 0.05$, p = 0.179 (*monitoring*), and $p > 0.05$, p = 0.263 (*evaluation*) of work, and $p > 0.05$, p = 0.543 (suitable *study environment*).

Objective 7: To explore the possible reasons for self-regulating skills to be well-developed or not well-developed among Grade 10 mathematics learners

The researcher achieved this objective by collecting data from the participants by means of semi-structured, face-to-face interviews.

The researcher summarises what transpired from the interviews in Figures 5.1 and 5.2. Figure 5.1 for the group of participants who apparently possess *weak to average* developed self-regulating skills.

Planning (*cf.* 4.8.1.1)

Participants probably do not really understand what planning implies.
Participants seem to lack skills to set goals.
Participants wait for the teacher to set goals.

Monitoring (*cf.* 4.8.1.2)

Participants probably lack the skills to monitor their work.
The use self-checking as the only monitoring skill.
Participants have imited support from parents friends.

Evaluation (*cf.* 4.8.1.3)

Participants seem not to comprehend the meaning of evaluation.
Participants seemingly rely on the teacher to mark their work and do not work independently; this is known as a passive approach.

Environment (*cf.* 4.8.1.4)

Participants indicated that their study environment is very noisy, and crowded and is not encouraging to learning.
Participants fail to adjust their study environment to make it conducive to learning.

Role of mathematics teacher to develop self-regulating skills (*cf.* 4.8.1.5)

- It seems as though the teachers do not enhance the development of self-regulating skills in the classroom: Teacher-centred approach.
- Seemingly the teacher only explains and follows up with a question like: "Do you understand?"

Help-seeking and support when completing mathematics tasks (*cf.* 4.8.1.6)

Participants do seek help from their friends or the teacher, but there is no evidence that self-regulating skills are developed.
Participants indicated support from family members, yet there is no evidence of self-regulating skills being modelled and developed.
Participants indicated that they do not seek help at all.

Are you motivated to complete a mathematics task? (*cf.* 4.8.1.7)

Participants indicated they are motivated to do mathematics as this will enable them to improve their lives.
Participants indicated intrinsic motivation, a willingness to put in an effort in doing mathematics.
Participants indicated an absence of motivation towards mathematics.

Figure 5.1: Factors impacting of the development of self-regulating skills: Perceptions of participants with weak to average skills

Figure 5.2 below summarises the data obtained for the group of participants who apparently possess *average* to *strong* self-regulating skills.

Planning (*cf.* 4.8.2.1)

Participants probably do not really comprehend what planning implies.
Participants seem to lack skills to set goals and manage their time effectively.
Limited strategies to benefit planning.

Monitoring (*cf.* 4.8.2.2)

- Although some participants self-check the correctness of their mathematical tasks, they fail to link it to achieving goals.
- Participants indicated that they do not monitor their work at all.

Evaluation (*cf.* 4.8.2.3)

- Participants seem to lack the skills to evaluate.
- Participants indicated a willingness to change their behaviour to better their mathematics results.

Environment (*cf.* 4.8.2.4)

Participants indicated that their study environment is, unsupportive, very noisy and crowded and is not conducive to learning.
Participants seemingly fail to adjust their study environment to make it suitable for learning and just accept it as it is.

Role of mathematics teacher to develop self-regulating skills (*cf.* 4.8.2.5)

It seems as though the teachers do not enhance the development of self-regulating skills in the classroom
Seemingly the teacher explains and asks, “Do you understand?”
Tutor assistance on Saturdays also does not enhance the development of self-regulating skills.

Help-seeking and support when completing mathematics tasks (*cf.* 4.8.2.6)

Participants do seek help from their friends but there is no evidence that self-regulating skills are developed.
Participants indicated support from family members but no evidence of self-regulating skills being modelled.
Participants indicated an absence of support at home.

Are you motivated to complete a mathematics task? (*cf.* 4.8.2.7)

Participants indicated an apparent lack of motivation to study and find mathematics difficult.
Participants appear to be motivated and eager to do mathematics.

Figure 5.2: Factors impacting of the development of self-regulating skills: Perceptions of participants with average to strong skills

According to Figures 5.1 and 5.2, the group of participants who perceived themselves to possess average to strong self-regulating skills, also appeared to be novices in being self-regulated during the planning, monitoring, and evaluation phases of the learning process. The only self-regulating strategy explicitly mentioned was that of self-checking, to monitor task completion. The study environments of all the participants appeared to display characteristics of noisiness and crowdedness that could negatively affect the effectiveness of their learning. It appears that the teachers of both groups of participants do not nurture the development of self-regulating skills and tend to stick to a teacher-centred approach in their classrooms. This approach does not nurture independent learning, which is unfortunate because the participants indicated that they are eager, willing, and passionate about their mathematics learning. Although the participants also receive tutor assistance, this mainly seems to focus on enabling participants to understand the work better and does not purposively and intentionally support participants in developing self-regulating skills. In addition, the researcher argues that the support indicated from home could be regarded as general or moral in nature, as no real evidence could be deduced from the data that parents model self-regulation strategies or assist the participants to develop self-regulating skills.

Objective 8: To make recommendations to enhance the development of self-regulating skills among Grade 10 mathematics learners

The researcher achieved this objective by making recommendations based on the literature review and findings of the study. The recommendations follow in section 5.6.

5.6 RECOMMENDATIONS

Considering the empirical findings of the research as well as the literature findings, the researcher makes the following general recommendation to enhance self-regulated learning among Grade 10 mathematics learners. Higher Education Institutions and the Department of Basic Education should join hands in determining the contents of teacher training curricula, to ensure that teachers are trained to adopt new teaching approaches that would enhance self-regulated learning among learners. The Department of Basic Education has in-service training opportunities for teachers to deepen their subject expertise, pedagogical knowledge and enhance the quality of teaching. The researcher recommends that these training programmes be scrutinised to ensure that in-service teachers are equipped with knowledge and skills to develop self-regulated learning among learners.

The following recommendations are made for pre-service and in-service teacher training programmes.

5.6.1 Recommendations: Planning

The research finding pertaining to the participants' skills in *planning* their learning (*cf*. 4.4.1, Table 4.7) alerted the researcher to the following.

The participants seem to lack self-regulating skills to plan properly for the execution of a mathematics task, to identify task intentions, manage time effectively for task completion, and set goals independently before starting a task. Main contributing factors to the aforementioned relate to a lack of understanding of what planning and goal setting implies, and that teachers do not enhance self-regulating skills of learners (*cf.* 4.8.1.1) (*cf.* 4.8.2.1)

According to the literature, planning happens in three stages:

- Setting a goal for a learning task
- Establishing strategies for achieving the goal
- Determining how much time and resources will be needed to achieve the goal (Boekaerts, 1996:107; Erlich & Russ-Eft, 2011:7; Pajares, 2008:111; Pintrich, 1999:462; Schraw, *et al*., 2006:114; Schunk, 2005a:173; Zumbrunn, *et al.*, 2011:10) (*cf.* 4.7.1.1)

Based on the research finding and the literature, the researcher makes the following recommendations to assist learners to develop stronger skills to apply self-regulation during the planning stage of learning.

- Learners should be encouraged to set a long-term goal they wish to achieve, as well as short-term goals that will help them to see if they keep on track (Pajares, 2008:111; Zumbrunn, *et al*., 2011:10) (*cf.* 2.6.8). Learners should be guided by their teachers to set long-term goals, such as aiming to get a good grade in the examination, as well as possible short-term goals to pave their way to reaching those long-term goals. Short-term goals in relation to getting a good grade in examination could include the following:

- The researcher suggests that the teacher can model setting up a time table, for planning a study environment and studying mathematics to enable learners to develop self-regulating skills to become independent in their learning. An example of a time table with criteria for planning a study environment and study time, is presented in Table 5.1 below.

Table 5.1: Criteria to plan for a suitable study environment and study time

Criteria for selecting a study environment		
	Yes	No
Good lighting		
Comfortable seating		
Clean environment – neat and tidy		
Identify and minimise distractions		
A place where one can be productive – think and be creative		
Comfortable temperature		
Criteria to regulate study time		
	Yes	No
Organise time: clear picture of days, weeks and months – time available for study		
Assess daily time available for study, relax and sleep		
Set priorities daily, weekly, monthly		
Draw a schedule to reflect the priorities		
Plot all priorities on a wall calendar – due dates, deadlines, exams etc.		
Plan for breaks and relaxation		

- Before involving learners in task completion or problem solving, the teacher should give learners a few guidelines and suggestions on how to achieve goals, complete tasks, and solve problems. When learners are given a chance to apply the strategies and guidelines suggested by the teacher, they get the opportunity to become more competent at applying the suggested strategies (Du Toit & Kotze, 2009:60) (*cf*. 2.6.8).

5.6.2 Recommendations: Monitoring

The research findings on monitoring indicated that many participants do not possess strategies to reverse negative feelings towards their work which could impact on their interest level in completing tasks. Furthermore, it appeared that the participants cannot monitor if they achieve goals; make changes to the strategies they are using to achieve goals; track their progress towards goal achievement; or remove obstacles from a study environment that hampers their learning progress. A lack of support to complete tasks also seems to be a reality among the participants who took part in the research (*cf.* 4.4.2; Table 4.8). The only strategies for monitoring work that the participants appear to have are self-checking and seeking help from friends to compare work (*cf.* 4.8.1.2; 4.8.2.2).

Strategies to enhance the development of self-regulating monitoring skills among all learners, could comprise the following:

- In order to be self-regulated, learners should be able to monitor their focus, clear their minds of distracting thoughts, and seek a suitable study environment. They could be introduced to coping strategies to focus and clear their minds. These strategies include breathing exercises, putting distracting materials aside while working (e.g. cell phones), and discard thoughts that are not related to the mathematics task at hand (Boekaerts & Cascallar, 2006:201).
- Teachers can help learners by removing stimuli that may cause distractions in the class and giving them frequent breaks to help them, in order to build up their attention span (Zumbrunn, *et al.* 2011:9, 10) (*cf.* 2.6.8). The researcher also suggests playing instrumental study music softly in the class, with the aim to help the learners focus, increase their motivation, improve their concentration which, in turn, will help learners to complete tasks quicker (White, 2007:4 & 9).
- At home the learners should give their learning first priority (Boekaerts & Cascallar, 2006:201). Given the unfavourable home environments of many township learners, the participants should try to belong to a Whatsapp group to assist them when help is needed. Participants can also form study groups that can meet at school where

they can assist each other when help is needed. Working with others in groups can broaden their problem solving skills and they can observe the use different strategies to solve the mathematics problems (Zumbrunn, *et al.,* 2011:12) (*cf.* 2.6.8).

- The learners should be taught to monitor their work to see if they are still on par to meet their desired goals. The learners can keep a journal to record their actions to achieve goals (Mitchell, 2014:107). If needs be, the self-regulation strategies the learners use to do the mathematics tasks should be adjusted. It takes time for a learner to learn and become comfortable with the strategies (Ertmer & Newby, 1996:13) (*cf.* 2.3.4.2) and teachers should invite learners to share information on a mathematical problem whilst sitting in small groups; which could give the teachers opportunities to evaluate the learners' self-regulating skills (Boekaerts & Cascallar, 2006:206).
- Teachers can help learners by modelling strategies for monitoring, and creating time for the participants to practise the strategies until they become independent and apply the strategies individually. The teacher could take a complex mathematics problem, break the problem down in to smaller parts, ask the participants to demonstrate verbally how they will deal with each of the manageable parts. Afterwards, learners can move back to solving the complex problem by applying all the strategies linked to the manageable parts (Zumbrunn, *et al*., 2011:14) (*cf.* 2.6.1).
- Teachers can also show learners how to set up and keep a record of the time spent on a particular task and the strategies they used. This will allow them to picture their progress and to make changes where necessary (Zumbrunn, *et al*., 2011:11) (*cf.* 2.6.8).
- Self-regulated learners also seek help from their peers and others to achieve their goals and become more independent. The teacher can promote positive help-seeking by providing learners with continuous feedback on what was done well, what needs to improve, steps to take to achieve improvement in their work (Zumbrunn, *et al.*, 2011:16). Teachers should rearrange their classrooms so that cooperative (group) learning can take place. Working in groups promotes different cues for monitoring and mastering of learning goals (Boekaerts & Cascallar, 2006:204).

- The classrooms' arrangements and atmosphere play significant roles in developing self-regulation. A classroom should be arranged in such a way that mathematical group discussion can take place where peers try to understand each other and work together to learn a specific skill. The class atmosphere should be filled with creativity, motivation, and engagement (Prideaux, 2007:10) (*cf.* 2.6.1). The learners should be able to discuss how to solve problems together with their peers, as this will help them to restructure their perceptions and also help them to monitor their progress (Vygotsky, cited by Du Toit & Kotze, 2009:61) (*cf*. 2.6.8).

5.6.3 Recommendations: Evaluation

Some of the main research findings in relation to the skills that the participants seem to apply during the evaluation (*cf.* 4.4.3; Table 4.9) stage of learning highlighted the following: The participants apparently do not have strategies to enable them to evaluate if they achieved their goals, deal with negative emotions and feelings when goals are not achieved, learn from their mistakes, or deal with obstacles that influence the outcome of a learning task negatively, and solve those problems on their own. The participants lack a proper understanding of what is expected during the evaluation phase of learning; therefore, tend to rely on their teachers to evaluate work (*cf.* 4.8.1.3; 4.8.2.3).

When learners are able to evaluate their own learning, apart from the teacher's summative assessment, they become more self-regulated. This enables learners to make adjustments with similar tasks in future (Pajares, 2008:112; Zumbrunn, *et al*., 2011:12) (*cf.* 2.6.8).

The researcher makes the following recommendations to enhance the development of self-regulating skills during the evaluation phase of learning.

- Teachers can help learners with self-evaluation by assisting them in monitoring their learning goals and strategies and making changes to the goals and strategies (Zumbrunn, *et al.,* 2011:12). Learners should be encouraged to keep a journal and keep record of the goals they have achieved, how successful their learning process was, and what should be changed. They should also keep record of the obstacles they encountered and how well they handled them (Ertmer & Newby, 1996:13; Montague, 2008:37) (*cf.* 2.6.8).

- Before a mathematics problem is solved, the teacher can give the class guidelines and model strategies to solve the problem, explain how to achieve the set goals, and what the time restrictions are to achieve the goals.
- The teacher can also give learners opportunities to describe the method they used to solve a problem. This will give the teacher insight into their thinking processes and the participants get opportunities to reflect on their strategies (De Corte, *et al.,* 2000:695) (*cf.* 2.6.8).

5.6.4 Recommendations: Promoting reflection

Reflection is a powerful link between planning, monitoring, and evaluation to increase self-regulation and life-long learning in learners (Paris & Paris, 2001:89; Zimmerman, 2000:14) (*cf.* 2.3.4.4).

Spending minimal time daily to teach learners self-regulation strategies could increase their academic achievement and motivation in the long run (Ertmer & Newby, 1996:19) (*cf.* 2.6.5). In this regard, the use of purposeful questioning in relation to the planning, monitoring, and evaluation phases of the learning process could sensitise learners to the process of regulating factors that could impact on the successful achievement of goals (*cf.* Table 2.3). Through reflection, learners pay careful attention to the task they have done, as well as themselves and the strategies they have used (Ertmer & Newby, 1996:14) (*cf.* 2.6.5).

The use of the Elements of a Plan self-regulation strategy (Feuerstein & Hoffman, 1995:5), presented in Figure 5.3 below, promotes reflection during learning that could also enhance self-regulated learning across different subjects. Teachers need to work through the steps in the Elements of a Plan explicitly, and guide learners through the steps, in order for them to become acquainted with the application of the strategy.

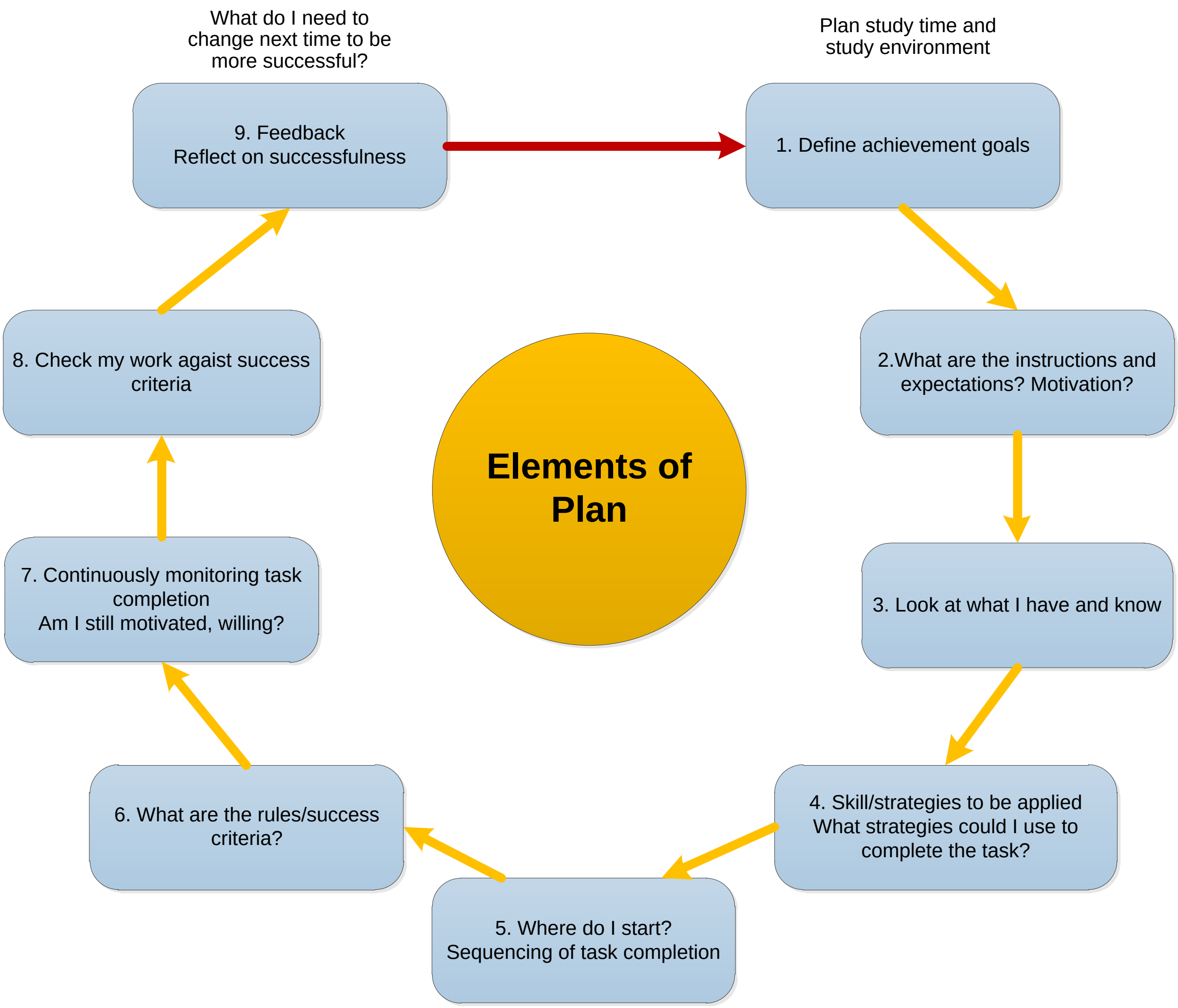


Figure 5.3: The Elements of a Plan self-regulation strategy

(Adapted from Feuerstein & Hoffman, 1995, p. 5)

The strategy comprises the following steps:

- Defining goals, links with the planning phase of the learning process, and learners need to be clear about what the task expectation are.
- Task instructions, and the criteria for achieving success need to be clear. The questions formulated for the planning phase in Table 2.3, will prompt the participants to purposively think and reflect aloud about the goals of a task, the task expectations, their motivation and interest levels to engage in the task, as well as study conditions

that would enable them to be successful. Answers to the questions could help learners to remove the obstructions that could impact on their successfulness.

- As part of the planning process, learners need to reflect and think about what they already know that will help to complete a task, as well as what information they still need to find in order to complete a task successfully, and where they could find the information.
- Learners need to be understand what a task expects of them, in order to choose a suitable cognitive strategy (*cf.* 2.3.3.1) to complete the task for example, should something be defined, summarised, compared, classified, discussed or evaluated. They also need to know how to apply the chosen strategy.
- It is important that learners learn to plan the completion of tasks systematically.
- During task completion, learners should be made aware to continuously look at the criteria that will be used to assess their completed tasks, so that they adhere to the criteria during task completion. Criteria should be made explicit by teachers during step 2, and could include aspects such as, the length of an answer, the mark allocation, number of facts to be provided, and resources to be used etcetera.

5.6.5 Recommendations: Study environment

The learning environment of learners should motivate them to learn, help them to focus, and control their attention. Distractions will influence the success of the learners. Learners with well-developed self-regulating skills will create a special time and place which will be conducive to learning. The conditions should be preferably quiet for optimal learning (Ertmer & Newby, 1996:3; Zimmerman, 2008:16-18) (*cf.* 2.3.4). Bandura (1999b:27) stated that the learning environment is a place of choice and if it is forced upon a person, that person always has a choice how to react upon the environment (*cf.* 2.3.3.4).

The findings of the research indicated that the study environments of the majority of the participants are not conducive to learning (*cf.* 4.4.4; Table 4.10). A lack of a proper place to study, noisiness, and crowded homes are some of the factors mentioned that do not maximise learning.

The researcher makes the following recommendations to enhance the development of self-regulating skills that could maximise learning in the study environments of all learners.

- Learners should be made aware of possible changes that they can make to their study environments; for example, to change their study environment to a different venue, such as a library or the school grounds (Bandura, 1999b: 24-26) (*cf.* 2.3.3.4). If it is not possible to choose another environment, the researcher suggests they listen to study music wearing earphones, to block out the noise from the environment. Background music has a positive effect on learner performance and enhances learning (White, 2007:4 & 9).
- The researcher suggests that the learners form study groups to discuss and complete mathematics tasks. Learners who are part of study groups appear to be more motivated, exposed to other learning strategies they observe among their peers, and have higher levels of goal achievement (Wolters, *et al.,* 2003; Ertmer & Newby, 1996:12) (*cf*. 2.3.4.1).
- Schools could consider after school support programmes where a safe environment and learning support is provided for learners with unfavourable study environments. Support programmes at schools could also target parents and provide initial training and guidance in how to support learners at home in becoming more self-regulated.

5.6.6 Recommendation: Self-motivation

According to the data, some participants appear to struggle in being motivated to do their mathematics tasks (*cf.* 4.8.1.7; 4.8.1.2). In this regard, the researcher makes the following recommendations to enhance self-motivation among learners.

- Learners should be given opportunities to independently practise the application of self-regulation strategies. In this way, learners take control of their learning and intrinsic motivation is developed, which plays an important role in self-regulation (Pajares, 2008:112; Zumbrunn, *et al.,* 2011:10) (*cf*. 2.6.8).
- According to Boekaerts and Cascallar (2006:206), teachers should make use of situated learning and let learners collaborate in small groups on solving problems where they share information and engage in knowledge building. Collaborative

meaning making and knowledge construction promotes the identification of mastery goals, resource provision, setting performance goals and wellbeing goals.

- Discussions about the value of a task before starting it, could enable learners to see the value of the task, which could motivate them to persist until the task is completed (Pajares, 2008:112) (*cf*. 2.6.8).

5.6.7 Recommendation: Teacher role and teaching strategies

Given the absence of teacher support in developing self-regulation, as found from the research data (*cf*. 4.8.1.4, 4.8.2.4), the researcher recommends the following to enable teachers to provide opportunities for the development of self-regulating skills.

- Self-regulation strategies should be taught to learners through direct instruction and modelling, and opportunities should be presented for learners to apply these strategies under controlled and structured conditions and in different contexts, with and without assistance (Zimmerman, 2000:29; Zumbrunn, *et al.,* 2011:14) (*cf.* 2.6.2, 2.6.3).
- The use of collaborative/cooperative learning will enable learners to engage in planning their collaborative learning efforts and reflect on how well they are progressing towards achieving their goals; which, in turn, will allow for the development of self-regulating skills (Hatami, 2015:2164) (*cf.* 2.6.6). In a collaborative/cooperative learning environment, self-regulated learning is promoted because learners are involved in processing information together, therefore learners get the opportunity to receive feedback from their peers regarding what was done well, and which aspects of a task need improvement. Additionally, learners can also observe their peers modelling solutions to problems (Zimmerman, 2000:29; Zumbrunn, *et al.,* 2011:14) (*cf.* 2.6.2, 2.6.4, 2.6.6).
- Problem solving fosters self-regulation, increases learner involvement in their learning and promotes self-responsibility to learn. Problem solving also assists learners to become reflective about their own work as well as the work of their peers (Flemming, 2014; Shinde & Kolmos, 2011; Vula, *et al.,* 2017:56) (*cf.* 2.6.7). Group discussions during problem solving is recommended, as discussion will help learners check if they are on the right track and making progress towards achieving their goals,

or whether they should implement different strategies to ensure their success (Du Toit & Kotze, 2009:61) (*cf.* 2.6.8).

5.7 LIMITATIONS OF THE STUDY

A number of limitations were identified during the research process. Taking these limitations into consideration, the researcher acknowledges that only tentative conclusions could be drawn from the research. The following limitations were identified by the researcher.

- The researcher focused only on the Grade 10 learners in the Further Education and Training phase. This limits the study, as deeper insights could be gained from research that focused on the entire phase; that is, including Grade 11 and Grade 12 learners.
- The current sample was drawn from schools and learners in the Sedibeng West District only, and the findings cannot be generalised to other learners and schools.
- The researcher used convenient sampling due to the time constraints, and acknowledges that the findings cannot be generalised.
- The researcher only focused on one subject, namely mathematics. This limits the generalisation of findings in relation to the development of self-regulation to other school subjects.
- The researcher acknowledges that the use of observations in the classroom would have been ideal in observing the teachers' practises in relation to developing learners' self-regulating skills, instead of relying on the learners' responses. The use of observations would have enabled the researcher to gain more accurate information about the teaching practises of teachers in relation to developing self-regulating skills.
- As a novice researcher, the researcher acknowledges that she could have made better use of probing to elicit richer data from the learner participants.

A few suggestions for further research, linked to the present study, will be proposed in the next section.

5.8 SUGGESTIONS FOR FUTHER RESEARCH

This study made the researcher aware of the importance of self-regulating skills to enhance academic performance in mathematics, as well as of the apparent absence of well-developed self-regulating skills among the learners who took part in the research. The following suggestions are made for further research.

- Comparative research across education districts could provide richer data in relation to the development of self-regulating skills among mathematics learners. The findings would reveal if the development of self-regulating skills is problematic across education districts.
- The same study can be done to determine how well-developed self-regulating skills are among learners in different Grades, starting from an early age, as well as how teachers of those Grades deal with the development of self-regulating skills. The findings would reveal if the development of self-regulating skills are problematic across the entire mathematics curriculum.
- Further research needs to be conducted to establish whether teachers understand the importance of self-regulation, what it entails, and know how to guide the development of self-regulation among learners.
- It will be essential to conduct observation studies to establish how teachers practically deal with the development of self-regulating skills during the teaching of mathematics.

In the next section, the researcher reflects about the contribution of her study.

5.9 CONTRIBUTION OF THE STUDY

5.9.1 Contribution to theory

Based on the recommendations made, mathematics teachers could become aware of ways to provide opportunities for the development of self-regulating skills among learners, that could enhance their mathematics performance. The research might have made the participants aware of the important self-regulating skills they lack to perform well in mathematics.

5.9.2 Contribution to practise

According to the research, the development of self-regulating skills does not appear to be a reality in the mathematics classrooms of the learners who took part in the research. This study could be significant to both learners and teachers. The findings of the study could create a greater awareness of the importance of self-regulating skills in the mathematics class among teachers, and could influence their willingness to become involved in greater efforts to develop self-regulating skills that would benefit the academic achievement of their learners. Being in Grade 10, learners might still have time to address their fragile self-regulating skills to improve their results for Grade 12. The recommendations made by the researcher (*cf.* 5.6), could provide some assistance to teachers to enhance the development of self-regulating skills.

This study alerted the researcher to the fact that the mathematics enrichment programme for mathematics at AMSC also does not incorporate the development of self-regulating skills among the learners who take part in the programme. The researcher envisages suggesting changes to the enrichment programme that would focus on intentionally developing self-regulating skills amongst learners. As teacher training is also done through the AMSC programme, in-service teachers could also be trained at AMSC in developing self-regulating skills at their schools.

5.10 CONCLUSION

Self-regulation is important in the mathematics classroom. Learners should be able to set long- and short-term goals, motivate themselves, and focus their attention on achieving their goals. In achieving their goals, learners' motivation increases, and they will continuously adjust their behaviour to ensure their success. To be able to set and achieve goals, learners should be able to apply efficient self-regulating skills (Bandura, 1999b:27) (*cf.* 2.3.3.4). It is important to achieve goals because it will increase learners' competence in mathematics and they will be willing to put extra effort into attaining new goals (Boekaerts & Cascallar, 2006:202).

The study was done to determine the perceptions of the Grade 10 mathematics learners on how well developed they perceive their self-regulating skills to be and what contributes to the development of their self-regulating skills, including the efforts of the teachers to enhance the development of self-regulating skills in their classrooms. To the researcher, the research findings are alarming. The study revealed evidence that the participants who took part in the study could be regarded as *novices* in the application of self-regulating skills. Moreover, teachers appear to uphold a teacher-centred approach during teaching, which does not promote the development of self-regulating skills in the mathematics classroom.

In order to address the alarming findings, the researcher argues that teachers should be trained to make the learners more autonomous in applying self-regulating skills. Mathematics classrooms should be learner-centered and inquiry-based to enhance learners' self-motivation, in order to promote self-regulation among learners. Self-regulation holds the potential to increase learners' mathematics achievement. Improved achievement in mathematics is something that South-Africa desperately needs, since the World Economic Forum (WEF) ranked South Africa as the country with the lowest mathematics Grades in the world (Cai, *et al.,* 2016:26). Promoting self-regulation in mathematics classrooms is therefore not an option, but the responsibility of each mathematics teacher.

REFERENCES

Abdalla, A.R.M., Cambell, S.E., Donald, H.S., Mathews, G. & Schwean, V.L. 2000. Personality, self-regulation and adaptation: A cognitive social framework. (*In* Boekaerts, M., Pintrich, P.R., Ziedner, M., *eds.* Handbook of self-regulation. New York: Academic Press. p. 171-201).

Anon. 2013. South African Government News Agency. http://www.SAnews.gov.za Date of access: 8 June 2018.

Arends, F., Reddy, V., Visser, M., & Winnaar, L. 2015. Highlights of mathematics and science achievement of Grade 9 South African learners. https://pmg.org.za/files/170221TIMSS.pptx Date of access: 15 June 2018.

Babbie, E. & Mouton, J. 2002. The practise of social research. Cape Town: Oxford University Press.

Bandura, A. 2003. Negative self-efficacy and goal effects revisited. *Journal of applied psychology,* 88(1):87-99.

Bandura, A. 2015. On deconstructing commentaries regarding alternative theories of self-regulation. *Journal of management*, 41(4): 1025-1044.

Bandura, A. 1986. Social foundation of thought and actions. New Jersey: Prentice Hall, Inc.

Bandura, A. 1991. Social cognitive theory of self-regulation. *Organizational behavior and human decision processes*, 50(2):248-287.

Bandura, A., 1993. Perceived self-efficacy in cognitive development and functioning. *Educational psychologist*, 28(2):117-148.

Bandura, A. 1999a. A social cognitive theory of personality. (*In* Previn, L., & Previn, J.O., *eds*. Handbook of personality. 2nd edition. New York: Guilford Publications. p.154-196).

Bandura, A. 1999b. A social cognitive theory: an agentic perspective. *Asian journal of social psychology,* 2:21-41.

Bandura, A. & Locke, E.A., 2003. Negative self-efficacy and goal effects revisited. *Journal of applied psychology,* 88(1):87-99.

Banks, J. & Mhunpiew, M. N. 2012. Authentic leadership, social cognitive theory, and character education: The transforming of theories into practises. *US-China education review,* B (12):1002-1006.

Bannert, M. & Reimann, P. 2012. Supporting self-regulated hypermedia learning through prompts. *Instructional Science,* 40:193-211.

Barnard, L., Crooks, S. M., Lan, W.Y. & Paton, V.O. 2008. The relationship between epistemological beliefs and self-regulated learning skills in the online course environment. *Merlot journal of online learning and teaching,* 4(3):261-266.

Bengtson, A. 2015. Personal communication between Prof. M. Grosser and Advocate Alison Bengtson at the Head Office of the Gauteng Department of Basic Education in Johannesburg, on 31 August 2015.

Bidjerano, T. & Dai, D. Y. 2007. The relationship between the big-five model of personality and self-regulated strategies. *Learning and individual differences,* 17:69-81.

Blair, C., Urasache, A., Vernon-Feagans, L. & Greenberg, M. 2015. Multiple aspects of self-regulation uniquely predict mathematics but not letter-word knowledge in the early elementary grades. *Development psychology*, 51(4):459-72.

Boeije, H. 2002. A purposeful approach to the constant comparative method in the analysis of qualitative interviews. *Quality and quantity*, 36:391-409.

Boekaerts, M. 1996. Self-regulated learning at the junction of cognition and motivation. *European phycologist,* 1(2):100-112.

Boekaerts, M. 1999. Self-regulated learning: Where we are today. *International journal of educational research, 31,* 445-457.

Boekaerts, M. & Cascallar, E. 2006. How far have we moved toward the integration of theory and practise in self-regulation? *Educational psychology review,* 18:199-210.

Boekaerts, M., Pintrich, P. R. & Zeidner, N. 2000. (In Boekaerts, M., Pintrich, P.R., & Zeidner, M., *eds.* Handbook of Self-Regulation. Massachusetts: Academic Press. p. 13-39).

Braun, I., Gurlitt, J. & Nückles, M. 2012. Cognitive and affective learning strategies. (*In* Seel, N., *ed.* Encyclopedia of the sciences of learning. Springer Science and Business Media, LLC. p. 536-565).

Brown, S. 2008. Measures of shape: Skewness and kurtosis. Web.ipac/Caltech/ edu/staff/fmasci/home/astro_refs/SkewStatSignif.pdf. Date of access: 4 February 2019.

Cai, J., Mok, I.A.C., Reddy, V. & Stacey, K. 2016. International comparative studies in mathematics. Switzerland: Springer.

Cazan, A-M. 2012. Assessing self-regulated learning: Qualitative verss quantitative research methods. Brasov: International Conference of Scientific Paper A fases.

Chick, H. L. & Vincent, J. L. E. 2005. Proceedings of the 29th Conference of the International Group for the Psychology of Mathematics Education, 10-15 July 2005. Melbourne: Design and Print Centre, University of Melbourne.

Chisholm, L. 2011. The challenges of South-African schooling: dimensions, targets and initiatives. *Transformation audit: from inequality to inclusive growth*: 50-57.

Cohen, L., Manion, L. & Morrison, K. 2007. Research methods in education. 6th edition. London & New York: Routledge.

Cox, M.W. 2011. The effects of behaviourist and constructivist instruction on student performance in college level remedial mathematics. Texas: A & M University. (Thesis - PhD).

Creswell, J. W. 2012. Educational research. Planning, conducting and evaluating quantitative and qualitative research. 4th edition. Boston: Pearson.

Creswell, J. W. 2009. Research design: qualitative, quantitative and mixed method approaches. 3rd edition. Los Angeles: Sage.

Da Silva-Marini, J. A. & Boruchovitch, E. 2014. Self-regulated learning in students of pedagogy 1. *Paidéia,* 24(59):323-330.

Darr, C. & Fisher, J. 2004. Self-regulated learning in the mathematics class. Paper presented at NZARE conference. Turning the kaleidoscope. Wellington, 24-26 November 2004. http://www.nzer.org.nz/pdfs/13903.pdf. Date of access: 8 June.2014.

De Corte, E., Op't Eynde, P. & Verschaffel, L. 2000. Self-regulation: a characteristic and a goal of mathematics education (*In* Boekaerts, M., Pintrich, P.R., Zeidner, M., *eds.* Handbook of self-regulation. Massachusetts: Academic Press. p. 687-703).

De Boer, H., Bergstra, A. & Kostons, D. 2012. Effective strategies for self-regulated learning: A meta-analysis. Groningen: GION onderzoek/onderwijs.

De Raad, B. & Mlacic, C. 2015. Big Five Model, theory and structure. (*In* International Encyclopedia of the Social & Behavioral Sciences, 2:559-566).

De Vos, A.S. 2003. Programme evaluation. (*In* De Vos A.S., *ed*. Research at grassroots: for the social sciences and human service professions. 2nd edition. Pretoria: Van Schaik. p. 373-393).

Delport, C.S.L. 2008. Quantitative data collection methods. (*In* De Vos A.S., *ed*. Research at grassroots: for the social sciences and human service professions. 2nd edition. Pretoria: Van Schaik. p.165-196).

Department of Basic Education *see* South Africa. Department of Basic Education.

Digman, J.M. 1990. Personality structure: emergence of the five-factor model. *Annual reviews psychology,* 41: 417-440.

Dignath, C. & Büttner, G. 2008. Components of fostering self-regulated learning among learners. A meta-analysis on intervention studies at primary and secondary school level. *Meta-cognition learning*, 3:231-264.

Dignath, C., Büttner, G. & Langfeldt, H.-P. 2008. How can primary school students learn self-regulated learning strategies most effectively? A meta-analysis on self-regulation training programmes. *Educational research review,* 3(2):101-129.

Dignath-Van Ewijk, C., Dickhäuser, O. & Büttner, G. 2013. Assessing how teachers enhance self-regulated learning: A multi-perspective approach. *Journal of cognitive education and psychology,* 12(3):338-358.

Dinsmore, D.L., Alexander, P.A. & Loughlin, S.M. 2008. Focusing the conceptual lens on meta-cognition, self-regulation, and self-regulated learning. *Educational psychology review,* 20:391-409.

Donker, A.S., De Boer, H., Kostons, D., Dignath-Van Ewijk, C.C. & Van der Wert, M.P.C. 2014. Effectiveness of learning strategies instruction on academic performance. A meta-analysis. *Educational research review,* 11:1-26.

Du Toit, S. & Kotze, G., 2009. Meta-cognitive strategies in the teaching and learning of mathematics. *Pythagoras*, 70:57-67.

Dyslin, C.W. 1998.Perceptual control theory: A model of volitional behaviour in accord with the ideas of Alfred Adler. *The journal of individual psychology,* 54(1):25-40.

Erlich, R.J. & Russ-Eft, D. 2011. Applying social cognitive theory to academic advising to assess student student learning outcomes, *National academic advertising association,* 3(2):5-15.

Ertmer, P.A. & Newby, T.J., 1996. The expert learner: strategic self-regulated and reflective. *Instructional science*, 24:1-20.

Ertmer, P.A. & Newby, T.J. 2013a. Behaviourism, cognitivism, constructivism: comparing critical features from an instructional design perspective. *Performance improvement quarterly,* 26(2):43-71.

Ertmer, P.A. & Newby, T.J. 2013b. Article update: Behaviourism, cognitivism, constructivism: connecting yesterday's theories to today's context. *Performance improvement quarterly,* 26(2):65-71.

Feuerstein, R., Feuerstein, R. S., Falik, L. H. & Rand, Y. 2002. The dynamic assessment of cognitive modifiability. Jerusalem, Israel: International Center for the Enhancement of Learning Potential.

Feuerstein, R. & Hoffman, M. B. 1995. Teacher's guide to organization of dots. Illinois: IRI/Skylight Training and Publishing.

Field, A. 2012. Discovering statistics using IBM SPSS statistics. 4th edition. London: Sage.

Finn, B. & Metcalfe, J. 2013. Meta-cognition and control of study choice in children. *Meta-cognition learning*, 8:19-46.

Flavell, J. H.1979. Meta-cognition and cognitive monitoring: a new area of cognitive-developmental inquiry. *American psychologist,* 34(10):906-911.

Flavell, J. H. 1985. Cognitive development. Englewood Cliffs, NJ: Prentice Hall.

Flemming, M.C. 2014. An introduction to undergraduate PBL (PBL) at the HKU Faculty of Dentistry. The University of Hong Kong. http://facdent.hku. hk/pbl/pbl10/ Date of access: 20 July 2014.

Flick, U. 2014. Designing qualitative research. Wiltshire: Cromwell Press Ltd.

Fosnot, C.T. & Perry, R.S. 2005. Constructivism: A psychological theory of learning. (*In* Fosnot, C. T., *ed.* Constructivism: theory, perspectives, and practise. Columbia: Teachers college, Columbia university. p. 8-38).

Fouché, C.B. & Delport, C.S.L. 2003. The place of theory and the literature review in the qualitative approach to research. (*In* De Vos, A. S., *ed*. Research at grass roots for the social sciences and human service professions. 2nd edition. Pretoria: Van Schaik. p.265-269).

Fox, E. & Riconscente, M.M. 2008. Meta-cognition and self-regulation in James, Piaget and Vygotsky. *Educational psychology review*, 20:373-389.

Francis J.J., Eccles, M.P., Entwistle V., Glidewell, C., Grimshaw, J.M., Johnston, M. & Robertson, C. 2010. What is an adequate sample size? Operationalising data saturation for theory-based interview study. *Psychology and health,* 25(10):1229-1245.

García-Sánchez, J.N. & Fidalgo-Redondo, R. 2006. Effects of two types of self-regulating instruction programs on students' learning disabilities in writing products, processes, and self-efficacy. *Learning disability quarterly,* 29:181-211.

Garson, D. 2008. Reliability analysis. http://www/2.chass.z.ncsu.education/garson Date of access: 16 July 2018.

Govender, P. 2016. It's not kids bunking-it's teachers. *Mail & Guardian*, 2 June. https://mg.co.za/article/2016-06-02-its-not-kids-bunking-its-teachers. Date of access: 31 March 2018.

Gredler, M.E. 2009. Hiding in plain sight: the stages of mastery/ self-regulation in Vygotsky's cultural-historical theory. *Educational psychologist,* 44(1):1-19.

Greeff, M. 2003. Information collection: interviewing. (*In* De Vos, A. S., Strydom, H., Fouché, C. B. & Delport, C. S. L., *eds.* Research at grass roots for the social sciences and human service professions. 2nd edition. Pretoria: Van Schaik. p.291-319).

Greeff, M. 2011. Information collection: interviewing. (*In* De Vos, A. S., Strydom, H., Fouché, C.B. & Delport, C.S.L., *eds.* Research at grass roots. For the social sciences and human services professions. 4th edition. Pretoria: Van Schaik. p. 341-375).

Harpe, S.E. 2015. How to analyse Likert and other rating scale data. *Currents in pharmacy teaching and learning,* 7:836-850.

Hatami, A. 2015. The effect of collaborative learning and self-assessment on self-regulation. *Educational research review*, 10(15):2164-2167.

Hattie, J.A.C. & Donoghue, G.M. 2016. Learning strategies: A synthesis and conceptual model. *Nature partner journal, 1,* 16013 doi:10.1038/npjscilearn.2016.13.

Hearn, J. 2015. Mixed method designs. (*In* McMillan, J. & Schumacher, S., *eds.* Research in education evidence-based inquiry. 7th edition. Essex: Pearson.p.424-446).

Hessels-Schlatter, C., Hessels, M., Godin, H., & Spillmann-Rojas, H. 2017. Fostering self-regulated learning: From clinical to whole class intervention. *Educational and child psyhology*, 34(1):110-125.

Houghton, J.D. 2000. The relationship between self-leadership and personality: a comparison of hierarchical factor structures. Virginia: State University. (Dissertation - PhD).

Ivankova, N.V., Creswell, J.W., & Plano Clark, V.L. 2008. Foundations and approaches to mixed methods research. (*In* Maree, K., *ed.* First steps in research. Pretoria: Van Schaik. p. 254-278).

Johnson, D.W., Johnson, R., & Smith, K. A. 1998. *Active learning: Cooperation in the classroom*. Edina, MN: Interaction Book Company.

Johnson, D. W., Johnson, R. T., & Smith, K. A. 2014. Cooperative learning: Improving university instruction by basing practise on validated theory. *Journal on excellence in college teaching,* 25:85–118.

Jossberger, H., Brand-Gruwel, S., Boshuizen, H. & Van de Wiel, M. 2010. The challenge of self-directed and self-regulated learning in vocational education: a theoretical analysis and synthesis of requirements. *Journal of vocational education and training*: 1-56.

Kaplan, A. 2008. Clarifying meta-cognition, self-regulation and self-regulated learning: What's the purpose? *Educational psychology review*, 20:477-484.

Karpicke, J.D., Butler, A.C. & Roediger, H.L. 2009. Meta-cognitive strategies in student learning: Do students practise retrieval when they study on their own*? Memory*, 17: 471–479.

Kay, D. & Kibble, J. 2016. Learning theories 101: application to everyday teaching and scholarship. *Advance physiology education,* (40):17-25.

Kistner, S., Rakoczy, K, Otto, B., Klieme, E. & Büttner, G. 2015. Teaching learning strategies. The role of instructional context and teacher beliefs. *Journal for educational research online,* 1:176-197.

Klieme, E. & Vieluf, S. 2009. Teaching practises, teachers' beliefs and attitudes. In *Creating effective teaching and learning environments: First results from Talis* Paris, France: OECD. p. 87-135).

Klinger, C.M. 2009. Behaviourism, cognitivism, constructivism, or connectivism? Tackling mathematics anxiety with 'isms' for a digital age*. Proceedings ALM-16.* Australia: University of South Australia.

Knowles, M.S. 1975. Self-directed learning: A guide for learners and teachers. New York: Association Press.

Kozulin, A. 2003. Psychological tools and mediated learning (*In* Kozulin, A., Gindis, B., Ageyev, V. S. & Miller, S. M., *eds.* Vygostky's educational theory in cultural context. Cambridge: Cambridge University Press. p. 15-38).

Kramarski, B., Desoete, A., Bannert, M., Narciss, S. & Perry, N. 2013. New perspectives on integrating self-regulated learning at school. *Education research international,* 1-4. doi:10.115/2013/49821.

Leech, N.L. & Barrett, K.C., & Morgan, G.A. 2005. SPSS for intermediate statistics: use and interpretation. 2nd edition. London: Routledge.

Leedy, P.D. & Omrod, J.E. 2005. Practical research planning and design. 8th edition. New Jersey: Pearson Education.

Leedy, P.D. & Ormrod, J.E. 2014. Practical research planning and design. 10th edition. Harlow: Pearson Education Limited.

Leedy, P.D. & Ormrod, J.E. 2015. Practical research: planning and design. 11th edition. England: Pearson Education Limited.

Lincoln, Y.S. & Guba, E.G. 1985. Naturalistic inquiry. California: Sage Publications.

Loyens, S.M M., Magda, J. & Rikers R.M.J.P. 2008. Self-directed learning in problem-based learning and its relationships with self-regulated learning. *Education psychology review*, 20:411-427. doi: 10.1007/s10648-008-9082-7. https://link.springer.com/ article/10.1007/s10648-008-9082-7 Date of access:18 March 2018.

Loynachan, C. 2018. Self-regulation and self-advocacy skills in a fifth grade mathematics classroom. School of education student capital projects. Hamline University. School of Education. https://digitalcommons.hamlineedu.edu/hse_cp/256 Date of access: 25 February 2019.

Maggioni, L. & Parkinson, M.M. 2008. The role of teacher epistemic cognition, epistemic beliefs, and calibration in instruction. *Educational psychology review*, 40:445–461.

Malan, S.B., Engelbrecht, P., & Ndlovo, M. 2014. Introducing problem-based education into a foundation programme to develop self-directing learning skills. *South African journal of education*, 34(1):1-16.

Marchis, I. 2011. How mathematics teachers develop their pupils' self-regulated learning skills. *Acta didacta napocensia*, 4(2-3):9-14.

Marcou, A. & Philippou, G. 2005. Motivational beliefs, self-regulated learning and mathematical problem solving. Melbourne: PME.

Maree, K. & Pietersen, J. 2007a. Surveys and the use of questionnaires. (*In* Maree, K., *ed.* First steps in research. Pretoria: Van Schaik. p. 155-169).

Maree, K. & Pietersen, J. 2007b. Standardisation of a questionnaire. (*In* Maree, K., *ed.* First steps in research. Pretoria: Van Schaik. 215-223).

Maree, K. & Van der Westhuizen, C. 2007. Planning a research proposal. (*In* Maree, K., *ed.* First steps in research. Pretoria: Van Schaik. p. 24-44).

Mason, L. 2013. Teaching students who struggle with learning to think before, while, and after reading: Effects of self-regulated strategy development instruction. *Reading and writing quarterly,* 29:124-144.

McCaslin, M. 2004. Co-regulation of opportunity, activity, and identity in student motivation: Elaborations on Vygotskian themes. (*In* McInerney, D.M. & Van Etten, S., *eds*. Research on sociocultural influences on motivation and learning: Big theories revisited. Greenwich: Information Age. p. 249-274).

McCrae, R.R. & Costa, P.T. 1996. Towards a new generation of personality theories: Theoretical context for the Five-Factor Model. (*In* Wiggens, J.S., *ed*. The Five-factor model of personality: Theoretical perspectives. New York, NY: Guilford press. p. 51-87).

McCrae, R.R. & Costa, P.T., 2005. Holistic interactionism: a perspective for research on personality (*In* Schultz, P.S. & Schultz, S.E., *ed.* Theories of personality. 8th edition. Florida: Thomson Wadsworth. p.282-294).

McGregor, D. 2007. Developing thinking developing learning: a guide to thinking skills in education. New York: McGraw-Hill.

McMillan, J.H. & Schumacher, S. 2006. 6th edition. Research in education: evidence-based inquiry. Boston: Pearson

McMillan, J.H. & Shumacher, S. 2014. Research in education: Evidence-based inquiry. 7th edition. Boston: Pearson.

Medina, E. 2011. Improving student mathematics achievement through self-regulation and goal setting. (*In* Plakhotnik, M.S., *ed.* Proceedings of the tenth annual College of education EGSN research conference. Miami: Florida International University. p. 147-153).

Merriam, S.B. 2009. Qualitative research. A guide to design and implementation. San Francisco: Jossey-Bass.

Mishra, L. 2008. Teaching of mathematics. New Delhi: APH Publishing.

Mitchell, D. 2014. What really works in special and inclusive education: using evidence-based teaching. New York: Routledge.

Montague, M. 2008. Self-regulation strategies to improve mathematical problem solving for students with learning disabilities. *Learning disability quarterly,* 31:37-44.

Monteith, J. L. de K. 1998. Personal and behavioural variables and the self-regulated learning abilities of African learners. *Koers* ,63(1 & 2):117-129.

Nel, N., Nel, M. & Lebeloane, O. 2012. Assessment and learner support (In Nel, N., Nel, M. & Hugo, A., *eds.* Learner support in a diverse classroom. Pretoria: Van Schaik. p. 47-77).

Nieuwenhuis, J. 2008a. Introducing qualitative research. (*In* Maree, K., *ed*. First steps in research. Pretoria: Van Schaik. p. 47- 68).

Nieuwenhuis, J. 2008b. Qualitative research designs and data gathering techniques. (*In* Maree, K., *ed.* First steps in research. Pretoria: Van Schaik. p. 70- 97).

Nieuwenhuis, J. 2008c. Analysing qualitative data. (*In* Maree, K., *ed*. First steps in research. Pretoria: Van Schaik. p. 99-117).

Ocak, G. & Yamaç, A. 2013. Examination of the relationships between fifth Graders' self-regulated learning strategies, motivational beliefs, attitudes, and achievement. *Educational theory and practise,* 13(1):380-387.

O'Malley, J.M. & Chamot, A. U. 1990. Learning strategies in second language acquisition. Cambridge: Cambridge University Press.

Pajares, F. 2008. Motivational role of self-efficacy beliefs in self-regulated learning (*In* Schunk, D.H. & Zimmerman, B.J., *eds*. Motivation and self-regulated learning: Theory, research and applications. NewYork: Erlbaum. p. 11-139).

Pajares, F. & Schunk, D. H. 2001. Self-believes and school success: self-efficacy, self-concept, and school achievement. (*In* Riding, R. & Rayner, S., *eds.* Perceptions. London: Ablex. p. 239-266).

Pandero, E. 2017. A review of self-regulated learning. Six models and four directions for research. Frontiers in psychology, 8(442) doi 10.3389/fpsyg.2017.00422.

Pandero, E., Jonsson, A., & Botella, J. 2017. Effects of self-assessment on self-regulated learning and self-efficacy: Four meta analyses. *Educational research review*, 22:74-98.

Pape, S.J. & Smith, C. 2002. Self-regulating mathematics skills. *Theory into practise*, 41(2):93-101.

Paris, S.G. & Paris, A.H. 2001. Classroom applications of research on self-regulated learning. *Educational psychologist*, 36(2):89-101.

Peeters, J., De Backer, F., Reina, V.R., Kindekens, A., Buffel, T. & Lombaerts, K. 2014. The role of teachers' self-regulation learning practises. *Procedia-social and behavioural sciences,* 116:1963-1970.

Pennequin, V., Sorel. O., Nanty, I. & Fontaine, R. 2010. Meta-cognition and low achievement in mathematics: The effects of training in the use of meta-cognitive skills to solve mathematical word problems. *Thinking and reasoning,* 16:198-220.

Perels, F., Dignath, C. & Schmitz, B. 2009. Is it possible to improve mathematical achievement by means of self-regulation strategies? Evaluation of an intervention in regular math classes. *European journal of psychology of education,* 24:17-31.

Perry, D.K. & Steck, A.K. 2015. Increasing student engagement, self-efficacy and meta-cognitive self-regulation in the High School geometry classroom: Do iPads help? *Interdisciplinary journal of practise, theory and applied research,* 32(2):122-143.

Pietersen, J. & Maree, K. 2016a. Standardisation of a questionnaire. (*In* Maree, K., *ed.* First steps in research. 2nd edition. Pretoria: Van Schaik. p.238-247).

Pietersen, J. & Maree, K. 2016b. Overview of some of the most popular statistical techniques (*In* Maree, K., *ed.* First steps in research. 2nd edition. Pretoria: Van Schaik. p.250-304).

Pietersen, J. & Maree, K. 2016c. Statistical analysis II: Interential statistics (*In* Maree, K., *ed.* First steps in research. 2nd edition. Pretoria: Van Schaik. p.220-236).

Pietersen, J. & Maree, K. 2016d. Statistical analysis I: Descriptive statistics (*In* Maree, K., *ed.* First steps in research. 2nd edition. Pretoria: Van Schaik. p.204-217).

Pintrich, P.R. 1999. The role of motivation in promoting and sustaining self-regulated learning. *International journal of educational research,* 31: 459-470.

Pintrich, P.R. 2000. The role of goal orientation in self-regulated learning. (*In* Boekaerts, M., Pintrich, P.L. & Zeidner, M., *eds.* Handbook of self-regulation. San Diego, CA: Academic. p. 451-502).

Powers, M.A. 1994. Control theory: A new direction for psychology. A reply to Todd Nelson. www.livingcontrolsystems.com/intro_papers/direction_for_psych.pdf. First published Feb.2005. Date of access: 16 Nov. 2016.

Powers, W.T. 2004. Making sense of behaviour: the meaning of control. (*In* Forssell, D., *ed*. Perceptual control theory: Science and applications: A book of readings. Hayward, CA: Living Control Systems Publishing p.120-130).

Powers, W.T. 2016. Making sense of behaviour: the meaning of control. (*In* Forssel, D., *ed.* Perceptual control theory. An overview of the third grand theory in psychology, introductions, readings and resources. Hayward, CA: Living Control Systems Publishing. p 146-157).

Pradeep, A.R. 2017. Self-directed learning. *Journal of indian society periodontology*, 21(3):177

Prideaux, J.B. 2007. The constructivist approach to mathematics teaching and the active learning strategies used to enhance student understanding. St Johns college. (Thesis-Masters). https://fisherpup.sjfc.edu/cgi/viewcontent.cgi?article=1028&context=mathcs etd_masters Date of access: 25 April 2018.

Ram, P., Ram, A. & Sprague, C. 2007. From student learner to professional learner: training for lifelong learning through online PBL. [Online]. http://gatech.academia.edu/ARam/Papers/21865/FromStudent-Learner-To-Professional-Learner Date of access: 28 November 2016.

Ramsey, C. & Witter, A. 2010. Ideal study environments and factors that influence studying. Writing and Learning Commons. Western Carolina University. http://www.wcu.edu/academics/campus-academic-resources/writing-and-learning-commons-walc/course-tutoring-and-academic-skills/academic-strategies/ideal-study-environments-and-factors-that-influence-studying.asp Date of access: 2 February 2019.

Redmond, B.F. 2010. Self-efficacy and social cognitive theories. https://wikispaces. psu. edu/display/PSYCH 484/.7 Date of access: 27 March 2016.

Revelle, W. & Zinbarg, R. 2009. Coefficients Alpha, Beta, Omega, and the glb: comment of Sijtsma. *Psychometrika*, 74(1):145-154.

Roth, A., Ogrin, S., & Schmitz, B. 2016. Assessing self-regulated learning in higher eduction: A systematic literature review of self-report instruments. *Educational assessment, evaluation and accountability*, 28(3):225-250.

Ryan, R.M. & Deci, E.L. 2000. Self-determination theory and the facilitation of intrinsic motivation, social development and well-being. *The American psychologist*, 55:68-78.

Sabornie, E. & de Bettencourt, L. 2009. Teaching students with mild and high incidence disabilities at the secondary level. Upper Saddle River, NJ: Pearson.

Sadi, O. & Uyar, M. 2013. The relationship between self-efficacy self-regulated learning strategies and achievement: A path model. *Journal of Baltic science education*, 12(1):1-33.

Saks K. & Leijen A. 2014. Distinguishing self-directed and self-regulated learning and measuring them in the e-learning context. *Procedia- social and behavioural sciences*, 112:190-198. http://www.sciencedirect.com/science/article/pii/S1877042814011720 Date of access: 6 April 2018.

Schoenfeld, A.J. 1985. Meta-cognitive and mathematical epistemological issues in mathematical understanding. (*In* Silver, E.A., *ed.* Teaching and learning mathematical problem solving: Multiple research perspectives. Hillside, NJ: Erlbaum. p. 20-48).

Schraw, G., Crippen, K.J. & Hartley, K. 2006. Promoting self-regulation in science education: Meta-cognition as part of a broader perspective on learning. *Research in science education,* 36:111-139.

Schunk, D.H. 2005a. Commentary on self-regulation in school context. *Learning and instruction,* 15:173-177.

Schunk, D.H. 2005b. Self-regulated learning: the educational legacy of Paul R. Pintrich. *Educational psychologist,* 40(2): 85-94.

Schunk, D.H., 2008. Meta-cognition, self-regulation, and self-regulated learning: research recommendations. *Educational psychology review,* 20:463-467.

Sekaran, U. 2000. Research methods for business. A skill-building approach. New York: Wiley.

Shinde, V. & Kolmos, A. 2011. Students' experience of Aalborg PBL model: A case study. 1st World engineering education flash week. vbn.aau.dk/files/262431640/pbl_in_engineering_education.pdf Date of access: 23 September 2018.

Simon, S. 2008. What's a good value for Conbach's alpha? http://www.childrensmercy.org/stats Date of access: 16 July 2018.

South Africa. Department of Basic Education. 2011. Curriculum and Assessment Policy for Grades 10-12. Pretoria: Department of Basic Education.

South Africa. Department of Basic Education. 2012. Curriculum and assessment policy statement (CAPS) FET band Mathematics. Pretoria: Government Printing Works.

South Africa. Department of Basic Education. 2015a. Gauteng Province Mathematics annual teaching plan Grade 10: 1-4. www.wonnies.co.za//Assessering%202015 //ATP%20Gr%2012%Math.pdf. Date of access: 26 May 2015.

South Africa. Department of Basic Education. 2015b. Basic Education postpones writing of Annual National Assessment. https://www.gov.za/.../media-statement-postponement-writing-annual-national-assessment. Date of access: 6 February 2019.

South Africa. Department of Basic Education. 2017. Grade 10: Annual teaching plan (ATP). Pretoria: Government Printing works.

Sperling, R. A., Howard, B. C. & Staley, R. 2004. Meta-cognition and self-regulated learning constructs. *Educational research and evaluation*, 10(2):117-139.

Spruce, R. & Bol, L. 2015. Teacher beliefs, knowledge and practise of self-regulated learning. *Meta-cognition and Learning,* 10(2):245-277.

Staff Writer. 2014. SA’s Grade 9 mathematics score: 10.8%. http://mybroadband.co.za/news/government/115229-sas-Grade-9-mathematics-score-10-8.html Date of access: 5 August 2014.

Taber, K.S. 2011. Constructivism as educational theory: contingency in learning, and optimally guided instruction. (*In* Hassaskhan, J., *ed.* Educational Theory. New York: Nova Science publisher. p. 39-61).

Tai, S.J. 2009. Using perceptual control theory and the methods of levels to work with people who experience psychosis. *The cognitive behaviour therapist,* 2:227-242.

Taylor, M.M. 1999. Perceptual control theory and its application: *Journal of human-computer studies,* 50:433-444.

Tella, A. 2011. Assessment of mathematics self-efficacy. *Life psychology* 1A, 19(1):430-440.

Thomas, D.R. 2003. A general inductive approach for qualitative data analysis. New Zeeland: University of Auckland.

Torrance, M., Fidalgo, R. & García, J-N. 2007. The teachability and effectiveness of cognitive self-regulation in sixth-grade writers. *Learning and instruction,* 17:265-285.

Van der Walt, M.S. 2006. 'n Ondersoek na metakognisie in wiskunde onderrig en -leer met besondere verwysing na die senior fase. Potchefstroom: NWU. (Proefskrif - M-Ed).

Van der Walt, M.S. & Maree, K. 2007. Do mathematics learning facilitators implement meta-cognitive strategies? *South African journal of education*, 27(2):223-241.

Vieluf, S., & Klieme, E. 2011. Cross-nationally comparative results on teachers' qualification, beliefs, and practises. (*In* Li, Y. & G. Kaiser, G., eds. *Expertise in mathematics instruction. An international perspective*. Boston, MA: Sprincer Science+Business Media LLC. p 295-326).

Vula, E., Avdyli, R., Berish, V., Saqipi, B. & Elezi, S. 2017. The impact of metacognitive strategies and self-regulating processes on solving math word problems. *International electronic journal of elementary education*, 10(1):49-59.

White, K.N., 2007. The effects of background music in the classroom on the productivity, motivation and behaviour of fourth Grade students. Columbia: Columbia College. (Thesis – Master of Education in divergent learning).

Wolters, C.A., Pintrich, P.R., & Karabenick, S.A., 2003. Assessing academic self-regulated learning. Paper prepared for the Conference on Indicators of Positive Development: Definitions, Measures, and Prospective Validity. March, 12-13.

Woolfollk, A. 2010. Educational psychology. 11th editon. Upper Saddle River: Pearson.

Ylvisaker, M. 2006. Cognitive and learning strategies. A program of the Brain Injury Association of New York State. projectlearnet.org/tutorials/cognitive_and_ learning_strategies.html Date of access: 8 August 2018.

Zhou, M. & Brown, D. 2014. Educational learning theories. http://creativecommons. org/licences/by/4.0/ Date of access: 22 June 2017.

Zimmerman, B.J. 1986. Becoming a self-regulated learner: Which are the key sub-processes. *Contemporary educational psychology,* 11:307-313.

Zimmerman, B.J. 2000. Attaining self-regulation, a social cognitive perspective. (In M. Boekaerts, M., Pintrich, P. R. & Zeidner, M., eds. Handbook of Self-Regulation. Massachusetts: Academic Press. p. 13-39).

Zimmerman, B.J. 2002. Becoming a self-regulated learner: An overview. *Theory into practise,* 41(2): 64-70.

Zimmerman, B.J. 2008. Investigating self-regulation and motivation: historical background, methodological developments and future prospects. *American educational research journal,* 45(1):166-183.

Zou, X. & Zhang, X. 2013. Effect of different score reports of web-based formative tests on students' self-regulated learning. *Computer and education*, 66:54-63.

Zulkosky, K. 2009. Self-efficacy: A concept analysis. *Nursing Forum,* 93-102.

Zumbrunn, S., Tadlock, J. & Roberts, E. D. 2011. Encouraging self-regulated learning in the classroom: a review of the literature. Virginia: Virginia Commonwealth University.

APPENDIX A

ETHICAL CLEARANCE

NORTH-WEST UNIVERSITY
YUNIBESITI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT

Private Bag X6001, Potchefstroom,
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Institutional Research Ethics Regulatory Committee
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Email : Ethics@nwu.ac.za

ETHICS APPROVAL CERTIFICATE OF STUDY

Based on approval by the **Basic and Social Sciences Research Ethics Committee (BaSSREC)** at the meeting held on **11/08/2016**, the North-West University Institutional Research Ethics Regulatory Committee (NWU-IRERC) hereby **approves** your study as indicated below. This implies that the NWU-IRERC grants its permission that, provided the special conditions specified below are met and pending any other authorisation that may be necessary, the study may be initiated, using the ethics number below.

Study title: Perception of self-regulating skills among Grade 10 mathematics learners.

Study Leader/Supervisor: Prof MM Grosser
Student: Ms AC van Rooyen

Ethics number:

N	W	U	-	HS	-	2	0	1	6	-	0	0	9	1
Institution						Study Number					Year			Status

Status: S = Submission; R = Re-Submission; P = Provisional Authorisation; A = Authorisation

Application Type: -

Commencement date: 2016-08-18 **Expiry date:** 2019-08-18 **Risk:** Low

Special conditions of the approval (if applicable):

- Translation of the informed consent document to the languages applicable to the study participants should be submitted to the BaSSREC (if applicable).
- Any research at governmental or private institutions, permission must still be obtained from relevant authorities and provided to the BaSSREC. Ethics approval is required BEFORE approval can be obtained from these authorities.

General conditions:

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

- *The study leader (principle investigator) must report in the prescribed format to the NWU-IRERC via BaSSREC:*
  - *annually (or as otherwise requested) on the progress of the study, and upon completion of the project*
  - *without any delay in case of any adverse event (or any matter that interrupts sound ethical principles) during the course of the project.*
  - *Annually a number of projects may be randomly selected for an external audit.*
- *The approval applies strictly to the proposal as stipulated in the application form. Would any changes to the proposal be deemed necessary during the course of the study, the study leader must apply for approval of these changes at the BaSSREC. Would there be deviated from the study proposal without the necessary approval of such changes, the ethics approval is immediately and automatically forfeited.*
- *The date of approval indicates the first date that the project may be started. Would the project have to continue after the expiry date, a new application must be made to the NWU-IRERC via BaSSREC and new approval received before or on the expiry date.*
- *In the interest of ethical responsibility the NWU-IRERC and BaSSREC retains the right to:*
  - *request access to any information or data at any time during the course or after completion of the study;*
  - *to ask further questions, seek additional information, require further modification or monitor the conduct of your research or the informed consent process.*
  - *withdraw or postpone approval if:*
    - *any unethical principles or practices of the project are revealed or suspected,*
    - *it becomes apparent that any relevant information was withheld from the BaSSREC or that information has been false or misrepresented,*
    - *the required annual report and reporting of adverse events was not done timely and accurately,*
    - *new institutional rules, national legislation or international conventions deem it necessary.*
- *BaSSREC can be contacted for further information or any report templates via Charmaine.Lekonyane@nwu.ac.za or 018 210 3483.*

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

Yours sincerely

Prof LA Du Plessis Digitally signed by Prof LA Du Plessis Date: 2016.11.22 16:08:15 +02'00'

Prof Linda du Plessis
Chair NWU Institutional Research Ethics Regulatory Committee (IRERC)

APPENDIX B

GDE APPROVAL

GAUTENG PROVINCE
Department: Education
REPUBLIC OF SOUTH AFRICA

8/4/4/1/2

GDE AMENDED RESEARCH APPROVAL LETTER

Date:	24 July 2017
Validity of Research Approval:	06 February 2017 – 29 September 2017 D2017/164 D2017/320AA
Name of Researcher:	Van Rooyen A.C
Address of Researcher:	P O Box 228
	Meyerton
	1960
Telephone Number:	016 362 2702 082 523 4619
Email address:	rooyrene@gmail.com
Research Topic:	Perception of self-regulating skills among Grade 10 Mathematics learners
Number and type of schools:	Four Secondary Schools
District/s/HO	Sedibeng West

Re: Approval in Respect of Request to Conduct Research

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

27/07/2017

The following conditions apply to GDE research. The researcher may proceed with the above study subject to the conditions listed below being met. Approval may be withdrawn should any of the conditions listed below be flouted:

1

Making education a societal priority

Office of the Director: Education Research and Knowledge Management
7th Floor, 17 Simmonds Street, Johannesburg, 2001
Tel: (011) 355 0488
Email: Faith.Tshabalala@gauteng.gov.za
Website: www.education.gpg.gov.za

The following conditions apply to GDE research. The researcher may proceed with the above study subject to the conditions listed below being met. Approval may be withdrawn should any of the conditions listed below be flouted:

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

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

Kind regards

....

Ms Faith Tshabalala
CES: Education Research and Knowledge Management

DATE: 27/07/2017

2

Making education a societal priority

Office of the Director: Education Research and Knowledge Management
7th Floor, 17 Simmonds Street, Johannesburg, 2001
Tel: (011) 355 0488
Email: Faith.Tshabalala@gauteng.gov.za
Website: www.education.gpg.gov.za

APPENDIX C
SESOTHO TRANSLATION LETTER

Tel: 083 464 0317

E-Mail: amasobela@gmail.com

2016 June 27

To whom it may concern

This is to confirm that, the undersigned has translated the letters of consent and the questionnaires from English to Sesotho for A.C. van Rooyen entitled: Perceptions of self-regulating skills among grade 10 mathematics learners.

Yours truly

Alinah Masobela

APPENDIX D1
ENGLISH LEARNER CONSENT

NORTH-WEST UNIVERSITY®
YUNIBESITI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT
VAAL TRIANGLE CAMPUS

PARTICIPANT INFORMATION LEAFLET AND CONSENT FORM

FOR GRADE 10 LEARNERS

TITLE OF THE RESEARCH PROJECT: Perceptions of self-regulating skills among Grade 10 mathematics learners

REFERENCE NUMBERS:

PRINCIPAL INVESTIGATOR: A.C. van Rooyen (known as Rene)

ADDRESS WHERE RESEARCH WILL TAKE PLACE : At your school

You are asked to take part in a study project that forms part of my study for a Master's degree in Education. Please take some time to read the information presented here, which will explain the parts of this project. Please ask the researcher any questions about any part that you do not fully understand. It is very important that you are fully happy and that you clearly understand what this research is about and how you could be involved. In addition, your participation is **totally your choice** and you are free to say no. You are also free to stop taking part in the study and withdraw at any time.

This study has been approved by the **Basic and Social Sciences Research Ethics Committee (BaSSREC) of the Faculty of Humanities of the North-West University (NWU)** and will be led according to the right guidelines and principles of the international Declaration of Helsinki and the ethical guidelines of the National Health Research Ethics Council. It might be necessary for the research ethics committee or relevant experts to inspect the research records to make sure that we (the researchers) are conducting research in the correct manner.

What is this research study all about?

I am Ms Rene van Rooyen, the Mathematics teacher at Arcelor Mittal Science Centre, who would like to involve you to take part in my research project, which I am completing for a Master's degree. My research project will be conducted at Arcelor Mittal Science Centre, Sebokeng.

In this study, I will determine how well developed the self-regulating skills among Grade 10 mathematics learners are, and explore the factors that contribute to the development of self-regulating skills. Self-regulating skills refer to skills used for the planning, monitoring and evaluation of one's own work.

During **planning,** a self-regulated learner sets clear goals and chooses plans to achieve the goals. During the **monitoring (checking)** stage, the self-regulated learner makes sure that he/she is making progress towards reaching his goals. Finally, the self-regulated learner tests how successful he/she was in achieving his/her goals during the **evaluating** phase. A learner also needs self-regulating skills to ensure a suitable study environment. Self-regulating skills are important for mathematics because traditionally, mathematics learning goals focused on the learning of facts, but nowadays the focus is on making sense of mathematics and solving real-life problems. Self-regulating skills help learners to become masters of their own learning. A study aimed at determining self-regulating skills is vital for successful problem solving in mathematics.

I would like to include all the grade 10 mathematics learners from Arcelor Mittal Science Centre in the research by obtaining permission from the Department of Basic Education and the Centre Manager, Mr Thami Mphokela, who will act as gatekeeper. There will be 130 grade 10 learners accepted in 2017, and who will be invited to take part in the study.

Why have you been invited to participate?

The 130 participants will be grade 10 mathematics learners from my own work environment, at Arcelor Mittal Science Centre (AMSC). All the grade 10 learners are invited to take part. There are four classes, two classes that I teach and two classes taught by a colleague. The grade 10s are chosen because their performance in mathematics can still benefit from acquiring self-regulating skills before they reach grade 12.

What will your responsibilities be?

You will have to complete a questionnaire to indicate to me how well do you think your self-regulating skills are developed. The responses of the participants in relation to the application of self-regulating skills will be measured using a closed four-point Likert scale of measurement, namely 1=Novice, 2=Able, 3=Skilled, 4=Expert.

The questionnaire may be completed in English or Sesotho. The questionnaire will consist of four sections, namely planning, monitoring and evaluation, as well as questions in relation to your study environment The questionnaire will not contain more than 20 questions and will take about thirty minutes to complete. Completing the questionnaire will be done after school hours in the auditorium.

I also want to conduct interviews with a selected group of about 16 learners after the completion of the questionnaire. Based on the questionnaire responses participants will be purposively selected learners who appear to have well developed, average developed and fragile developed self-regulating skills, for the interviews. The interviews will be face-to-face, individual interviews of approximately one hour each. The aim of the interview is to determine the factors that the learners think play a role in the development of or contribute to the development of their self-regulating skills.

Interviews will be recorded to ensure accuracy of what is discussed during the interviews. A Sesotho interpreter will be present during the interviews, to clarify uncertainties that the learners might have about the interview questions, or to assist them in expressing their views.

All the learners who will be approached to take part in the research are from Boipatong and Evaton township schools, Sesotho-speaking, male and female learners and between

16 and 18 years old. I acknowledge working with a vulnerable population and will ensure that the learners' rights and welfare will be protected, by not exposing them to harmful situations

Recruitment of the possible participants will be done in the participants' mathematics classes where the groups are smaller, after school in the auditorium at the centre. This will give a more personal atmosphere and create more freedom to ask clarification questions. I will do the recruitment personally, assisted by the independent person Mrs Alinah Masobela, who will ensure that ethical principles are upheld during the recruitment. Participants will receive a power-point hand-out that will explain the research. After the recruitment session, participants will receive an informed consent form to sign. The parents of the participants will also receive and informed consent form that they need to sign and return to the researcher. Participants will be required to give permission to take part in the research it their own time without the presence of the researcher. There will be a week's time lapse between the recruitment/information session and the handing in of the written permission forms of the parents and the learners.

Will you benefit from taking part in this research?

The actual benefits for you as participant will probably be the following:

(1) Self-regulating skills could help learners to develop an active and independent approach to learning.

(2) Self-regulating skills could contribute to higher achievement in mathematics.

The benefits that are indirectly gained will most probably be that:

(1) Researchers at other universities could be informed about the development of self-regulating skills among grade 10 mathematics learners and how self-regulating skills influence mathematics performance. They can conduct further studies in other contexts to prove the benefits of self-regulating skills.

(2) The research findings could be used to make recommendations to the Department of Education, regarding the possible improvement of the teaching practises of mathematics teachers to ensure the development of self-regulating skills.

(3) The teaching practise of the greater population of mathematics teachers could benefit from teaching self-regulating skills, as self-regulating skills could contribute to improving mathematics results.

Are there risks involved in your taking part in this research and how will these be managed?

The possible risks in this study, and how I will manage them, are summarised in the table below:

Probable/possible risks/discomforts	**Strategies to minimise risk/discomfort**
Conflict of interest and the power relationship because the researcher will also be a teacher at the AMSC.	The researcher acknowledges that the group of participants will be a vulnerable group due to the conflict of interest and hierarchical teacher-learner relationship that will exist, because she will be a teacher at AMSC. However, the use of an independent person, in this case the study leader of the researcher to do the recruitment of the participants, obtain informed consent, administer data collection and verify the findings of the study, will avoid that participants feel coerced to take part in the research, and avoid them being influenced by the teacher-learner relationship. Vulnerability could be reduced in this way. The independent person will not know or have any contact with the participants and do not teach any of the participants. This will ensure that, the participants' will not be forced to do something against their will, or be threatened, pressurised or persuaded with force to take part in the study to please their teacher.
Completing questionnaires and taking part in interviews might cause anxiety and stress, and inconvenience participants to remain after school for 1 hour to take part in interviews.	The independent person, who will do the recruitment, obtain informed consent and collect the data, will explain the following to the participants. (i) They do not need to prepare or study for the completion of the questionnaire and the interviews. (ii) The data collection with the questionnaire will take place at times convenient to the participants, preferably during a register period on the timetable to avoid additional traveling to complete the questionnaire. Refreshments will

	be provided after the completion of the questionnaire. The interviews will take place after school hours for approximately one hour. (iii) The questionnaires and interviews will not influence the participants' passing or failing mathematics. (iv) The data will only be used for research purposes to find out if the self-regulating skills of the Grade 10 mathematics learners are developed or not. (v) Data collection will not overburden the participants. The questionnaire completion will not exceed 30 minutes, and not disturb teaching time. Refreshments will be given after the completion of the questionnaire. The interview will take place after school, for no longer than an hour. Transport money and Refreshments will be provided by the researcher. (vi) To avoid anxiety, the recruiting, informed consent completion of the questionnaires and conducting the interviews will be observed by a Sesotho-speaking person who could help with uncertainties and explanations in the home language of the participants. (vii) The questionnaire will also be translated into Sesotho.
Complete anonymity cannot be guaranteed	In order to identify which participants are experts or novices in terms of the development of self-regulating skills for the purpose of the interviews, numbers will be linked to the names of learners on a class list. The numbers will be used when the questionnaires are completed, and afterwards linked to the name of the student. The researcher will not know the numbers and names of learners, as the independent person and independent observer will do the selection of the participants for the interviews.

The researcher has planned for proper measures to minimise research-related risks, so that the learners could experience the benefits that the research could hold. The risks appear to be reasonable in relation to the importance of knowledge to be gained that can possibly improve the teaching and learning of mathematics.

Who will have access to the data?

Your questionnaire responses will not be linked to your name. A number process will be used in order to identify participants individually. The data will only be available to the researcher, her study leader, co-study leader and the Statistical Services to secure confidentiality. All results regarding the research will be linked to a number to ensure that responses remain anonymous.

What will happen to the data?

All information regarding the research will be stored in a password-protected computer. The data obtained will be held in a locked cupboard at AMSC for five years. The researcher is the only person with a key to unlock the cupboard.

Will you be paid/compensated to take part in this study and are there any costs involved?

No, you will not be paid to take part in the study, but refreshments will be provided. If participating in the research means that you have to travel, specifically for the purpose of participating, then your travel costs will be paid. There will thus be no costs involved for you.

How will you know about the findings?

Feedback will be given to all parents in a short report and explanations regarding the research findings. All questions about the report can be directed to the researcher, at the contact details below, to discuss your questions.

Is there anything else that you should know or do?

- You can contact Rene van Rooyen at rooyrene@gmail.com or 082 523.4619, or
- Prof Mary Grosser at 083490 0501 or mary.grosser@nwu.ac.za if you have any further queries or encounter any problems.

You can contact the chair of the BaSSREC (Prof. Jaco Hoffman) at 016 910 3456 or jaco.hoffman@nwu.ac.za if you have any concerns or complaints that have not been adequately addressed by the researcher.

If you have difficulty in following and understanding the explanation of the research, please contact the researcher at the details below, and she will arrange a time with you to meet with you to explain what is problematic to you. The researcher will involve an interpreter to assist you in understanding the detail of the research project, if the need arises.

You will receive a copy of this information and consent form for your own records.

Declaration by participants

By signing below, I …………………………………..…………agree that I will take part in a research study entitled: **Perceptions of self-regulating skills among Grade 10 mathematics learners**

I declare that:

- I have read and understood this information and consent form and it is written in a language with which I am fluent and comfortable.
- I have had a chance to ask questions to both the person obtaining consent, as well as the researcher (if this is a different person), and all my questions have been adequately answered.
- I understand that taking part in this study is **voluntary** and I have not been pressurised to give consent to take part.
- I understand that my research findings could be reproduced publically and/or quoted, but without reference to my personal identity.
- I may choose to leave the study at any time and will not be penalised or prejudiced in any way.
- I may be asked to leave the study before it has finished if the researcher feels it is in my best interests, or if I do not follow the study plan as agreed to.

Signed at (*place*) ....…........…………….. on (*date*) …………....……….. 20....

....

Signature of participant **Signature of witness**

- You may contact me again ☐ **Yes** ☐
  No
- I would like a summary of the findings of this research ☐ **Yes** ☐ **No**

The best way to reach me is:

Name & Surname: ____

Postal Address: ____

Email: ____

Phone Number: ____________________

Cell Phone Number: ____________________

In case the above details change, please contact the following person who knows me well, who does not live with me and who will help you to contact me:

Name & Surname:

____

Phone/ Cell Phone Number /Email:

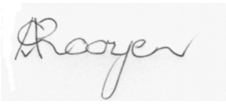
____

Declaration by person obtaining consent

I A.C. van Rooyen…………………………………………..……… declare that:

- I explained the information in this document to Gr 10 learners…………………………………..
- I encouraged him/her to ask questions and took sufficient time to answer them.
- I am satisfied that he/she adequately understands all aspects of the research, as discussed above
- I did/did not use an interpreter.

Signed at (*place*) .Sebokeng...........................….... on February…………...2017....



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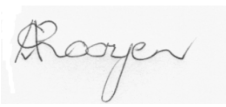
Signature of person obtaining consent **Signature of witness**

Declaration by researcher

I *(name)* Amarencia C van Rooyen…………………………………………..……… declare that:

- I explained the information in this document to Gr 10 learners…………………………………..
- I encouraged him/her to ask questions and took sufficient time to answer them.
- I am satisfied that he/she adequately understands all aspects of the research, as discussed above
- I did/did not use an interpreter.

Signed at (*place*) .....Sebokeng.............. on February …. 2017...

 ....

Signature of researcher **Signature of witness**

APPENDIX D2

SESOTHO LEARNER CONSENT

NORTH-WEST UNIVERSITY
YUNIBESITI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT
VAAL TRIANGLE CAMPUS

MONKAKAROLO

BUKANA YA DINTLHA LE FOROMO YA TUMELLO YA BA BAITHUTE (LEARNERS) BA NKA KAROLO BA SEHLOPHA SA LESHOME

SEHLOOHO SA PATLISISO MORERO: Ntshetsopele ya bokgoni ka bong hara baithuti ba dipalo sehlopheng sa leshome.

DINOMORO TSA REFERENSE:

HLOOHO YA DIPATLISISO: Mme Amarencia C Van Rooyen (tsejoa e le Rene)

Aterese moo dipatlisiso di tla etsahala teng

: Sekolong sa hao

O memelwa ho nka karolo ho etsa dipatlisiso morerong wa dithuto tsa ka tsa lengolo la thuto e phahameng ya Masters. O kotjwa hore o nke nako bakeng sa ho bala boitsebiso bo boletsweng mo, e leng ho hlalosa dintlha tse qaqileng tsa morero ona. O kotjwa hore o botse Mofuputsi dipotso ka karolo efe kapa efe eo osa e utlwisiseng.Ho bohlokwa hore o kgotsofale le hore o utlwisise hantle hore patlisiso e eka eng le kamoo o tla amehang.Hape, ho ba le seabo ke ka ho **feletseng ka boithatelo** le hore ho lokile hore a hane honka karolo.Haeba o re, sena ha seno ama hampe ka tsela efe kapa efe eng. O lokolohile ho ka ikhula thutong ka nako engwe le engwe le ha o dumela hore a nke karolo.

O ka boela wa mpotsa ho hlakola boitsebiso bo / ka tshedimosetso ya hao boo ke bo bokelletseng. O tla boetse o fana ka tumello ya hao ka dithahasello tsa hao ho nka karolo patlisiso kapa tjhe. O lokela ho tseba hore esita le haeba o fana ka tumello ya ho nka karolo, o na le ho khetha ho etsa qeto ya haeba o batla ho nka karolo patlisisong kapa tjhe.

Ena thuto e amohetswe ke **Botho le bophelo bo botle, le diphuputso tsa bophelo boitshwaro** (**Humanities & Health Research Ethics Committee**:BaSSREC) ya Goro ya Botho ya North-West University (NWU) e tla etswa ho ya ka boitshwaro tataiso le melao-motheo ya machaba phatlalatso ya Helsinki le boitshwaro dikaelo tsa Naha le Bophelo bo botle le diphuputso tsa bophelo boitshwaro lekgotla la Phethahatso (National Health Research Ethics Council). Ho ka ba ho hlokahala hore patlisiso komiti ya botho kapa baholo ba maleba ho hlahloba direkoto tsa patlisiso ho tiisa hore re (mofuputsi) o kganna patlisiso ka tsela e lokileng.

Patlisiso e mabapi le eng?

Ke nna Mme. Rene Van Rooyen, morutisi wa thuto ya dipalo wa mora / moradi wa hao, ke ne ke ka rata ho akarelletsa mora / moradi porojekeng ya patlisiso ya ka,eo ke e tlatsa bakeng sa dithuto tsa ka tsa lengolo la thuto e phahameng ya Masters . Porojeke ya ka ya dipatlisiso e tla etswa ko ArcelorMittal Science Centre, Sebokeng.

Thutong ena, ke tla fumana mofuta wa bokgoni ka bong (self regulation) ba baithuti ba sehlopha sa leshome (10) thutong ya dipalo le ho hlahloba dintho tse ka ekelletsang ho ntshetsopele ya boiphihlelo. Bokgoni ka bong bo bua ka moralo, tlhokomelo le tekolo ya mosebetsi wa motho.

Nakong ya **moralo**, moithuti o beha dipakane tse hlakileng leho khetha merero ya ho fihlela dipakane tse. Nakong ya ho **beha leihlo ditlhokoa**, moithuti o etsa bonnete ba hore o etsa kgatelopele ho fihlella dipakane tsa hae. Qetellong, moithuti o etsa teko ho sheba hore ho tsweletse pele jwang ho fihlella dipakane tsa hae nakong ya ho **hlahloba**

mohato.Moithuti o boetse o hloka ntshetsopele ya bokgoni ka bong ho netefatsa tikoloho e lokileng yaho ithuta.

Bokgoni ka bong bo bohlokoa ho thuto ya dipalo hobane ka tlwaelo, thuto ya dipalo dipakane tsa ho ithuta di lebisa tlhokomelong le bokgoning dintlheng le mekgwa ya tshebetso, empa matsatsing ana bo bua haholo ka ho etsa kutlwisiso ya thuto ya dipalo le ho rarolla mathata a bophelo.

Bokgoni ka bong bo bua ka moo baithuti ba ka kgonang ho ithusa dithutong tsa bona. Ho nahana ho phetha karolo ya bohlokwa ho dikgato tse tharo e leng moralo, hlokomelo le tekolo ya dithulahanyo, mme ho akarelletsa ho fetola mokhwa kapa tsela ya ho ithuta.Ho nahana ke bokgoni ba ho etsa diqeto ho tloha diphihlelong ho bopa phetolo nakong e tlang e hlophisitsweng, ho phetha mosebetsi o ka katleho.

Thuto e,e ikemiseditse ho lekola hore na bokgoni ka bong bo bohlokoa ho atleheng ho lokisa mathata thutong ya dipalo.

Ke tla rata ho akarelletsa bohle baithuti ba sehlopheng sa 10 ba dipalo ba ArcelorMittal Science Centre patlisisong ka ho fumana tumello ho Lefapha la Thuto le ho mookamedi Mr Thami Mphokela ya tla e ba molebeledi wa heke. Ho tla ba le baithuti ba 130 sehlopheng 10 batla amohelwang ka 2017.

Ke hobaneng o memelwa ho ba le seabo?

Bankakarolo ba 130 e tla ba baithuti ba sehlopha sa 10 ba dipalo ba tswang mosebetsing waka, Arcelor Mittal Science Centre (AMSC).

Baithuti ba sehlopheng sa leshome (10) bohle ba memelwa ho nka karolo.Ho na le dihlopha tse nne,tse pedi tse ke di rutang le dihlopha tse pedi tse rutwang ke mosebetsi mmoho le nna.Baithuti ba sehlopha sa leshome ba khethoa hobane baka rua molemo wa ho fumana bokgoni ka bong pele ba fihla sehlopheng sa 12. Ke kgetha baithuti bana, e le ke tla rata ho ntlafatsa bokgoni ba bong ba baithuti ba AMSC, ka sepheo sa ho theha hore na ntlafalo ya bokgoni ba bong e ka ntlafatsa tshebetso ya bona ya dipalong.

Boikarabelo ba hao e tla ba bofe?

O tla lokela ho tlatsa dipotso ho mpontsa kamoo o nahanang hantle hore ditsebo tsa hao tsa bokgoni ka bong bo etsoa joang.Dikarabelo tsa bankakarolo mabapi le tshebediso ya bokgoni ba bong bo tla lekanya ho sebediswa (closed four point Likert scale of measurement), e leng: 1= Ya qalang, 2= Ho kgona,3= Ya nang le tsebo, 4=Ya hlahlwa.

Dipotso dientswe ka Sesotho kapa Senyesemane. Dipotso ditla akarelletsa dikarolo tse nne, e leng ho rera, tlhokomelo le hlahlobo,le dipotso tse bateng tsa dikamano le tikoloho ya thuto. Dipotso ha dino fetang 20,di tla nka mashome a mararo metsotso ho di tlatsa.Ho tlatswa ha dipotso tsena hot la etsoa ka mora dihora tsa sekolo ka holong.

Ke boetse ke batla ho buisana le sehlopha se khethiloeng se ka bang 16 ka mora ho araba dipotso.Ho ya ka dikarabo tsa dipotso tsa bankakarolo batla gethwa bao ba bonahalang ba hlahile hantle,ba karolelano e tsoetseng pele le e fokolang ya bokgoni ba ntshetso pele bakeng sa dipuisano.

Puisano e tla ba sefahleho le sefahleho e tla nka hora ho e mong le e mong. Sepheo sa dipuisano ke ho tseba hore na dintlha tse baithuti ba nahanag hore ba bapala karolo ho ntsetsopele ho ntlafatsa tsebo ea bona ya bogoni ka bong. Dipuisano di tla ngodisoa ho netefatsa hore seo se tsohloang se nepahetse nakong ya dipuisano. Mofetoledi oa sesotho o tla ba teng nakong ya puisano ho hlakisa dipelaelo tseo baithuti ba kabang le tsona ka dipotso tsa puisano,kapa ho ba thusa ho hlalosa maikutlo a bona.

Bohle baithuti ba tla kopa ho nka karolo ho patlisiso batswa dikolong tsa Boipatong le Evaton. barutuoana ba banna le basadi ba buang Sesotho bale pakeng tsa lemo tse 16 & 18. Ke dumela ho sebetsa le batho ba tlokotsing mme ke tla etsa bonnete ba hore ditokelo tsa baithuti le boiketlo ba bona di tla sireletsoa, ka ho sa ba pepesetse maemo a kotsi.

Kgetho ya bankaralo e tla etsoa phaphusing ya dipalo moo dihlopha di leng nyenyane, ha selolo se tswile ka holong ya sekolo. Sena se tla fana ka sepakapaka sa botho le ho etsa bolokolohi bo bongata ba ho botsa dipotso tsa ho hlakisa. Ke tla iketsetsa getho,ke thuswa keya ikemetseng Me Alinah Masobela, ya tla netefatsang hore melao-motheo ya boitshoaro di tsehetsoa nakong ya getho. Barupeluoa ba tla fumana ntlha ya power point e tla hlalosa patlisiso.Ka mora lenaneho la kgetho,bankakarolo batla fumantshwa tumello e tsebahalang ya foromo ho tekena.Batswadi ba banka karolo batla tla fumantshwa foromo ya tumello ya tsebo oe batla e tekena ba e gutlesetse ho mofuputsi.Banka karolo batla kotjwa ho nka karolo patlisisong ka nako ya bona ka ntle leho bateng ha mofuputsi.Ho tla ba le nako ya beke e fedileng pakeng tsa ho gethwa le tlhahiso ya tlhahisoleseding le ho fumantshwa tumello e ngoetseng ya diforomoya batswadi le baithuti

Na o tla rua molemo honkeng karolo phuputso ena?

Ka ho toba, melemo eo o kae rua jwale ka monkakarolo e tlaba e latelang:

1. Bokgoni ka bong bo kgothaletsa baithuti ho ba le mafolofolo le hoba mahlonoko hotsa thuto ho hlophisa le ho ilaola le mesebetsi ya bona ka boikarabelo.
2. Bafuputsi ba etsa qeto ya hore bokgoni ka bong bo kenya letsoho tshebetsong e phahameng thutong ya dipalo.

Ho rua molemo o sa tobang e ka ba:

1. Bafuputsi ba diyunibesiti tse ding ba ka tsebiswa ka ntshetsopele ya bokgoni ka bong hara baithuti ba sehlopheng sa leshome thutong ya dipalo le ka moo bokgoni ka bong bo ka susumetsa tshebetso ya thuto ya dipalo. Bafuputsi ba ka nna ba tsweletsa dithuto tse ding ho bontsha melemo e ka ruwang ya bokgoni ka bong.
2. Diphihlello tsa dipatlisiso di ka sebediswa ho etsa dikgothaletso ho Lefapha la Thuto, mabapi le ntlafatso ya ho ruta mekhoa ya thuto ya barutisi ba ruta dipalo ho etsa bonnete ba ntshetsopele ya bokgoni ka bong.
3. Mokgwa wa ho ruta barutisi ba bangata ba thuto ya dipalo o ka rua molemo ho ruteng bokgoni ka bong, haeba ho na le molemo ho ntlafatsa diphetho tsa thuto ya dipalo.

Na ho na le dikotsi tsa ho akarelletsa ho patlisiso ena le hona sena se ka laolwa jwang?

Khoneho ya dikotsi thutong ena, le ka moo ke tla di laola,di ya kgutsufatswa tafoleng e ka tlase:e ka tlase:

Dikotsi	
Ho ntsha kotsi mmeleng	• Ha ho no ntsha kotsi mmeleng ho ho lebeletsweng bakeng sa ho tlatsa dipotso. • Ho phethwa ha dipotso ha hono feta metsotso e mashome a mararo (Maree & Pietersen, 2008d:159) • Ha ho dikotsi tse lebeletsweng bakeng sa Mofuputsi.
	• Puisano e tla etsahala ka mora hore sekolong, setswe bakeng se sa feteng hora. • Tjhelete ya dipalangwa le dijo di tla fuwa.
Setjhaba	• Ha ho no ba le sekgobo hoba ba tla nkakarolo.
Moruo	• Ho nka karolo patlisisong ha hono lefellwa ke bankakarolo le ho akarelletsa leha e le efe ditjeho ho barutisi kapa tahleheloa nakong ya ho ruta.
Kelello	• Ho qoba ho tshwenyeha, dipuisano di tla etswa ke motho ya buang Sesotho. • Dipotso di tla fetolelwa ka Sesotho • Mofuputsi ha no ba le tshusumetso tswelopeleng ya bankang karolo sebakeng se ke sebetsang ho sona. • Patlisiso ha e no kenya tshabo, mogathala, le matshwenyeho kapa ho jewa ke bodutu. • Ditaba tse ho bokellelwang ditla bokellwa AMSC, e leng sebaka se o ba se tsebang.

Mofuputsi o rerile bakeng sa ho fokotsa dikotsi tse ka amang patlisiso, e le hore bankakarolo ba kaba le melemo e patlisiso e ka bang le yona

Dikotsi dibonahala e le kahlolo e molemo mabapi le bohlokwa ba tsebo bo ntlafatsang ho rutwa le ho ithuta dipalo.

Ke mang ya tla ba le phihlelo ho tshedimosetso?

Sephetho sa dihlahlobo se tla amahangwa le lebitso la hao. Thulahanyo di tla sebediswa e le hore ho kgetholla bankakarolo ka bomong. Diphihlello di tla ba teng ho Mofuputsi , moeta-pele wa dithuto tsa hae,ya ithutang le yena le dipalopalo ho boloka lekunutu. Diphetho mabapi le patlisiso di tla amahangwa le palo ho netefatsa ho dula ho sena lebitso.

Ho tla etsahalang ka tshedimosetso?

Tlhahisoleseding yohle mabapi le patlisiso di tla bolokwa phasewete-e tshireletsang. Tshedimosetso e fumanweng e tla notlelwa lebokosong mosebetsing ka AMSC dilemo tse hlano. Mofuputis e tla ba yena fela ya nang lesenotlolo sa ho bula lebokoso le.

Na o tla lefuwa / fumana tefo ho nkeng karolo dithutong tsena, na hona le tefello e kenyeleditsweng?

Tjhe, o ke ke wa leshwa ho nka karolo ho ithuta, empa dijo tse bobe di tla fiwa ya nka karolo diphuphutsong. Empa ha o tla tlameha ho tsamaya haholo-holo ka morero wa ho nka karolo, ka nako ya hao maeto ditshenyehelo di tla patalwa. Kantle le moo, ha ho noba le ditshehenyelo tse tla patalwa

O tla tseba jwang ka diphetho?

Karabo/ tlaleho e tla fiwa batswadi bohle e le kgutswanyane le ditlhaloso mabapi le diphitlhelelo. Dipotso tsohle mabapi le tlaleho di ka lebiswa ho mofuputsi, dintlheng tsa kgolahanyo e ka tlasa mona, ho buisana ka potso ya hao.

Na ho na le engoe hape eo o lokela ho tseba ka yona kapa ho se etsa?

- O ka ikopanye le Rene Van Rooyen. ka .rooyrene @ gmail.com kapa
- 082 523,4619., Moporofesa Mary Grosser ho 083 490 0501 kapa

mary.grosser@nwu.ac.za haeba o na le dipotso kapa ha o thulana le mathata.

O ka ikopanya le modulasetulo wa BaSSrec (Moporofessa Jaco Hoffman) ho 016 910 3456 kapa jaco.hoffman@nwu.ac.za haeba o ba le ho ameha kapo ditletlebo tse sokang di hlaloswa hantle ke mofuputsi .

Ha eba o na le mathata ho latela le ho utlwisisa tlhaloso ya phuputso, ka kopo ikopanye the mofuputsi kapa mofuputsi ya ikemetseng ho dintlha tse qaqileng ka tlaase mona, mme batla lokisa nako le wena ho hlalosa se o e leng mathata ho wena.Mofuputis o tla akareletsa toloko ho thusa ho utlwisisa ka botlalo porojeke ya dipatlisiso.

Phatlalatso ka monkakarolo

Ka ho tekena mona ka tlase, ke …………………………ke dumela ho nka karolo thuto ya patlisiso e leng: **Hlaloso le hlahlobo ntshetsopele ya bokgoni ka bong hara baithuti ba dipalo sehlopheng sa leshome.**

Ke bolela hore:

- ke bala le ho utlwisisa boitsebiso bona le foromo ya tumello le hore e ngodilwe ka puo eo ke e utlwisisang e bile ke e tsebang.
- ke bile le monyetla wa ho botsa dipotso ho motho ya fumanang tumello hammoho le mofuputsi (haeba sena e le tsela e fapaneng),mme dipotso tsohle tsa ka diile tsa arabiwa.
- ke utlwisisa hore ho honka karolo dithutong tsena **ha keya qobelwa** ke nkile karolo e le boithatelo baka.
- ke utlwisisa hore dipheto di ka ingatafatsa kapa ho qotsitsoeng,mpa ntle le referense ho boitsebahatso ba botho baka.
- Ke ka khetha ho tlohela dithuto tse nako efe kapa efe mme ha ke no getholwa.
- ke ka nna ka kopiwa ho tlohella dithuto tse na pele di fela, haeba mofuputsi a ikutlwa ho le molemong wa ka, kapa haeba ke sa latela moralo wa thuto,ka tumellano.

E tekenwe ka (sebaka)……………………………………… mohla wa (letsatsi)………………..20..........

……………………………. …………………………

Tshaeno ya monkakarolo **Tshaeno ya bopaki**

- O ka ikopanya le nna hape E ya Tjhe

Phatlalatso ka motho ho fumana tumello ya hae

Nna (Lebitso)………………… ……………ke phatlhalatsa hore:

- Ke ile ka hlalosa boitsebiso bo tokomaneng ena ho ....

• Ke mo kgothalletsa hore a botse dipotso mme a nke nako e lekaneng ho di araba.

• Ke kgotsofetse hore o utlwisisa dikarolo tsohle tsa patlisiso, joalo kaha re ithutile ka hodimo

• Ke ile ka sebedisa toloko.

Saennweng ka (sebaka) ……………………………………… mohla wa (letsatsi)…………….20...

…………………………….   ………………………….

Tshaeno ya motho ya fumanang tumello   **Tshaeno ya paki**

Phatlalatso ka Mofuputsi e

Nna (Lebitso)………………… ……………ke phatlhalatse hore:

- Ke ile ka hlalosa boitsebiso bo tokomaneng ena ho...................................... .
- Ke mo khothalletsa hore a nke nako e lekaneng ho di araba.
- Ke kgotsofetse hore o utlwisisa dikarolo tsohle tsa patlisiso, joalo kaha re ithutile ka hodimo
- Ke ile ka sebedisa toloko / ha ka sebedisa toloko

Saennweng ka (sebaka) ……………………………………….. mohla wa (letsatsi) ……………….20...

………………………….................. ………………………………….

Tshaeno ya mofuputsi ya ikhethang **Tshaeno ya paki**

APPENDIX E1

ENGLISH PARENT CONSENT

NORTH-WEST UNIVERSITY
YUNIBESITI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT
VAAL TRIANGLE CAMPUS

INFORMATION LEAFLET AND CONSENT FORM FOR PARENTS OF GRADE 10 MATHEMATICS PARTICIPANTS.

TITLE OF THE RESEARCH PROJECT: Describing and exploring the development of self-regulating skills among grade 10 mathematics learners.

REFERENCE NUMBERS:

PRINCIPAL INVESTIGATOR: A.C.van Rooyen (known as Rene).

ADDRESS:

CONTACT NUMBER: 016 988 0507

Your son/daughter is invited to take part in a research project that forms part of my study for a Master’s degree in Education. Please take some time to read the information presented here, which will explain the details of this project. Please ask the researcher any questions about any part that you do not fully understand. It is very important that you are fully satisfied and that you clearly understand what this research is about and how your son/daughter could be involved. Also, their participation is **entirely voluntary** and he/she is fine to decline participation. If you say, this will not affect your son/daughter negatively in any way whatsoever. Your son/daughter is also free to withdraw from the study at any point, even if you do agree that they take part. You may also ask me to delete information/data about your son/daughter that I collected. Your son/daughter will also give consent on their own to take part in the research or not. You need to know that even if you give consent that your son/daughter may take part, they have the choice to decide if they want to take part in the research or not.

This study has been approved by the **Basic and Social Sciences Research Ethics Committee (BaSSREC) OF THE Faculty of Humanities of the North-West University (NWU)** and will be conducted according to the ethical guidelines and principles of the international Declaration of Helsinki and the ethical guidelines of the National Health Research Ethics Council. It might be necessary for the research beliefs committee members or relevant authorities to inspect the research records to make sure that we (the researchers) are conducting research in an ethical manner.

What is this research all about?

I am Me. Rene van Rooyen, the Mathematics teacher of your son/daughter, who would like to involve your son/daughter in my research project, which I am completing for a Master's Degree. My research project will be conducted at ArcelorMittal Science Centre, Sebokeng.

In this study, I will determine the nature of self-regulating skills among Grade 10 mathematics learners, and explore the factors that add to the development of self-regulating skills. Self-regulating kills refer to the planning, monitoring and evaluation of one's own work

During **planning,** the self-regulated learner sets clear goals and chooses plans to achieve the goals. During the **monitoring** stage, the learner makes sure that he is making progress towards reaching his goals. Finally, the self-regulated learner test how successful he was in achieving his goals during the **evaluating** phase. In addition, a learner also needs to possess self-regulating skills to establish a suitable study environment.

Self-regulating skills are important for mathematics because traditionally, mathematics learning goals focused on the mastering of facts and procedures, but nowadays the focus is on making sense of mathematics and solving real-life problems

Self-regulation refers to how learners become masters of their own learning. Reflection plays an important role in all three phases of planning, monitoring and evaluation processes, and involves changing a method or way of learning. Reflection is the ability to draw conclusions from experiences to create a positive change in future processes to complete a task successfully.

A study aimed at determining the development of self-regulating skills is vital for successful problem solving in mathematics.

I would like to include all the grade 10 Mathematics learners from ArcelorMittal Science centre in the research by obtaining permission from the Department of Education and the centre manager mr Thami Mphokela, who will act as gatekeeper. There will be 130 grade 10 learners accepted in 2017.

Why has your son/ daughter been invited to participate?

The 130 participants will be grade 10 mathematics learners from my own work environment, Arcelor Mittal Science Centre (AMSC). The inclusion criteria for the sample will be all the grade 10 learners. There are four classes, two classes that I teach and two classes taught by a colleague. The grade 10 are chosen because they can still benefit from acquiring self-regulating skills before they reach grade 12. I am choosing these learners, as I would like to improve AMSC learners' self-regulating skills with the aim to establish whether improvement in self-regulating skills could enhance their mathematics performance.

What will your son's/daughter's responsibilities be?

Maree and Pietersen (2008a:161) describe a closed questionnaire that has a question format. These questions are set in such a way that the participants choose one or more responses (Maree & Pietersen, 2008a:161).

Closed questions are quick to answer and easy to analyse. However, one disadvantage is that this also occurs even if the question is misunderstood or the participant has no opinion on the subject (Maree & Pietersen, 2008a:164).
The responses of the participants in relation to the application of self-regulating skills will be measured using a closed four point Likert scale of measurement, namely: 1. Novice. 2. Able. 3. Skilled. 4. Expert. The Likert scale provides an ordinal measure of the participants' perceptions (Maree & Pietersen, 2008a:167).

The reason for choosing a closed questionnaire is because the learners' home language is eminently Sesotho and they find it difficult to express themselves in written English. The questionnaire will consist of four sections, namely planning, monitoring and evaluation, as well as question related to the learners' study environment. The questionnaire will not contain more than 20 questions and will take thirty minutes to complete. The questions will be in both English and Sesotho as their home language is eminently Sesotho. As suggested by my Sesotho colleagues, it is best to have a Sesotho female to conduct the questionnaire. Completing the questionnaire will be done during a register period in the auditorium. An independent person, Me Alinah Masobela will assist with the translation of questionnaires.

The interviews will be face-to-face interviews of approximately one hour each. The aim of the interview is to determine the factors that play a role in the development of or contribute to the development of self-regulating skills, linked to the responses obtained by the questionnaire.

The interviews will be conducted by an independent researcher who is experienced in the use of interviews for data collection, and knowledgeable on self-regulation. I will conduct the interviews personally. Interviews will be recorded to ensure accuracy. Recordings will be submitted to the researcher and study leaders to monitor accuracy and maintain oversight A Sesotho interpreter will be present to clarify uncertainties. All the learners are from Boipatong and Evaton township schools only and are between 16 and 18 years old. I acknowledge working with a vulnerable population and justify the inclusion of grade 10 based on the fact that the study wishes to enhance performance of mathematics at school level. The learners' rights and welfare will be protected, see 10.4. The learners are all black learners and the home language of the majority is Sesotho. Male and female learners are included in the sample.

Recruitment of the possible participants will be done in their classes where the groups are smaller. This will give a more personal atmosphere and create more freedom to ask clarification questions. I will do the recruitment with the assistance of the independent person, Mrs Alinah Masobela, who will ensure that ethical principles are upheld during the recruitment. This will be done during a register period of one hour. The classrooms are exceptionally well furnished with enough desks and chairs to accommodate the learners. Flyers explaining the research will be given to possible participants to clear up any questions they may have later.

The researcher is in a dependant relationship with half of the possible participants due to the fact that she teaches some of them. The other half is taught by a colleague. An independent person will facilitate the informed consent in the presence of the researcher. The researcher and her study leaders will train the independent person to be knowledgeable in dealing with the contents of the informed consent letter. The participants will give consent to take part in the research in their own time without the presence of the researcher. There will be a week's time lapse between the informed consent session and the submission of the participants' written confirmation, which the independent person will collect from the participants at the centre.

Will your son/daughter benefit from taking part in this research?

The direct benefits for your son/daughter as participant will probably be the following:

Self-regulating skills are to encourage learners to have an active and critical approach to learning and to organise and manage themselves and their activities, responsibly and effectively.

Researchers concluded that self-regulating skills contribute to a higher performance in mathematics.

The indirect benefit will probably be that:

Researchers at other universities could be informed about the development of self-regulating skills among grade 10 mathematics learners and how self-regulating skills influence mathematics performance. They can conduct further studies in other contexts to prove the benefits of self-regulating skills.

The research findings could be used to make recommendations to the Department of Education, regarding the possible improvement of the teaching practises of mathematics teachers to ensure the development of self-regulating skills.

The teaching practise of the greater population of mathematics teachers could benefit from teaching self-regulating skills, if it holds merit for improving mathematics results.

Are there risks involved in your son/daughter taking part in this research and how will these be managed?

The possible risks in this study, and how I will manage them, are summarised in the table below:

Risks	
Physical harm	• No physical harm is envisaged for completing the questionnaire. • The questionnaire completion will not exceed 30 minute (Maree & Pietersen, 2008d:159) • No risks are envisaged for the researcher.
	• The interview will take place after school, for not more than an hour. • Transport money and refreshments will be provided.
Social	• No stigmatisation of participants will take place.
Economic	• Taking part in the research will not involve any costs to the participants or loss in teaching time.
Psychological	• To avoid anxiety, the interviews will be assisted by a Sesotho-speaking person. • The questionnaire will also be translated into Sesotho • Research will have no influence on the participants' progress at the centre. • The research does not involve any intervention that could cause fear, tiredness, anxiety or boredom. All data collection will be done at AMSC, which is a very comfortable setting that they are familiar with.

The researcher has planned for appropriate measures to minimise research-related risks, so that the participants could experience the benefits that the research could hold. The risks appear to be reasonable in relation to the importance of knowledge to be gained that can possible improve the teaching and learning of mathematics.

Who will have access to the data?

Your son's/daughter's test results will not be linked to his/her name. A number process will be used in order to identify participants individually. The data will only be available to the researcher, her study leader, co-study leader and the Statistical Services to secure confidentiality. All results regarding the research will be linked to the number to ensure it stays nameless. Feedback will be given to all parents in a short report and explanations regarding the research findings will be given. All questions about the report can be directed to the researcher, contact details below, to discuss your question.

All information regarding the research will be stored in a password- protected computer.

The data obtained will be held in a locked cupboard at AMSC for five years. The researcher is the only person with a key to unlock the cupboard.

Will you be paid/compensated to take part in this study and are there any costs involved?

No, you will not be paid to take part in the study, but refreshments will be..given.. If participating in the research means that you have to travel especially for the purpose of participating, then your travel costs will be paid. There will thus be no costs involved for you.

Is there anything else that you should know or do?

- You can contact Rene van Rooyen. at .rooyrene@gmail.com or at
- 082 523.4619. Prof Mary Grosser at 083490 0501 or mary.grosser@nwu.ac.za.. if you have any further queries or encounter any problems.
- You can contact the chair of the Humanities and Health Research Ethics Committee (Prof Linda Theron) at 016 910 3076 or Linda.theron@nwu.ac.za if you have any concerns or complaints that have not been adequately addressed by the researcher. You can also contact, the co-chair, Prof Tumi Khumalo (016 910 3397 or Tumi.khumalo@nwu.ac.za). You can leave a message for either Linda or Tumi with Ms Daleen Claasens (016 910 30441)
-
- You will receive a copy of this information and consent form for your own records.

Declaration by participant

By signing below, I …………………………………..…………. agree to take part in a research study entitled:

I declare that:

- I have read and understood this information and consent form and it is written in a language with which I am fluent and comfortable.
- I have had a chance to ask questions to both the person obtaining consent, as well as the researcher (if this is a different person), and all my questions have been adequately answered.
- I understand that taking part in this study is **voluntary** and I have not been pressurised to take part.
- I understand that what I contribute (what I report/say/write/draw/produce visually) could be reproduced publically and/or quoted, but without reference to my personal identity.
- I may choose to leave the study at any time and will not be penalised or prejudiced in any way.
- I may be asked to leave the study before it has finished, if the researcher feels it is in my best interests, or if I do not follow the study plan, as agreed to.

Signed at (*place*) ....…........……………... on (*date*) …………....……….. 20....

....

Signature of participant **Signature of witness**

- You may contact me again ☐ **Yes** ☐ **No**
- I would like a summary of the findings of this research ☐ **Yes** ☐ **No**

The best way to reach me is:

Name & Surname: ____

Postal Address: ____

Email: ____

Phone Number: _____________________

Cell Phone Number: ______________________

In case the above details change, please contact the following person who knows me well and who does not live with me and who will help you to contact me:

Name & Surname:

___

Phone/ Cell Phone Number /Email:

___

Declaration by person obtaining consent

I *(name)* …………………………………………..……… declare that:

- I explained the information in this document to …………………………………..
- I encouraged him/her to ask questions and took adequate time to answer them.
- I am satisfied that he/she adequately understands all aspects of the research, as discussed above
- I did use an interpreter.

Signed at (*place*) ....…........…………….. on (*date*) …………...……….. 20....

....	....
Signature of person obtaining consent	**Signature of witness**

Declaration by researcher

I *(name)* …………………………………………..……… declare that:

- I explained the information in this document to …………………………………..
- I encouraged him/her to ask questions and took adequate time to answer them.
- I am satisfied that he/she adequately understands all aspects of the research, as discussed above
- I did use an interpreter.

Signed at (*place*) ....…........…………….. on (*date*) …………...……….. 20....

....

Signature of researcher **Signature of witness**

APPENDIX E2

SESOTHO PARENT CONSENT

NORTH-WEST UNIVERSITY®
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VAAL TRIANGLE CAMPUS

LETSATSI:

MONKAKAROLO

BUKANA YA DINTLHA LE FOROMO YA TUMELLO YA BATSWADI (PARENTS) BA BAITHUTE BA NKA KAROLO BA SEHLOPHA SA LESHOME BA THUTO YA DIPALO

SEHLOOHO SA PATLISISO MORERO: Hlaloso le hlahlobo ntshetsopele ya bokgoni ka bong hara baithuti ba dipalo sehlopheng sa leshome.

DINOMORO TSA REFERENSE:

HLOOHO YA DIPATLISISO: Mme Amarencia C Van Rooyen (tsejoa e le Rene)

Aterese:

NOMORO YA MOHALA: 016 9880507

Mora / moradi wa hao o memelwa ho nka karolo ho etsa dipatlisiso morerong wa dithuto tsa ka tsa lengolo la thuto e phahameng ya Masters. O kotjwa hore o nke nako bakeng sa ho bala boitsebiso bo boletsweng mo, e leng ho hlalosa dintlha tse qaqileng tsa morero ona. O kotjwa hore o botse Mofuputsi dipotso ka karolo efe kapa efe eo osa e utlwisiseng.Ho bohlokwa hore o kgotsofale le hore o utlwisise hantle hore patlisiso e eka eng le kamoo mora / moradi wa hao a amehang.Hape,ho ba le seabo ke ka ho **feletseng ka boithatelo** le hore ho lokile hore a hane honka karolo.Haeba o re, sena ha seno ama mora / moradi wa hao hampe ka tsela efe kapa efe eng. Mora / moradi wa hao o lokolohile ho ka ikhula thutong ka nako engwe le engwe le ha o dumela hore a nke karolo.

O ka boela wa mpotsa ho hlakola boitsebiso bo / ka tshedimosetso ka mora / moradi wa hao boo ke bo bokelletseng. Mora / moradi wa hao o tla boetse a fana ka tumello ya hae ka dithahasello tsa hae ho nka karolo patlisiso kapa tjhe. O lokela ho tseba hore esita le haeba o fana ka tumello ya hore mora / moradi wa a nke karolo, o na le ho khetha ho etsa qeto ya haeba o batla ho nka karolo patlisisong kapa tjhe.

Ena thuto e amohetswe ke **Botho le bophelo bo botle,le diphuputso tsa bophelo boitshwaro** (**Humanities & Health Research Ethics Committee**:(BaSSREC) **ya Goro ya Botho ya North-West University (NWU)** e tla etswa ho ya ka boitshwaro tataiso le melao-motheo ya machaba phatlalatso ya Helsinki le boitshwaro dikaelo tsa Naha le Bophelo bo botle le diphuputso tsa bophelo boitshwaro lekgotla la Phethahatso (National Health Research Ethics Council). Ho ka ba ho hlokahala hore patlisiso komiti ya botho kapa baholo ba maleba ho hlahloba direkoto tsa patlisiso ho tiisa hore re (mofuputsi) o kganna patlisiso ka tsela e lokileng.

Patlisiso e mabapi le eng?

Ke nna Mme. Rene Van Rooyen, morutisi wa thuto ya dipalo wa mora / moradi wa hao, ke ne ke ka rata ho akarelletsa mora / moradi porojekeng ya patlisiso ya ka,eo ke e tlatsa bakeng sa dithuto tsa ka tsa lengolo la thuto e phahameng ya Masters . Porojeke ya ka ya dipatlisiso e tla etswa ko ArcelorMittal Science Centre, Sebokeng.

Thutong ena, ke tla fumana mofuta wa bokgoni ka bong (self regulation) ba baithuti ba sehlopha sa leshome (10) thutong ya dipalo le ho hlahloba dintho tse ka ekelletsang ho ntshetsopele ya boiphihlelo. Bokgoni ka bong bo bua ka moralo, tlhokomelo le tekolo ya mosebetsi wa motho.

Nakong ya **moralo**, moithuti o beha dipakane tse hlakileng leho khetha merero ya ho fihlela dipakane tse. Nakong ya ho **beha leihlo ditlhokoa**, moithuti o etsa bonnete ba hore o etsa kgatelopele ho fihlella dipakane tsa hae. Qetellong, moithuti o etsa teko ho sheba hore ho tsweletse pele jwang ho fihlella dipakane tsa hae nakong ya ho **hlahloba mohato**.Hodima moo moithuti o tla hloka tsebo ya ntshetsopele ya bogoni ka bong ho theha sebaka se loketseng sa tikoloho yaho bala.

Bokgoni ka bong bo bohlokoa ho thuto ya dipalo hobane ka tlwaelo, thuto ya dipalo dipakane tsa ho ithuta di lebisa tlhokomelong le bokgoning dintlheng le mekgwa ya tshebetso, empa matsatsing ana bo bua haholo ka ho etsa kutlwisiso ya thuto ya dipalo le ho rarolla mathata a bophelo.

Bokgoni ka bong bo bua ka moo baithuti ba ka kgonang ho ithusa dithutong tsa bona. Ho nahana ho phetha karolo ya bohlokwa ho dikgato tse tharo e leng moralo, hlokomelo le tekolo ya dithulahanyo, mme ho akarelletsa ho fetola mokhwa kapa tsela ya ho ithuta.Ho nahana ke bokgoni ba ho etsa diqeto ho tloha diphihlelong ho bopa phetolo nakong e tlang e hlophisitsweng, ho phetha mosebetsi o ka katleho.

Thuto e,e ikemiseditse ho lekola hore na bokgoni ka bong bo bohlokoa ho atleheng ho lokisa mathata thutong ya dipalo.

Ke tla rata ho akarelletsa bohle baithuti ba sehlopheng sa 10 ba dipalo ba ArcelorMittal Science Centre patlisisong ka ho fumana tumello ho Lefapha la Thuto le ho mookamedi Mr Thami Mphokela ya tla e ba molebeledi wa heke. Ho tla ba le baithuti ba 130 sehlopheng 10 batla amohelwang ka 2017.

Ke hobane'ng ha mora wa hao / moradi a memelwa ho ba le seabo?

Bankakarolo ba 130 e tla ba baithuti ba sehlopha sa 10 ba dipalo ba tswang mosebetsing waka, Arcelor Mittal Science Centre (AMSC).

Kenyelletso ya dintlha bakeng sa mohlala o hlahang e tla ba bohle baithuti ba sehlopheng sa leshome (10).Ho na le dihlopha tse nne,tse pedi tse ke di rutang le dihlopha tse pedi tse rutwang ke mosebetsi mmoho le nna.Baithuti ba sehlopha sa leshome ba khethoa hobane baka rua molemo wa ho fumana bokgoni ka bong pele ba fihla sehlopheng sa 12. Ke kgetha baithuti bana, e le ke tla rata ho ntlafatsa bokgoni ba bong ba baithuti ba AMSC, ka sepheo sa ho theha hore na ntlafalo ya bokgoni ba bong e ka ntlafatsa tshebetso ya bona ya dipalong.

Boikarabelo ba mora / moradi wa hao e tla ba bofe?

Maree le Pietersen (2008a: 161)o hlalosa dipotso tse kwetseng tse nang le potso sebopeho. Dipotso tsena di behwa ka tsela e leng hore bankakarolo ba khetha karabo e le ngwe kapa tse eketsehileng (Maree & Pietersen, 2008a:161).

Dipotso tse koetseng di potlakele ho di araba le bonolo ho disekaseka. Leha ho le joalo, ho na le bothata bo bongata ke hore sena se boetse se etsahala le haeba potso e sa utloisisoe hantle, kapa monkakarolo ha a na maikutlo mabapi le taba ena (Maree & Pietersen, 2008a:164).

Dikarabelo tsa bankakarolo mabapi le tshebediso ya bokgoni ba bong bo tla lekanya ho sebediswa (closed four point Likert scale of measurement), e leng: 1. Ya qalang, 2. Ho kgona.3. Ba nang le tsebo. 4. Setsebi. Likert scale e fana ka tekanyo ya maikutlo a ba arabang (Maree & Pietersen, 2008a:167).

Lebaka la ho khetha dipotso tse koetsoeng ke ho bane puo ya moithuti ya lapeng ke Sesotho me ba fumana ho le thata ho ihlalosa ka Senyesemane se ngotsoeng.

Dipotso ditla akarelletsa dikarolo tse nne, e leng ho rera, boalosi le bohlahlobi le potso tse amana le tikoloho ya ho ithuta.

Dipotso ha dino fetang 20,di tla nka mashome a mararo metsotso ho di tlatsa. Dipotso ditla ba ka bobedi Senyesemane le Sesotho ka ha puo ya le lapeng la bona e leng Sesotho.Ho tlatsa dipotso ho tla etswa ha sekolo se tswile ka holong. Mme Alinah Masobela o tla thusa ka ho fetolela dipotso.

Puisano e tla ba sefahleho le sefahleho e tla nka hora ho e mong le e mong. Morero wa puisano ke ho fumana hore na dintho tse bapalang karolo ya bohlokoa ntshetsopele kapa ho kenya letsoho ho ntshetsopele ya bokgoni ba bong, hoamahangoa le dikarabo tse fumanweng ha ho botswa dipotso.

Dipuisano di tla etsoa ke ba ikemetseng ya nang le tsebo mosebetsing wa dipuisano bakeng sa pokello ya dintlha le tsebo ka bogoni ka bong. Ke tla khanna dipuisano ka bonna. Dipuisano di tla ngodisoa ho netefatsa hore di nepahetse. Ditlaleho di tla romelloa ho mofuputsi le baetapele ba thuto ho sheba ho nepahala le ho boloka botsitso. Mofetoledi wa sesotho o tla ba teng ho hlakisa dipelaelo.Bohle baithuti ba tla kopa ho nka karolo ho patlisiso batswa dikolong tsa Boipatong le Evaton. barutuoana ba banna le basadi ba buang Sesotho bale pakeng tsa lemo tse 16 & 18. Ke dumela ho sebetsa le batho ba tlokotsing le ho dumellana le ho kenngoa ha sehlopha sa leshome 10 ka lebaka la hore thuto e lakatsa ho ntlafatsa tshebetso ya dipalo sekolong. Ditokelo le boiketlo tsa baithuti di tla sireletsoa,bona 10.4

mme ke tla etsa bonnete ba hore ditokelo tsa baithuti le boiketlo ba bona di tla sireletsoa, ka ho sa ba pepesetse maemo a kotsi. Baithuti bohle ke barutuoa ba batsho mme puo ya hae ya ba bangata ke Sesotho. Barutuoa ba banna le ba basali ba kenyeleditsoe .

Ho gethwa ha baithuti ba khonang ho tla etsoa dihlopheng tsa bona moo dihlophadi seng di le nyenyane. Sena se tla fana ka sepakapaka sa botho le ho etsa bolokolohi bo bongata ba ho botsa dipotso tsa ho hlakisetswa. Ke tla etsa mosebetsi wa ho getha ka thuso ya motho ya ikemetseng, Mme Alinah Masobela, ya tla etsa bonnete ba hore melao-motheo ya boitshoaro e tsehetsoa nakong ya ho gethwa. Sena se tla etsoa nakong ya ngodiso ya nako ya hora e le ngoe. Diphaphusi tse ding tsa boithutelo di na le ditafole tse lekaneng le ditulo tse ka lekanang baithuti. Ditokomane tse hlalosang dipatlisiso di tla fuoa bankakarolo ba khonehang ho hlakisa dipotso tse baka bang le tsona hamorao.

Mofuputsi o na le kamano e itshetlehileng ka karolo ya halofo ya bankakarolo ka lebaka la hore o ruta ba bang ba bona.Ba bang ba bankakarolo ba rutwa ke mosebetsi mmoho le nna. Motho ya ikemetseng o tla tsamaisa tumello ya tsebo ho na le mofuputsi. Mofuputsi le baetapele ba hae ba d ithuto ba tla koetlisa motho ya ikemetseng ho ba le tsebo ya ho sebetsana le ditaba tsa lengolo la tumello. Banakarolo ba tla fana ka tumello ya ho ke nya letsoho dipatlisisong ka nako ya bona ntle le boteng ba mofuputsi. Ho tla ba le nako ya beke e fedileng pakeng tsa kopano ya tumello e tsebisitsoeng le ho fana ka tiiso ya mangolo a ngotsoeng ya bankakarolo, ya motho ya itshetlehileng ka tla bokella ho bankakarolo sekolong.

Na Mora / moradi wa ha o tla rua molemo honkeng karolo phuputso ena?

Ka ho toba, melemo eo mora / moradi wa hao a kao rua jwale ka monkakarolo e tlaba e latelang:

(1) Bokgoni ka bong bo kgothaletsa baithuti ho ba le mafolofolo le hoba mahlonoko hotsa thuto ho hlophisa le ho ilaola le mesebetsi ya bona ka boikarabelo.
(2) Bafuputsi ba etsa qeto ya hore bokgoni ka bong bo kenya letsoho tshebetsong e phahameng thutong ya dipalo.

Molemo o sa tobang o tla ba joalo:

(1) Bafuputsi ba diyunibesiti tse ding ba ka tsebiswa ka ntshetsopele ya bokgoni ka bong hara baithuti ba sehlopheng sa leshome thutong ya dipalo le ka moo bokgoni ka bong bo ka susumetsa tshebetso ya thuto ya dipalo. Bafuputsi ba ka nna ba tsweletsa dithuto tse ding ho bontsha melemo e ka ruwang ya bokgoni ka bong.

(2) Diphihlello tsa dipatlisiso di ka sebediswa ho etsa dikgothaletso ho Lefapha la Thuto, mabapi le ntlafatso ya ho ruta mekhoa ya thuto ya barutisi ba ruta dipalo ho etsa bonnete ba ntshetsopele ya bokgoni ka bong.

(3) Mokgwa wa ho ruta barutisi ba bangata ba thuto ya dipalo o ka rua molemo ho ruteng bokgoni ka bong, haeba ho na le molemo ho ntlafatsa diphetho tsa thuto ya dipalo.

Na ho na le dikotsi tsa ho akarelletsa mora / moradi wa hao patlisiso ena le hona sena se ka laolwa jwang?

Khoneho ya dikotsi thutong ena, le ka moo ke tla di laola,di ya kgutsufatswa tafoleng e ka tlase:e ka tlase:

Dikotsi	
Ho ntsha kotsi mmeleng	• Ha ho no ntsha kotsi mmeleng ho ho lebeletsweng bakeng sa ho tlatsa dipotso. • Ho phethwa ha dipotso ha hono feta metsotso e mashome a mararo (Maree & Pietersen, 2008d:159) • Ha ho dikotsi tse lebeletsweng bakeng sa Mofuputsi.
	• Puisano e tla etsahala ka mora hore sekolong, setswe bakeng se sa feteng hora. • Tjhelete ya dipalangwa le dijo di tla fuwa.
Setjhaba	• Ha ho no ba le sekgobo hoba ba tla nkakarolo.
Moruo	• Ho nka karolo patlisisong ha hono lefellwa ke bankakarolo le ho akarelletsa leha e le efe ditjeho ho barutisi kapa tahleheloa nakong ya ho ruta.
Kelello	• Ho qoba ho tshwenyeha, dipuisano di tla etswa ke motho ya buang Sesotho. • Dipotso di tla fetolelwa ka Sesotho • Mofuputsi ha no ba le tshusumetso tswelopeleng ya bankang karolo sebakeng se ke sebetsang ho sona. • Patlisiso ha e no kenya tshabo, mogathala, le matshwenyeho kapa ho jewa ke bodutu. • Ditaba tse ho bokellelwang ditla bokellwa AMSC, e leng sebaka se o ba se tsebang.

Mofuputsi o rerile bakeng sa ho fokotsa dikotsi tse ka amang patlisiso, e le hore bankakarolo ba kaba le melemo e patlisiso e ka bang le yona

Dikotsi dibonahala e le kahlolo e molemo mabapi le bohlokwa ba tsebo bo ntlafatsang ho rutwa le ho ithuta dipalo.

Ke mang ya tla ba le phihlelo ho tshedimosetso?

Sephetho sa dihlahlobo sa mora wa hao / moradi se amahangwa le lebitso la hae. Thulahanyo di tla sebediswa e le hore ho kgetholla bankakarolo ka bomong. Diphihlello di tla ba teng ho Mofuputsi , moeta-pele wa dithuto tsa hae,ya ithutang le yena le dipalopalo ho boloka lekunutu. Diphetho mabapi le patlisiso di tla amahangwa le palo ho netefatsa ho dula ho sena lebitso.

Na o tla lefuwa / fumana tefo ho nkeng karolo dithutong tsena, na hona le tefello e kenyeleditsweng?

Tjhe, o ke ke wa leshwa ho nka karolo ho ithuta.Kantle le moo, ha ho noba le ditshehenyelo tse tla patalwa

O tla tseba jwang ka diphetho?

Karabo/ tlaleho e tla fiwa batswadi bohle e le kgutswanyane le ditlhaloso mabapi le diphitlhelelo. Dipotso tsohle mabapi le tlaleho di ka lebiswa ho mofuputsi, dintlheng tsa kgolahanyo e ka tlasa mona, ho buisana ka potso ya hao.

Na ho na le engoe hape eo o lokela ho tseba ka yona kapa ho se etsa?

- O ka ikopanye le Rene Van Rooyen. ka .rooyrene @ gmail.com kapa
- 082 523,4619., Moporofesa Mary Grosser ho 083490 0501 kapa mary.grosser@nwu.ac.za haeba o na le dipotso kapa ha o thulana le mathata.
- O ka ikopanya le modulasetulo wa Humanities and Health Research Ethics Committe (Jaco Hoffman) ho 016 910 3456, jaco.hoffman@nwu.ac.za). haeba o ba le ho ameha kapo ditletlebo tse sokang di hlaloswa hantle ke mofuputsi . O ka siya molaetsa bakeng sa Tumi ho Ms Daleen Claasens (016 910 3044).

Phatlalatso ka monkakarolo

Ka ho tekena mona ka tlase, ke ………………………ke dumela ho nka karolo thuto ya patlisiso.

Ke bolela hore:

- ke bala le ho utlwisisa boitsebiso bona le foromo ya tumello le hore e ngodilwe ka puo eo ke e utlwisisang e bile ke e tsebang.
- ke bile le monyetla wa ho botsa dipotso ho motho ya fumanang tumello hammoho le mofuputsi (haeba sena e le tsela e fapaneng),mme dipotso tsohle tsa ka diile tsa arabiwa.
- ke utlwisisa hore ho honka karolo dithutong tsena ha keya qobelwa ke nkile karolo e le **boithatelo** baka.

E tekenwe ka (sebaka)…………………………………… mohla wa (letsatsi)………………..20..........

…………………………….   …………………………

Tshaeno ya monkakarolo   **Tshaeno ya bopaki**

- O ka ikopanya le nna hape   E ya   Tjhe

Phatlalatso ka motho ho fumana tumello ya hae

Nna (Lebitso)………………… ……………ke phatlhalatsa hore:

- Ke ile ka hlalosa boitsebiso bo tokomaneng ena ho ....
- Ke mo kgothalletsa hore a botse dipotso mme a nke nako e lekaneng ho di araba.
- Ke kgotsofetse hore o utlwisisa dikarolo tsohle tsa patlisiso, joalo kaha re ithutile ka hodimo
- Ke ile ka sebedisa toloko.

Saennweng ka (sebaka) ……………………………………… mohla wa (letsatsi)…………….20...

……………………………. ………………………….

Tshaeno ya motho ya fumanang tumello **Tshaeno ya paki**

Phatlalatso ka Mofuputsi e

Nna (Lebitso)………………… ……………ke phatlhalatse hore:

- Ke ile ka hlalosa boitsebiso bo tokomaneng ena ho...................................... .
- Ke mo khothalletsa hore a nke nako e lekaneng ho di araba.
- Ke kgotsofetse hore o utlwisisa dikarolo tsohle tsa patlisiso, joalo kaha re ithutile ka hodimo
- Ke ile ka sebedisa toloko.

Saennweng ka (sebaka) ……………………………………….. mohla wa (letsatsi) ……………….20...

……………………………. …………………………………

Tshaeno ya mofuputsi **Tshaeno ya paki**

APPENDIX F1
ARCELOR MITTAL PRINCIPAL CONSENT

NORTH-WEST UNIVERSITY ®
YUNIBESITI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT
VAAL TRIANGLE CAMPUS
:

PARTICIPANT INFORMATION LEAFLET AND CONSENT FORM
FOR GRADE 10 LEARNERS: ARCELOR MITTAL CENTRE PRINCIPAL

TITLE OF THE RESEARCH PROJECT: Perceptions of self-regulating skills among Grade 10 mathematics learners

REFERENCE NUMBERS:

PRINCIPAL INVESTIGATOR (RESEARCHER): A.C. van Rooyen (known as Rene)

ADDRESS WHERE RESEARCH WILL TAKE PLACE
: Arcelor Mittal Science Centre, 4 SAMUEL STREET, SEBOKENG
CONTACT NUMBER: 016 988 0507

The Grade 10 mathematics learners who take part in the Arcelor Mittal Enrichment Programme, are asked to take part in a study project that forms part of my study for a Master's degree in Education. Please take some time to read the information presented here, which will explain the parts of this project. Please ask the researcher any questions about any part that you do not fully understand. It is very important that you are fully happy and that you clearly understand what this research is about and how you could be involved. In addition, your participation is **totally your choice** and you are free to say no. You are also free to stop taking part in the study and withdraw at any time.

This study has been approved by the **Basic and Social Sciences Research Ethics Committee (BaSSREC) of the Faculty of Humanities of the North-West University (NWU)** and will be led according to the right guidelines and principles of the international Declaration of Helsinki and the ethical guidelines of the National Health Research Ethics Council. It might be necessary for the research ethics committee or relevant experts to inspect the research records to make sure that we (the researchers) are conducting research in the correct manner.

What is this research study all about?

I am Ms Rene van Rooyen, the Mathematics teacher at Arcelor Mittal Science Centre, who would like to involve the Grade 10 mathematics learners to take part in my research project, which I am completing for a Master's degree. My research project will be conducted at Arcelor Mittal Science Centre, Sebokeng.

In this study, I will determine how well developed the self-regulating skills among Grade 10 mathematics learners are, and explore the factors that contribute to the development of self-regulating skills. Self-regulating skills refer to skills for the planning, monitoring and evaluation of one's own work.

During **planning,** a self-regulated learner sets clear goals and chooses plans to achieve the goals. During the **monitoring (checking)** stage, the self-regulated learner makes sure that he/she is making progress towards reaching his goals. Finally, the self-regulated learner tests how successful he/she was in achieving his/her goals during the **evaluating** phase. In addition, self-regulating skills are also required to select a suitable study environment.

Self-regulating skills are important for mathematics because traditionally, mathematics learning goals focused on the learning of facts, but nowadays the focus is on making sense of mathematics and solving real-life problems. Self-regulating skills help learners to become masters of their own learning. A study aimed at determining self-regulating skills is vital for successful problem solving in mathematics.

I would like to include all the grade 10 mathematics learners from Arcelor Mittal Science Centre in the research by obtaining permission from the Department of Education and the Centre Manager, Mr Thami Mphokela, who will act as gatekeeper. There will be 130 grade 10 learners accepted in 2017, and who will be invited to take part in the study.

Why has your centre been invited to participate?

The 130 participants will be grade 10 mathematics learners from my own work environment, at Arcelor Mittal Science Centre (AMSC). All the grade 10 learners are invited to take part. There are four classes, two classes that I teach and two classes taught by a colleague. The grade 10s are chosen because their performance in mathematics can still benefit from acquiring drlg-regualting skills before they reach grade 12.

What will the learners' responsibilities be?

The learners will have to complete a questionnaire to indicate to me how well do they think their self-regulating skills are developed. The responses of the participants in relation to the application of self-regulating skills will be measured using a closed four-point Likert scale of measurement, namely 1=Novice, 2=Able, 3=Skilled, 4=Expert.

The questionnaire may be completed in English or Sesotho. The questionnaire will consist of four sections, namely planning, monitoring and evaluation, as well as a section on the learners' study environments. The questionnaire will not contain more than 20 questions and will take about thirty minutes to complete. Completing the questionnaire will be done after school hours in the auditorium at the Arcelor Mittal Centre.

I also want to conduct interviews with a selected group of about 16 learners after the completion of the questionnaire. Based on the questionnaire responses I will purposively select learners who appear to have well developed, average developed and fragile developed self-regulating skills, for the interviews. The interviews will be face-to-face, individual interviews of approximately one hour each. The aim of the interview is to determine the factors that the learners think play a role in the development of or contribute to the development of their self-regulating skills.

Interviews will be recorded to ensure accuracy of what is discussed during the interviews. A Sesotho interpreter will be present during the interviews, to clarify uncertainties that the learners might have about the interview questions, or to assist them in expressing their views.

All the learners who will be approached to take part in the research are from the Boipatong and Evaton township schools, Sesotho-speaking, male and female learners and between 16 and 18 years old. I acknowledge working with a vulnerable population and will ensure that the learners' rights and welfare will be protected, by not exposing them to harmful situations.

Recruitment of the possible participants will be done in the participants' register classes at the centre, where the groups are smaller. This will give a more personal atmosphere and create more freedom to ask clarification questions. I will do the recruitment with the assistance of an independent person, Ms Alinah Mosabala, who will ensure that ethical principles are upheld during the recruitment. Participants will receive a hand-out that will explain the research. After the recruitment session, participants will receive an informed consent form to sign. The parents of the participants will also receive and informed consent form that they need to sign and return to the researcher. Participants will be required to give permission to take part in the research it their own time without the presence of the researcher. There will be a week's time lapse between the recruitment/information session and the handing in of the written permission forms of the parents and the learners.

Will the learners benefit from taking part in this research?

The actual benefits for a participant will probably be the following:

Self-regulating skills could help learners to develop an active and independent approach to learning.

Self-regulating skills could contribute to higher achievement in mathematics.

The benefits that are indirectly gained will most probably be that:

Researchers at other universities could be informed about the development of self-regulating skills among grade 10 mathematics learners and how self-regulating skills influence mathematics performance. They can conduct further studies in other contexts to prove the benefits of self-regulating skills.

The research findings could be used to make recommendations to the Department of Education, regarding the possible improvement of the teaching practises of mathematics teachers to ensure the development of self-regulating skills.

The teaching practise of the greater population of mathematics teachers could benefit from teaching self-regulating skills, as self-regulating skills could contribute to improving mathematics results.

Are there risks involved in the learners taking part in this research and how will these be managed?

The possible risks in this study, and how I will manage them, are summarised in the table below:

Risks	
Physical harm	• No physical harm is • foreseen for completing the questionnaire. • The questionnaire completion will not exceed 30 minutes (Maree & Pietersen, 2008d:159).
	• The interview will take place after school, for not more than an hour. • Transport money and refreshments will be provided.
Social	• No embarrassment of participants will take place. Interviews will be conducted on an individual basis with participants, and all information will be kept confidential.
Economic	• Taking part in the research will not involve any costs to the participants or loss in teaching time.
Psychological	• To avoid fear, that could possible exist during the interviews, the researcher will be assisted by a Sesotho-speaking person to clarify information to the learners which they might not understand, and to convey a

	learners' responses to the researcher if language becomes a barrier. • The questionnaire will also be translated into Sesotho. • Research will have no influence on the participants' progress at the centre, or at school. • The research does not involve any interference that could cause fear, tiredness, anxiety or boredom. All data collection will be done at AMSC, which is a very comfortable setting that learners are familiar with.

The researcher has planned for proper measures to minimise research-related risks, so that the learners could experience the benefits that the research could hold. The risks appear to be reasonable in relation to the importance of knowledge to be gained that can possibly improve the teaching and learning of mathematics.

Who will have access to the data?

The questionnaire results will not be linked to a learners' name. A number process will be used in order to identify participants individually. The data will only be available to the researcher, her study leader, co-study leader and the Statistical Services to secure confidentiality. All results regarding the research will be linked to a number to ensure that responses remain anonymous.

What will happen to the data?

All information regarding the research will be stored in a password-protected computer. The data obtained will be held in a locked cupboard at AMSC for five years. The researcher is the only person with a key to unlock the cupboard.

Will learners be paid/compensated to take part in this study and are there any costs involved?

No, learners will not be paid to take part in the study, but refreshments will be provided. If participating in the research means that learners have to travel, specifically for the purpose of participating, then their travel costs will be paid. There will thus be no costs involved for learners.

How will you know about the findings?

Feedback will be given to all parents in a short report and explanations regarding the research findings. All questions about the report can be directed to the researcher, at the contact details below, to discuss your questions.

Is there anything else that you should know or do?

- You can contact Rene van Rooyen at rooyrene@gmail.com or 082 523.4619, or
- Prof Mary Grosser at 083490 0501 or mary.grosser@nwu.ac.za if you have any further queries or encounter any problems.

You can contact the chair of the BaSSREC (Prof. Jaco Hoffman) at 016 910 3456 or jaco.hoffman@nwu.ac.za if you have any concerns or complaints that have not been adequately addressed by the researcher.

If you have difficulty in following and understanding the explanation of the research, please contact the researcher at the details below, and she will arrange a time with you to meet with you to explain what is problematic to you. The researcher will involve an interpreter to assist you in understanding the detail of the research project, if the need arises.

You will receive a copy of this information and consent form for your own records.

Declaration by participants

By signing below, I ………………………………..…………agree that I (Arcelor Mittal Centre) will take part in a research study entitled: **Perceptions of self-regulating skills among Grade 10 mathematics learners**

I declare that:

- I have read and understood this information and consent form and it is written in a language with which I am fluent and comfortable.
- I have had a chance to ask questions to both the person obtaining consent, as well as the researcher (if this is a different person), and all my questions have been adequately answered.
- I understand that taking part in this study is **voluntary** and I have not been pressurised to give consent to take part.
- I understand that the research findings could be reproduced publically and/or quoted, but without reference to my personal identity.
- Learners may choose to leave the study at any time and will not be penalised or prejudiced in any way.
- Learners may be asked to leave the study before it has finished if the researcher feels it is in their best interests, or if they do not follow the study plan as agreed to.

Signed at (*place*) ....…......……………….. on (*date*) …………...……….. 20....

....

Signature of participant **Signature of witness**

- You may contact me again ☐ **Yes** ☐ **No**
- I would like a summary of the findings of this research ☐ **Yes** ☐ **No**

The best way to reach me is:

Name & Surname: ____

Postal Address: ____

Email: ____

Phone Number: ____________________

Cell Phone Number: ____________________

In case the above details change, please contact the following person who knows me well, who does not live with me and who will help you to contact me:

Name & Surname:

____

Phone/ Cell Phone Number /Email:

____

Declaration by person obtaining consent

I *(name)* …………………………………………..……… declare that:

- I explained the information in this document to …………………………………..
- I encouraged him/her to ask questions and took sufficient time to answer them.
- I am satisfied that he/she adequately understands all aspects of the research, as discussed above
- I did/did not use an interpreter.

Signed at (*place*) ....…......……………….. on (*date*) …………....……….. 20....

....

Signature of person obtaining consent **Signature of witness**

Declaration by researcher

I *(name)* …………………………………………..……… declare that:

- I explained the information in this document to …………………………………..
- I encouraged him/her to ask questions and took sufficient time to answer them.
- I am satisfied that he/she adequately understands all aspects of the research, as discussed above
- I did/did not use a interpreter.

Signed at (*place*) ....…......……………….. on (*date*) …………....……….. 20....

....

Signature of independent researcher **Signature of witness**

APPENDIX F2
SCHOOL PRINCIPAL CONSENT

NORTH-WEST UNIVERSITY ®
YUNIBESITI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT
: VAAL TRIANGLE CAMPUS

PARTICIPANT INFORMATION LEAFLET AND CONSENT FORM
FOR GRADE 10 LEARNERS: SCHOOL PRINCIPAL

TITLE OF THE RESEARCH PROJECT: Perceptions of self-regulating skills among Grade 10 mathematics learners

REFERENCE NUMBERS:
PRINCIPAL INVESTIGATOR: A.C. van Rooyen (known as Rene)
ADDRESS WHERE RESEARCH WILL TAKE PLACE: Schools of learners in Evaton and Boipatong
CONTACT NUMBER: 016 988 0507

Your Grade 10 mathematics learners who receive enrichment training at Arcelor Mittal Science Cente are asked to take part in a study project that forms part of my study for a Master’s degree in Education. Please take some time to read the information presented here, which will explain the parts of this project. Please ask the researcher any questions about any part that you do not fully understand. It is very important that you are fully happy and that you clearly understand what this research is about and how you could be involved. In addition, your participation is **totally your choice** and you are free to say no. You are also free to stop taking part in the study and withdraw at any time.

This study has been approved by the **Basic and Social Sciences Research Ethics Committee (BaSSREC) of the Faculty of Humanities of the North-West University (NWU)** and will be led according to the right guidelines and principles of the international Declaration of Helsinki and the ethical guidelines of the National Health Research Ethics Council. It might be necessary for the research ethics committee or relevant experts to inspect the research records to make sure that we (the researchers) are conducting research in the correct manner.

What is this research study all about?

I am Ms Rene van Rooyen, the Mathematics educator at Arcelor Mittal Science Centre, who would like to involve you to take part in my research project, which I am completing for a Master's degree. My research project will be conducted at Arcelor Mittal Science Centre, Sebokeng.

In this study, I will determine how well developed the self-regulating (SR) skills among Grade 10 mathematics learners are, and explore the factors that contribute to the development of SR skills. SR skills refer to the planning, monitoring and evaluation of one's own work, and to secure a suitable study environment.

During **planning,** a self-regulated learner sets clear goals and chooses plans to achieve the goals. During the **monitoring (checking)** stage, the self-regulated learner makes sure that he/she is making progress towards reaching his goals. Finally, the self-regulated learner tests how successful he/she was in achieving his/her goals during the **evaluating** phase. Self-regulating skills are important for mathematics because traditionally, mathematics learning goals focused on the learning of facts, but nowadays the focus is on making sense of mathematics and solving real-life problems. Self-regulating skills help learners to become masters of their own learning. A study aimed at determining self-regulating skills is vital for successful problem solving in mathematics.

I would like to include all the grade 10 mathematics learners from Arcelor Mittal Science Centre in the research by obtaining permission from the Department of Education and the Centre Manager, Mr Thami Mphokela, who will act as gatekeeper. There will be 130 grade 10 learners accepted in 2017, and who will be invited to take part in the study.

Why have the learners been invited to participate?

The 130 participants will be grade 10 mathematics learners from my own work environment, at Arcelor Mittal Science Centre (AMSC). All the grade 10 learners are invited to take part. There are four classes, two classes that I teach and two classes taught by a colleague. The grade 10s are chosen because their performance in mathematics can still benefit from acquiring SR skills before they reach Grade 12.

What will the learners' responsibilities be?

They will have to complete a questionnaire to indicate to me how well do they think their SR skills are developed. The responses of the participants in relation to the application of self-regulating skills will be measured using a closed four-point Likert scale of measurement, namely 1=Novice, 2=Able, 3=Skilled, 4=Expert.

The questionnaire may be completed in English or Sesotho. The questionnaire will consist of four sections, namely planning, monitoring and evaluation, and study environment. The questionnaire will not contain more than 20 questions and will take about thirty minutes to complete. Completing the questionnaire should be done after school hours, or during a slot on the time table that will not interfere with teaching time.

I also want to conduct interviews with a selected group of about 15 learners after the completion of the questionnaire. Based on the questionnaire responses participants will be purposively selected learners who appear to have well developed, average developed and fragile developed self-regulating skills, for the interviews. The interviews will be face-to-face, individual interviews of approximately one hour each. The aim of the interview is to determine the factors that the learners think play a role in the development of or contribute to the development of their self-regulating skills.

Interviews will be recorded to ensure accuracy of what is discussed during the interviews. A Sesotho interpreter will be present during the interviews, to clarify uncertainties that the learners might have about the interview questions, or to assist them in expressing their views.

All the learners who will be approached to take part in the research are from Boipatong and Evaton township schools, Sesotho-speaking, male and female learners and between 16 and 18 years old. I acknowledge working with a vulnerable population and will ensure that the learners' rights and welfare will be protected, by not exposing them to harmful situations.

Recruitment of the possible participants will be done in the participants' mathematics classes where the groups are smaller, after school. This will give a more personal atmosphere and create more freedom to ask clarification questions. I will do the recruitment of participants personally, and will be assisted by one of my Sesotho-speaking colleagues, Mrs Alinah Mosabela who will ensure that ethical principles are upheld during the recruitment. Participants will receive a power-point hand-out that will explain the research. After the recruitment session, participants will receive an informed consent form to sign. The parents of the participants will also receive and informed consent form that they need to sign and return to the researcher. Participants will be required to give permission to take part in the research it their own time without the presence of the researcher. There will be a week's time lapse between the recruitment/information session and the handing in of the written permission forms of the parents and the learners.

Will the learners benefit from taking part in this research?

The actual benefits for a participant will probably be the following:

(1) Self-regulating skills could help learners to develop an active and independent approach to learning.

(2) Self-regulating skills could contribute to higher achievement in mathematics.

The benefits that are indirectly gained will most probably be that:

(1) Researchers at other universities could be informed about the development of self-regulating skills among grade 10 mathematics learners and how SR skills

influence mathematics performance. They can conduct further studies in other contexts to prove the benefits of self-regulating skills.

(2) The research findings could be used to make recommendations to the Department of Education, regarding the possible improvement of the teaching practises of mathematics teachers to ensure the development of self-regulating skills.

(3) The teaching practise of the greater population of mathematics teachers could benefit from teaching self-regulating skills, as self-regulating skills could contribute to improving mathematics results.

Are there risks involved in taking part in this research and how will these be managed?

The possible risks in this study, and how I will manage them, are summarised in the table below:

Probable/possible risks/discomforts	**Strategies to minimize risk/discomfort**
Conflict of interest and the power relationship because the researcher will also be a teacher at the AMSC.	The researcher acknowledges that the group of participants will be a vulnerable group due to the conflict of interest and hierarchical teacher-learner relationship that will exist, because she will be a teacher at AMSC. However, the use of an independent person, in this case the study leader of the researcher to do the recruitment of the participants, obtain informed oneconsent, administer data collection and verify the findings of the study, will avoid that participants feel coerced to take part in the research, and avoid them being influenced by the teacher-learner relationship. Vulnerability could be reduced in this way. The independent person will not know or have any contact with the participants and do not teach any of the participants. This will ensure that, the participants' will not be forced to do

	something against their will, or be threatened, pressurised or persuaded with force to take part in the study to please their teacher.
Completing questionnaires and taking part in interviews might cause anxiety and stress, and inconvenience participants to remain after school for 1 hour to take part in interviews.	The independent person, who will do the recruitment, obtain informed consent and collect the data, will explain the following to the participants. (i) They do not need to prepare or study for the completion of the questionnaire and the interviews. (ii) The data collection with the questionnaire will take place at times convenient to the participants, preferably after school at the center to avoid additional traveling to complete the questionnaire. Refreshments will be provided after the completion of the questionnaire. The interviews will take place after school hours for approximately one hour. (iii) The questionnaires and interviews will not influence the participants' passing or failing mathematics. (iv) The data will only be used for research purposes to find out if the self-regulating skills of the Grade 10 mathematics learners are developed or not. (v) Data collection will not overburden the participants. The questionnaire completion will not exceed 30 minutes, and not disturb teaching time. Refreshments will be given after the completion of the questionnaire. The interview will take place after school, for no longer than an hour. Transport money and refreshments will be provided by the researcher. (vi) To avoid anxiety, the recruiting, informed consent completion of the questionnaires and conducting

	the interviews will be observed by a Sesotho-speaking person who could help with uncertainties and explanations in the home language of the participants. (vii) The questionnaire will also be translated into Sesotho.
Complete anonymity cannot be guaranteed	In order to identify which participants are experts or novices in terms of the development of self-regulating skills for the purpose of the interviews, numbers will be linked to the names of learners on a class list. The numbers will be used when the questionnaires are completed, and afterwards linked to the name of the student. The researcher will not know the numbers and names of learners, as the independent person will do the selection of the participants for the interviews.

The researcher has planned for proper measures to minimise research-related risks, so that the learners could experience the benefits that the research could hold. The risks appear to be reasonable in relation to the importance of knowledge to be gained that can possibly improve the teaching and learning of mathematics.

Who will have access to the data?

The questionnaire responses will not be linked to your name. A number process will be used in order to identify participants individually. The data will only be available to the researcher, her study leader, co-study leader and the Statistical Services to secure confidentiality. All results regarding the research will be linked to a number to ensure that responses remain anonymous.

What will happen to the data?

All information regarding the research will be stored in a password-protected computer. The data obtained will be held in a locked cupboard at AMSC for five years. The researcher is the only person with a key to unlock the cupboard.

Will learners be paid/compensated to take part in this study and are there any costs involved?

No, they will not be paid to take part in the study, but refreshments will be provided. If participating in the research means that they have to travel, specifically for the purpose of participating, then their travel costs will be paid. There will thus be no costs involved for the learners.

How will you know about the findings?

Feedback will be given to all participants in a short report as well as explanations regarding the research findings. All questions about the report can be directed to the researcher, at the contact details below, to discuss your questions.

Is there anything else that you should know or do?

- You can contact Rene van Rooyen at rooyrene@gmail.com or 082 523.4619, or
- Prof Mary Grosser at 083490 0501 or mary.grosser@nwu.ac.za if you have any further queries or encounter any problems.

You can contact the chair of the BaSSREC (Prof. Jaco Hoffman) at 016 910 3456 or jaco.hoffman@nwu.ac.za if you have any concerns or complaints that have not been adequately addressed by the researcher.

If you have difficulty in following and understanding the explanation of the research, please contact the researcher at the details below, and she will arrange a time with you to meet with you to explain what is problematic to you. The researcher will involve an interpreter to assist you in understanding the detail of the research project, if the need arises.

You will receive a copy of this information and consent form for your own records.

Declaration by participants

By signing below, I ……………………………….………….agree that I will take part in a research study entitled: **Perceptions of self-regulating skills among Grade 10 mathematics learners**

I declare that:

- I have read and understood this information and consent form and it is written in a language with which I am fluent and comfortable.
- I have had a chance to ask questions to both the person obtaining consent, as well as the researcher (if this is a different person), and all my questions have been adequately answered.
- I understand that taking part in this study is **voluntary** and I have not been pressurised to give consent to take part.
- I understand that the research findings could be reproduced publically and/or quoted, but without reference to my school's personal identity or me.
- Learners may choose to leave the study at any time and will not be penalised or prejudiced in any way.
- A learner may be asked to leave the study before it has finished if the researcher feels it is in his/her best interests, or if he/she does not follow the study plan as agreed to.

Signed at (*place*) ....…........…………….. on (*date*) …………..……….. 20....

....	....
Signature of participant	**Signature of witness**

- You may contact me again ☐ **Yes** ☐ **No**
- I would like a summary of the findings of this research ☐ **Yes** ☐ **No**

The best way to reach me is:

Name & Surname: ____

Postal Address: ____

Email: ____

Phone Number: ____________________

Cell Phone Number: ____________________

In case the above details change, please contact the following person who knows me well, who does not live with me and who will help you to contact me:

Name & Surname:

____

Phone/ Cell Phone Number /Email:

____

Declaration by person obtaining consent

I *(name)* …………………………………………………..……… declare that:

- I explained the information in this document to …………………………………..
- I encouraged him/her to ask questions and took sufficient time to answer them.
- I am satisfied that he/she adequately understands all aspects of the research, as discussed above
- I did/did not use an interpreter.

Signed at (*place*) ....…........…………….. on (*date*) …………...……….. 20....

....

Signature of person obtaining consent **Signature of witness**

Declaration by researcher

I *(name)* …………………………………………..……… declare that:

- I explained the information in this document to …………………………………..
- I encouraged him/her to ask questions and took sufficient time to answer them.
- I am satisfied that he/she adequately understands all aspects of the research, as discussed above
- I did/did not use a interpreter.

Signed at (*place*) ....…........…………….. on (*date*) …………...……….. 20....

....

Signature of independent researcher **Signature of witness**

APPENDIX G1

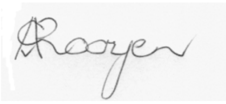
QUESTIONNAIRE ENGLISH

NORTH-WEST UNIVERSITY
YUNIBESITI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT
VAAL TRIANGLE CAMPUS

QUESTIONNAIRE TO LEARNERS

Dear Learner

You have indicated that you are willing to participate in the research project, which I am conducting to obtain my Master's Degree at the North-West University, Vaal Triangle Campus. My research focuses on describing and exploring the development of self-regulating skills among grade 10 mathematics learners. I will appreciate it if you could complete the questionnaire below that requests of you to judge the development of your self-regulating skills, namely how well you can plan, monitor and evaluate yourself when doing mathematics tasks, as well as how you manage to secure a suitable study environment. You will complete the questionnaire anonymously and all information will be handled with the utmost confidentiality. If you do not feel comfortable answering the questions, you may withdraw at any time. Thank you, your time and cooperation are valued.



Mrs van Rooyen

SECTION A: BIOGRAPHIC INFORMATION

Complete the following information about yourself by marking with an X in the appropriate block:

1.	Gender	Male	Female

2.	Have you ever repeated grade 10?	Yes	No

3.	Who do you live with:	Both parents	Single parent	Guardian	Alone with other brothers and sisters

Explanation of words:

Novice = someone with no or little experience and knowledge.

Able = someone with limited experience and knowledge.

Skilled = having experience and knowledge to do something well.

Expert = a very experienced and knowledgeable learner

SECTION B PLANNING

Read the following statements and rate your planning skills on the numerical scale from 1-4 with an X where you feel it is applicable.	Novice	Able	Skilled	Expert
1.1 I plan how I am going to do a maths task before I begin.	1	2	3	4
1.2 I make sure that I know what I am going to learn before I start a maths task.	1	2	3	4
1.3 I plan how much time I will need to complete a maths task before I start the task.	1	2	3	4
1.4 I set goals for myself which I want to achieve before I start a maths task.	1	2	3	4
1.5 I know what strategies to use to complete maths tasks.	1	2	3	4

SECTION C MONITORING

Read the following statements and evaluate your skills on the numerical scale from 1-4 with an X where you feel it is applicable.	Novice	Able	Skilled	Expert
2.1 When I am busy doing a maths task, I ask myself questions to make sure I understand what I am busy doing.	1	2	3	4
2.2 When I am doing a maths task, I can rectify my mistakes on my own if I do something wrong.	1	2	3	4
2.3 When I am doing a maths task, I ask myself continuously if I understand what I am doing.	1	2	3	4
2.4 When I am doing a maths task, I stay motivated to continue even if I experience problems.	1	2	3	4
2.5 When doing a maths task I am able to keep track of my progress.	1	2	3	4

SECTION D EVALUATION

Read the following statements and evaluate your skills on completing the mathematical tasks on your numerical scale from 1-4 with an X where you feel it is applicable.	**Novice**	**Able**	**Skilled**	**Expert**
3.1 After completing a maths task, I know how to check if I have achieved the goals of the task.	1	2	3	4
3.2 After completing a mathematic task, I set new goals that I would like to achieve.	1	2	3	4
3.3 After completing a mathematics task, I can explain what I learned.	1	2	3	4
3.4. While I am working on a mathematics task, I stay motivated until I have completed the task.	1	2	3	4
3.5 When completing a maths task, I feel confident that I will succeed.	1	2	3	4

SECTION E STUDY ENVIRONMENT

Read the following statements and evaluate your study environment when completing mathematical tasks on your numerical scale from 1-4 with an X where you feel it is applicable.	**Almost always**	**Often**	**Some-times**	**Almost never**
4.1 I have good study conditions when I want to work on my mathematical tasks	1	2	3	4
4.2 I have enough support to assist me in completing my mathematical tasks	1	2	3	4
4.3 I can identify the obstacles/problems that hinder me to complete my mathematical tasks	1	2	3	4
4.4 When I am doing a maths task, I plan to allow myself enough time to complete the task.	1	2	3	4

Explanatory words:

Almost Always: On a daily basis

Often: Three to four times a week

Sometimes: Twice a week

Almost never: Once a week

APPENDIX G2
QUESTIONNAIRE SESOTHO

NORTH-WEST UNIVERSITY
YUNIBESITI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT
VAAL TRIANGLE CAMPUS

Hlaloso le hlahlobo ntshetsopele ya bokgoni ka bong hara baithuti ba dipalo sehlopheng sa leshome.

DIPOTSO TSA BAITHUTI (Learners)

Moithuti ya ratehang

O bontshitse hore o ikemiseditse ho kenya letsoho ka ho nka karolo porojeke ya dipatlisiso eo ke e kgannang ho fumana dithuto tsa ka tsa Masters Universithing ya North West Vaal Triangle Campus. Patlisiso ya ka e bua ka hlaloso le hlahlobo ntshetsopele ya bokgoni ka bong hara baithuti ba dipalo sehlopheng sa leshome. Ke tla ananela ha o ka tlatsa dipotso tse ka tlaase mona ho fumana hore na hantle bokgoni ka bong thutong ya dipalo bo hodile jwang,hore na o ka rera le ho ihlahloba,ha o etsa mosebetsi wa dipalo,le ho gona ho sireletsa tikoloho yaho ithuta. O tla tlatsa dipotso ntle le ho tsejwa mme boitsebiso bohle bo tla sebetsoa ka lekunutu. Haeba o sa phuthulloha ho araba dipotso tse, o ka nna wa ikgula nako engwe le engwe. Ke ya leboha, nako ya hao le tshebedisano di ya ananeloa.

Mme: van Rooyen. ………..

KAROLO YA A: TSA BOTHO BAKA

Tlatsa hlahisoleseding e latelang ka wena ka ho tshwaya X lebokosong le loketseng:

1.	Bong	Motona	Motshehadi

2.	Na o kile wa pheta sehlopha sa leshome?	Ee / Nnete	Tjhe

3.	O phela le:	Batswadi ka bodedi	Motswadi a le mong	Mohlokomedi

Hlaloso ya mantsoe

Ya qalang = Ke motho ya senang kapa ya nang le bokgoni le tsebo e nyenyane.

Ho kgona = ke motho ya nang le bokgoni bo lekaneng

Tsebo = hoba le bokgoni le tsebo baho etsa dintho hantle

Ya hlahlwa = moithuti ya nang le boiphihlelo le tsebo

KAROLO YA B: HO HLOPHISA

Bala dipolelo tse latelang o lekanye thulahanyo ya hao ho tekanyo ya dipalo ya ho tloha 1-4 ka X moo o ikutlwang ho hlokeya feela ho tshwaneleha. Hlophiso ke ho bopa leano la ho finyella karabo ya bothata ba dipalo.	**Ya qalang**	**Kgona**	**Tsebo**	**Ya hlwahlwa**
1.				
1.2 Ke rera hore na ke tla etsa jwang mosebetsi wa dipalo pele ke o qala.	1	2	3	4
1.2 Ke etsa bo nnete ba hore ke tseba seo ke tla ithuta pele ke qala mosebetsi wa dipalo	1	2	3	4
1.3 Ke rera nako eo ke tla e hloka ho qeta mosebetsi wa dipalo pele ke o qala.	1	2	3	4
1.4 Ke ipehela dipakane bakeng sa seo ke batlang ho se finyella pele ke qala mosebetsi wa dipalo.	1	2	3	4
1.5 Kea tseba hore na ke mekhoa efe e ke lokelang ke ho isebedisa ho qeta mosebetsi wa dipalo.	1	2	3	4

KAROLO YA C: TEKOLO

Bala dipolelo tse latelang le ho hlahloba tshebetso ya hao ya ho tlatsa bothata ba dipalo / mosebetsi wa dipalo ka tekanyo ya dipalo ho tloha 1-4 ka X moo o ikutlwa o feela ho tshwaneleha.	Ya qalang	Kgona	Tsebo	Ya hlwahlwa
2.				
2.1 Ha ke etsa mosebetsi wa dipalo, ke ipotsa dipotso,hore ke etse bonnete bahore ke utlwisisa seo kese etsang	1	2	3	4
2.2 Ha ke etsa mosebetsi wa dipalo,ke ka gona holokisa diphoso ka bonna ha ho na le phoso eo ke entseng.	1	2	3	4
2.3 Ha ke etsa mosebetsi wa dipalo, ke ipotsa ka mehla hore utlwisisa seo ke se etsang.	1	2	3	4
2.4 Ha ke etsa mosebetsi wa dipalo,ke dula ke susumeletseha le ha ke kopana le mathata.	1	2	3	4
2.5 Ha ke etsa mosebetsi wa dipalo,ke gona ho boloka tlaleho ya tsoelopele ya ka.	1	2	3	4

KAROLO YA D: HO HLAHLOBA

Bala dipolelo tse latelang le ho hlahloba tshebetso ya hao ya dipalo ka tekanyo ho tloha 1-4 ka ho tshwaya X moo o ikutlwa ho tshwaneleha.	Ya qalang	Kgona	Tsebo	Ya hlwahlwa
3.				
3.2 Ka mora ho qeta mosebetsi wa dipalo,ke tseba ho hlahloba hore na ke finyelletse dipakane tsa mosebetsi.	1	2	3	4
3.3 Ka mora ho qeta mosebetsi wa dipalo,ke ipehela dipakane tse ncha tseo nka lakatsang ho difinyella.	1	2	3	4
3.3 Ka mora ho qeta mosebetsi wa dipalo,ke ka gona ho hlalosa seo ke ithutileng sona.	1	2	3	4
3.4 Ha kentse ke sebetsa mosebetsi wa dipalo,ke dula ke susumetseoa ho fihlela ke qetile mosebetsi ona.	1	2	3	4
3.5 Ha ke qetile mosebetsi wa dipalo,ke ikutloa ke kholisehile hore ke tla atleha.	1	2	3	4

Hlaloso ya mantsoe

Kamehla: letsatsi le leng le le leng

Hangata: ha raro le ha nne mo bekeng

Ka dinako tse ding: Habedi mo bekeng

Hoo e ka bang ha ho mohla : Ha ngwe mo bekeng.

APPENDIX H
INTERVIEW QUESTIONS

Interview questions

The same set of questions were used for both groups of participants to establish what factors influence their self-regulating skills to be well-developed/not well-developed. Wording of the questions were adapted during the interview sessions to engage in a conversation with the learners about their questionnaire responses, rather than just posing questions and waiting for answers.

Question 1: Explain the factors that possibly influence the development of your self-regulating skills to plan effectively when doing mathematics.

Question 2: Explain the factors that possibly influence the development of your self-regulating skills to monitor work effectively.

Question 3: Explain the factors that possibly influence the development of your self-regulating skills to evaluate mathematics task outcomes.

Question 4: Do you have a specific study environment? Please describe your study environment.

Question 5: Explain how your mathematics teachers contribute to the development of your self-regulating skills to plan, monitor and evaluate your work.

Question 6: Can you tell me more about how you seek help and obtain other resources to help you in completing a mathematics task?

Question 7: Please tell me how motivated you are to do mathematics.

APPENDIX I

EXAMPLE OF CODING (PARTICIPANT 16)

Questions	Participant 16 Open coding	Axial coding
	1. Hi, good morning. 2. Good morning. 3. I'm Mrs van Rooyen from ArcelorMittal Science 4. Centre. 5. Hi. 6. And I am doing research on self-regulated learning. 7. I want to, really thank you, that you are here. 8. Yah, thank you Mam. 9. Right, and you did sign a consent form? 10. Yes, I did. 11. And your parents also did sign the consent form/ 12. Yes, they did. 13. Right thank you. 14. Now we did the questionnaire and I am just going to 15. refresh our minds. It was on planning, 16. a-ha 17. and monitoring and evaluation. 18. Ya. 19. Ok. The planning is before you start your maths task, 20. you set goals for yourself. 21. a-ha 22. you plan your time you are going to spend, and you	

Question 1 Explain the factors that possibly influence the development of your self-regulating skills to plan effectively when doing mathematics.	23. plan the methods that you are going to use. And 24. then, while you are doing the task you do the 25. monitoring, and that is to check your progress while 26. you are doing that, and if you are still on the right 27. track. You can correct your own mistakes while you 28. do monitoring. 29. So, monitoring is like a trial? a trial where maybe, like, 30. where you practise monitoring? 31. Ja, you check if see you are correct. 32. All right. 33. Ok. And if you see you made a mistake, you correct 34. the mistake, while you are busy with the task. 35. Yes. 36. Ok, and you also make sure that you understand what 37. you are doing. 38. Yes. 39. Ok. And the evaluation part is after you have done the 40. maths task. You check to see if you achieved your 41. goals that you set, and you set new goals for yourself, 42. and you are motivated and you are confident, while 43. you are doing it, and after you have done it. 44. Yes. 45. Ok. 46. Yes. 47. Alright. Now we are having a look at your 48. questionnaire, there it is. Ok? 49. Yes Mam.	

Question 2 Explain the factors that possibly influence the development of your self-regulating skills to monitor work effectively	50. And from your questionnaire it seems as though you can do planning, and set goals before the time. How 51. do you do it? 52. Planning? You know used to before I study with my 53. friends at the library. We usually play and not 54. studying instead of. No. so, yeh, I decided to study at 55. home and work on myself first then, yeh I started 56. planning on things that I don't know and I don't that I 57. can't work on maths. So yes. 58. Ok. And also from your questionnaire it seems you 59. find monitoring a bit difficult. 60. Yes. 61. And it is difficult to you to rectify your mistakes. Why? 62. Yah, eh . 63. Can you see if you made a mistake? 64. No. I can't see because I don't like to go back and 65. check on that I failed, maybe.	Decide to study at home independently and plan things. Plan on things I don't know Cannot see mistakes Does not like to go back and check work Checks to see if goals were achieved.
Question 3 Explain the factors that possibly influence the development of your self-regulating skills to evaluate mathematics task outcomes.	66. Ok. That is good. And also from your questionnaire it 67. seems you always check if you achieved your goal. 68. Yes, yes. 69. After you have done it? 70. Yes. 71. How do you do that? 72. How do I do? 73. The checking, to see if you have achieved your goal. 74. When I get a report and I see my marks, are my you 75. know my achievement for mathematics. So that is 76. where I see where my my weakness. Yes. 77. Ok. 78. What is your maths mark? 79. Mark?	Checks marks to see if goals were achieved. Marks indicate weaknesses

Question 4 Do you have a specific study environment? Please describe your study environment. Question5 Explain how your mathematics teachers contribute to the development of your self-regulating	80. Ja. On your report, more or less. 81. Level 5. 82. Level 5? 83. Level 5. 84. Ok. 85. Also from your questionnaire it seems as if your study 86. environment doesn't support you when studying or 87. working. 88. Yes. 89. Why? 90. That I said, like, I party when study with my friends 91. playing instead of practising. And at home nobody 92. you know helps me and try to be there for me. So 93. that's the reason cause some of the things I'm not 94. perfect so some of things I can't do on my own, or I 95. need help, and say my aunt is old too, you know, she 96. can't be able to help me. And we yah, are only 2 in 97. the house and my dad lives in Kimberley. So, like he 98. is always at work. So 99. So, it's only you and your aunt? 100. Its only me and my aunt. 101. Ok. 102. Yes. 103. Alright. 104. Here at school, what do your maths teacher do to 105. help you, to plan or to monitor or to evaluate? 106. They are Mr N, Mr N (no names for confidentiality) 107. yeh, he ask before we do some lesson, the next 108. lesson maybe he is going to teach us new lesson 109. , maybe, yeh. I can say. So, he ask that, like, do 110. we are understand that previous lesson he	Achieved Level 5 for mathematics Likes to play instead of studying Nobody at home to help Lives with aunt who is too old to help. Teacher checks for understanding before teaching something new

skills to plan, monitor and evaluate your work	111. teached taught us. So yeh, he ask us before we 112. go to a next lesson. 113. Ok.	
Question 6 Can you tell me more about how you seek help and obtain other resources to help you in completing a mathematics task?	114. Then the last few questions. What do you do, if 115. you are not sure on how to complete a maths 116. task? 117. How do I do? 118. If don't know how to complete a maths task. What 119. do you do? 120. I just go to ask for help like, I don't just like let 121. things go. I want to understand, and you know. 122. Who do you ask? 123. My peers cause they the people I understand, you 124. know, maybe like Mbali, Miya. When your peer 125. like explains to you, you you you understand 126. more, more than someone older explains to you 127. cause like sometimes we understands by where 128. we are at our ages, cause like when I ask her	Ask help from peers if maths is not understood. Understand better when peers explain to you.
Question 7 Please tell me how motivated you are to do mathematics.	129. some personal stuff he she tell me something that 130. go to her and go for her then I'll understand. And 131. also the whole person yah. I'll understand. 132. Are you motivated to complete the tasks? 133. Yeh, yes. 134. Why? What motivates you? 135. I think about, I think about my goals and things I	Motivated to complete tasks Want to achieve goals I set own goals.

	want to achieve before I do the maths. So, yeh. Your goals Yeh Ok. And after you completed a maths task do you set new goals or do you wait for your teacher to set the goals? I set new goals cause when you wait for someone eish, it’s a waste of time sometimes. Yes. So, I set my own goals. New goals at the right time. Yah for myself. Ok. Who provide you with support to complete your tasks? My teacher. Mr N. Yes. Thank you very much.	Waiting for somebody else to set goals wastes time Teacher provides support to complete tasks

APPENDIX J

LETTER FROM LANGUAGE EDITOR

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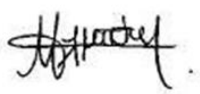
18 February 2019

To whom it may concern

This is to confirm that I, the undersigned, have language edited the completed research of Amarencia C van Rooyen for the Master of Education thesis entitled: *Perception of self-regulating skills among Grade 10 mathematics learners.*

The responsibility of implementing the recommended language changes rests with the author of the thesis.

Yours truly,



AngelikiAlbanis