EXPLORING THE EFFECT OF IMPLEMENTING INTENTIONAL TEACHING STRATEGY ON GRADE 9 LEARNERS' PERCEPTIONS OF TEACHING OF MATHEMATICS

Rita April

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Keywords

Learners' perceptions

Intentional Teaching

Feedback

Rasch analysis

Declaration

I, Rita Elizabeth April declare that "Exploring the effect of implementing intentional teaching strategy on grade 9 learners' perceptions of teaching of mathematics" is my own work and that it has not been submitted for any degree or examination in any other university. The sources I have used or quoted have been acknowledged by complete references.

Rita Elizabeth April December 2020

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Abstract

In this study I explored grade 9 learners' perceptions after the implementation of "intentional teaching". The research question is: "What are the perceptions of grade 9 learners of the teaching they experience in mathematics?" Conceptually the study is situated in "learners' perceptions" of teaching with "intentional teaching" as the context. The design used was a survey where learners had to complete a questionnaire, adapted from the Students Evaluating Accomplished Teaching-Mathematics (SEAT-M) instrument. Learners from two grade 9 classes, taught by me, participated. Rasch analysis was used to analyse the data.

It was found that learners ranked "the teacher's ability to encourage them to place a high value on mathematics" the highest. "The teacher's ability to challenge learners to think through and solve problems, either by themselves or together as a group" was ranked the lowest.

It is recommended that all role-players and teachers develop skills of authentic pedagogical dialogue to promote dynamic learning in mathematics classrooms.

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"I can do all things through Christ who strengthens"

"Nothing is impossible for those who believe"

Abbreviations

ANA	Annual National Assessments
CAPS	Curriculum and Assessment Policy Statement
DBE	Department of Basic Education
DoE	Department of Education
FET	Further Education and Training
IEA	Association for the Evaluation of Educational Achievement
LEDIMTALI	Local Evidence Mathematics Improving Teaching and Learning Initiative
MET	Measure Effective Teaching
NKJV	New Kings James Version
SEAT-M	Students Evaluating Accomplished Teaching-Mathematics
SSME	School of Science and Mathematics Education
TIMSS	Trends in International Mathematics and Science Study

Dedication

I dedicate this thesis to my Dad, Andreas April and late Mom, Maria April, for all the sacrifices they have made to give me and my sisters the best they could, including education. Thank you Mommy and Daddy.

CHAPTER 1

BACKGROUND AND OVERVIEW OF STUDY

1.1 Introduction

I have been teaching mathematics to grade 9 learners for approximately 10 years. The alarming observation throughout these years was the continued unsatisfactory learner results and limited learner achievement, especially in their high-stakes examinations. Aware of the socio-economic challenges which the learners faced, I became interested in considering ways to improve my teaching in order to improve the achievement of the learners. Consequently, I participated in different projects searching for continuing professional development dealing with techniques, strategies and approaches that would enhance the quality of my teaching in the subject, mathematics. I came across two main categories, namely: the teacher-centred approach and the student-centred approach, which I refer to as the learner-centred approach in this study. The teacher- centred approach is the traditional way of teaching while engineering education has moved towards a learner-centred learning approach which has been proven to be more effective when compared to the teacher-centred approach, especially for acquiring 21st Century skills (Radzali, Mohd-Yusof and Phang, (2018, p. 1) and Geven and Attard, (2012). Researchers have implemented many student-centred models. These include Sport Education (Casey and MacPhail (2018), Cooperative Learning (Dyson and Casey (2016) and Physical Education (Wibowo and Dyson, 2021))

However, the learner-centred approaches that I was involved in, are Inquiry Based Education (IBE) and "intentional teaching". IBE supports mathematics teachers and science teachers to move from teaching approaches characterized as traditional toward approaches based on inquiry based education (Beswick, 2021 and Van Graan, 2020). I only attended two training workshops for IBE, although I was one of the participants in the project for one year.

On the other hand, intentional teaching was and still is an integral part of the LEDIMTALI project (2016 -2021) of which I am also a participant for 6 years. The continuing professional development project's generic underlying teaching approach is "intentional teaching". This is mainly why I decided to use Intentional Teaching as the context in which I did my research.

I pondered on whether the implementation of some of the ideas dealt with in the continuing professional development initiative would meaningfully impact the Grade 9 learners' learning experience of mathematics. I applied this approach strictly for a period of 8 months for

research purposes, where after learners provided feedback on the perceptions of their experience in the teaching of mathematics. It is important to note that the study will not relate teacher competence to learner perceptions. Furthermore, it is not a requirement for learners to fully understand the pedagogical knowledge required in intentional teaching, because as a teacher, I guided them through the process, encouraging deep mathematical thinking. It is mainly a study to explore the perceptions of the learners of how they experience the teaching of mathematics.

In addition, I would also like to share a personal experience that inspires me to continue this study. Ian (I use another name) was a young boy in my mathematics class in grade 9 in 2016 at the same school where I had completed the practical component of this particular study. Ian was a quiet, very well-mannered boy. One day I discovered he could not read and he only copied that which was written on the chalkboard. Despite his situation, he tried very hard. I decided to spend more time with Ian, using the intentional teaching strategy. I taught him mathematics according to his level so that he could gain confidence in doing mathematics. As he improved, I started to apply deep mathematical thinking skills (Julie, 2013) and encouraged him to memorize the multiplication table, because I am of the opinion that memorizing multiplication tables is the exercise for brain development (Leaf, 2013). I mainly used intentional teaching techniques with him, but we still had a long way to go, because he was condoned to the next grade due to his age.

However, Ian proved to be unstoppable. He slowly, but surely started to improve. Ian started to gain self-confidence as his mathematicalness (Julie, 2013) improved and as a result, he started to focus on learning how to read. He did not only learn how to read, but he was teaching himself—sterling endeavour. Although he still failed mathematical literacy in grade 10, there was a marked improvement in his schoolwork in general.

Fortunately, I taught him again in grade 11. By now Ian's reading skill has developed much more. I requested that the school should apply to the Education Department for him to get extra time to finish his exams. I gathered all the necessary documents to apply for him, but I was informed by the coordinator that Ian's reading capacity was only 1.31, the level of a grade 1 learner, he therefore did not qualify to get extra time. Extra time was only given to learners who demonstrated academic potential, but require more time to finish the exam. I was told Ian was too weak academically. I could not understand their argument, because in my opinion, Ian was supposed to get extra time above learners who are already doing well. I argued that he would do much better in his examinations if he was only given more time. My arguments of how he improved since grades 8 and 9 carried no weight. I felt angry at the system that failed so many

of our learners, but even worse, I felt that I had failed Ian as well as so many other learners who were in the same boat as Ian.

However, Ian did not give up. He started to respond to questions in class. What was more amazing was the fact that some of his peers started to ask him how he had found the answers to certain questions. By then he had grown in confidence and even started to do body-building at the gymnasium. I continued supporting him in grade 11 and he went from strength to strength. The key question was: Would he be strong enough mathematically when he gets to matric? My heart went out to him, while I witnessed his drastic improvement in mathematics since grade 9, I feared that he was not going to improve at a fast enough rate that would enable him to pass matric. I left the school because I received a promotion as the Head of the Mathematics department at another school and did not expect to hear what I am about to share with you next.

One day, in the middle of 2019, I went to the mall and walked into one of Ian's class mates. With great excitement and enthusiasm, he told me that Ian had passed matric. What was worth mentioning was the fact that Ian had passed while some of the learners who did better than him since I taught them in grade 9 had failed in matric. He achieved the goal he had set for himself.

I agree with Moran and Gardner (2018) that human beings possess not just a single intelligence. The level of Ian's literacy in the mathematics language inspired his need to become literate in the mathematical language. I became convinced Mathematics might just be the catalyst to ignite and unlock learners' desire to initiate and develop their ability to read

1.2 Background and Rationale

The Trends in International Mathematics and Science Study (TIMSS) measured the mathematics and science knowledge of fourth and eighth grade students in some countries around the world. TIMSS was developed by the International Association for the Evaluation of Educational Achievement (IEA) to allow participating nations to compare learners' educational achievement across borders. TIMSS was conducted in South Africa for the first time in 1995 and subsequently in 1999, 2002; 2011, 2015 and 2019. Reddy (2006) and Reddy, Visser, Winnaar, Arends, Juan, and Prinsloo (2016, p. 1) analyzed the change in TIMSS mathematics scores for the 25 countries that participated in TIMSS 2003 and TIMSS 2015. Thirty-six countries participated in TIMSS 2015 at the Grade 8 level and three countries (Norway, Botswana and South Africa) at the Grade 9 level. In TIMSS 2019, the most recent in the TIMSS trend series, approximately 60 countries used TIMSS trend data for monitoring the effectiveness of their

educational systems in a global context (Mullis, 2019). "The TIMSS 2015 Encyclopedia: Education Policy and Curriculum in Mathematics and Science" provides an important resource for helping to understand the teaching and learning of mathematics…" (Mullis, Martin, Goh and Cotter, 2016, p. 4).

The TIMSS achievement scale has been set with a centre point of 500 and a standard deviation of 100. In addition to this, a set of international benchmarks have been set to provide countries with more meaningful descriptions of what learners know (Reddy, Visser, Winnaar, Arends, Juan, and Prinsloo (2016, p. 2-6) TIMSS defines four categories of benchmarks, namely:

1. scores between 400 and 475 points classifies as an achievement at a low level,
2. scores between 475 and 550 points classifies as achievement at an intermediate level,
3. scores from 550 to 625 points classifies as an achievement at a high level and
4. scores above 625 points that are classifies as achievement at an advanced level.

As indicated by Reddy *et al* (2016, pp. 2-6) in the TIMSS 2015 report, the top five countries for mathematics were from East Asia, namely: Singapore with a score of 621 followed by the Republic of Korea (606), Chinese Taipei (599), Hong Kong SAR (594) and Japan (587). The countries with the lowest performing scores as indicated in TIMSS were: Botswana (391), Jordan (386), Morocco (384), South Africa (372) and Saudi Arabia (368).

The 3 findings for South Africa indicated by Reddy *et al* (2016, p. 6) in the TIMSS report that are particularly noteworthy regarding the mathematical performance from 2003 to 2015 are:

1. Over this period, there was an improvement of 87 points for mathematics, more than for any other country with comparable data. This is equivalent to an improvement in performance of approximately two grades.
2. The highest gains were achieved at the lower end of the achievement distribution, which implies that those with the lowest levels of achievement are improving.
3. The distribution of scores between the top and the bottom performers is still wide, but has narrowed from 2003 to 2011, and again to 2015, showing a narrowing of the gap between these groups. Educational inequalities are decreasing, albeit slowly (Reddy *et al*, 2016, p. 6).

Another large-scale test conducted in South Africa is the Annual National Assessments (ANA). Results from ANA test indicate that there is a general downward trend in mathematics

test results from grade 1 to 9. The Ministry of Basic Education have introduced the ANA Test in 2008, which is one of the national strategic tools for monitoring and improving the quality of teaching and learning in schools (ANA, 2013, 2012; Pausigere & Graven, 2013). The ANA is thus a set of grade-specific state-mandated mathematics tests for Grade 1 to Grade 6 and Grade 9 learners that focusses on fundamental skills of numeracy (ANA, 2012). Furthermore, the ANA can thus be regarded as a national diagnostic instrument to assess and detect learner problems to assess progress of the education system. The report of the ANA noted that "as baseline, the average of 13% at Grade 9 levels was disturbingly low" (ANA, 2012, p. 24).

The consequences and severity of learners' poor performance in Grade 9 mathematics were also highlighted by the then Minister of Basic Education, who noted, "These results explain to a large extent why, among many other reasons, we have such high failure and dropout rates at Grades 10 and 11" (ANA, 2012, p. 2). An international study done by Thijsse (2011), involving Grade 7 and Grade 8 learners from 41 countries in which the mathematical proficiency of participants was tested, shows that South Africa scored the lowest. Furthermore, the mathematics performances of Grade 9 learners in the ANA tests in 2012, 2013 and 2014 were 13%, 14% and 10.8%, respectively (see ANA, 2014, ANA, 2013; ANA, 2012, DBE)

In light of the above, it is obvious and critical that the teaching of mathematics in South Africa has to be revised and improved in order to improve learner performance and achievement in mathematics. One of the strategies that can be followed is implementing and researching teaching approaches that have the potential to positively change mathematical performance, especially at the beginning of the high school period. A study by the Melinda and Bill Gates Foundation (Kane and Staiger, 2012) found that achievement is linked to the perceptions learners' hold of teaching. The learners who hold high perceptions of the teaching they receive, generally achieve higher than those who hold low perceptions. The perceptions are, however, linked to the teaching approaches being used by the teacher. It is on these grounds that I decided to investigate whether grade 9 learners' perceptions of the teaching of mathematics will be positively impacted if intentional teaching is implemented?

1.3 Statement of the problem

There is a general global trend that mathematics performance is steadily decreasing. However**,** this trend is even more serious in South Africa. In this study, I included learners' perceptions via feedback to identify possible areas in which I, as a teacher, might need to develop. This technique might be intimidating initially, but will definitely contribute to finding

a solution that can solve the current poor mathematics performance in South Africa. South African learners are under-performing in mathematics throughout the schooling system. (TIMMS, 2011, Department of education, 2001). Research that tries to explain the under-performance of learners in South Africa suggests that teachers generally lack both content knowledge and pedagogical skills to teach mathematics in an effective and meaningful way (Schollar, 2008 and Spaull & Kotze, 2014).

Given the importance of learners' views of the teaching they experience and the possible guidance these views can provide for the development of teaching, I pursued the perspectives learners hold of the teaching they receive.

1.4 Aim and research question

The aim of this study is to explore the perceptions of grade 9 learners of the teaching they experience in mathematics. The research question thus is:

What are the perceptions of grade 9 learners of the teaching they experience in Mathematics?

1.5 Conclusion

This chapter provided an introduction the thesis by presenting some background and motivation. Also included is the problem statement and the aim and research question.

Chapter 2 deals with the literature review and the underlying theoretical framework. The research design and the methods employed for data collection and analysis are presented in Chapter 3. The results of the study are presented in Chapter 4 and Chapter 5 concludes the study.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter consists of three sections, namely: learners' perceptions of teaching, intentional teaching and feedback. Section *one* provides a discussion that relates to the following issues: a review of literature concerning learners' perceptions of teaching in general and learners' perceptions of teaching of mathematics. I differentiate between students and learners, while globally, students are used when referring to individuals attending college, university and schools. In this study I am reserving learners for schools and students for higher education institutions. Section *two* discusses intentional teaching and elements thereof. Section *three* deals with feedback, which is an important element of intentional teaching.

2.2 Learners' Perceptions

Globally the word "students" has been used for universities, colleges and schools. However, in South Africa, the word "learners" is used to refer to young people in schools and "students" are referred to those in colleges and universities. Therefore, I will refer to students as those who are attending universities and colleges and learners those attending schools. In this study the emphasis is on learners' perceptions of teaching of mathematics in South Africa. However, I will also refer to students' perceptions in the literature. According to the English Cambridge Dictionary the meaning of perception is: a belief or opinion often held by many people and based on how things seem.

In this study I researched the beliefs and opinions of learners based on how it seems to them while they have been taught mathematics using intentional teaching by the teacher. In other words, the learners' perceptions were researched while intentional teaching was used as a technique.

The theoretical framework outlines the theory or theories that underpin the research topic. The theoretical entry point relevant to this study includes learners' perceptions and includes the work of many researchers (Ojo and Olakulehin, 2006; Marsh and Roche, 1993; Ryan and Harrison, 1995; Marsh and Hocevar, 1991; Clark, 1995; Kane and Staiger, 2012; Moloi, Dzvimbo, Potgieter, Wolhuter and Van der Walt, 2010; Jencks, Acland, Bane, Cohen, Gintis, Heyns, Michelson and Smith (1972); Teddlie and Reynolds, 2000; Steyn, Wolhuter, Oosthuizen and Van Der Walt 2003; Mckenzie and Van Winkelen, 2004; Creemers, Campbell RJ and Christofidou (2002) Creemers and Kyriakides, 2008a; Creemers and Kyriakides, 2008b;

Creemers and Kyriakides, 2009; Kyriakides and Creemers, 2008 and Adu, Adu and Chikungwa) about the teacher teaching mathematics while the approach, "intentional teaching" (Epstein, 2011; Julie, 2013) was used as the context in which the teaching took place.

2.2.1 Learners' Perceptions of Teaching

In this section I give a description of the learners' perceptions of teaching in general, followed by their perceptions to the teaching of mathematics specifically. Where researchers have used the word "students" in schools, I refer to learners from here onwards, depending on the context and except when a direct quotation is written. According to Ojo and Olakulehin (2006), universities and schools have the spotlight on the students' and learners' perceptions of teaching. Therefore, I will first refer to students' perception before I describe learners' perceptions which is a crucial part of this study.

2.2.1.1 Students' perceptions of teaching

Ojo and Olakulehin (2006) assert that the notion of asking students to provide feedback on the quality of the teaching that they encounter during their academic careers have been with us for almost a century.

Marsh and Roche (1993) researched students' evaluations of teaching effectiveness as a means of enhancing teaching. They evaluated the effect of interventions into instructor behaviours. Instructor behaviours were informed by evaluations conducted at midterm and end-of-term. Marsh and Roche (1993) are of the opinion that factors contributing to the effectiveness of teaching could be improved if the intervention included concrete strategies to facilitate the enhancement of specific areas of instruction.

Ryan and Harrison (1995) investigated how students weighed various teaching components in arriving at their overall evaluation of teaching effectiveness. Ralph (2003) conducted a study on teaching effectiveness using how well students learn as the criterion. This study took place at a Canadian university where these students were given 32 hypothetical instructor profiles and were asked to rank nine selected teaching factors developed by Marsh and Hocevar (1991). In his study Ralph (2003) identified five attributes of effective instructors: commitment to learners; knowledge of material; organization and management of the environment; desire to improve in collaboration with others. Ralph (2003) concluded that exemplary university teaching is discernible and the quality of components that define it can be assessed.

Similar studies provided students with a set of characteristics regarding the teacher/teaching of mathematics from which to choose (Clark, 1995). He identified cognitive and affective goals of effective teaching at the university level by developing a questionnaire covering a wide range of teaching activities associated with effective instruction and the achievement of cognitive and affective objectives. The questionnaire, administered at the University of Winnipeg, Manitoba, identified qualities of effective university teaching determined by the researcher. These included four cognitive components, namely: knowledge, organization of instruction, clarity of expression and quality of presentation. In addition, there were four affective components: student interest, student participation and openness to ideas, interpersonal relations and lastly, communication and fairness (Clark, 1995).

Many course evaluation questionnaires administered at university campuses across Canada, including Memorial University, included these qualities. Students were asked to rank each instructor on each of these qualities (Clark (1995). Up till now I mainly referred to students in universities, however, there was also research done with learners at school level.

2.2.1.2 Learners' perceptions to teaching

An institute that measured the learners' perception of teaching was The Bill and Melinda Gates Foundation. This institute measured learners' perceptions of teaching on school level, using The Measures of Effective Teaching (MET) tool (Kane and Staiger, 2012). The MET project 2012 (Kane and Staiger, 2012) included nearly 3000 teachers who volunteered helping them identify a better approach to teacher development and evaluation, located in six predominantly urban school districts across the America: Charlotte-Mecklenburg Schools, Dallas Independent School District, Denver Public Schools, Hillsborough County Public Schools (including Tampa and Florida), Memphis City Schools and the New York City Department of Education. Multiple data sources were collected and analysed over two school years, including learner achievement gains on state assessments and supplemental assessments designed to assess higher-order conceptual understanding, classroom observations and teacher reflections on their practice, assessments of teachers' pedagogical content knowledge, learner perceptions of the classroom instructional environment and teachers' perceptions of working conditions and instructional support at their schools (Kane and Staiger, 2012).

Another institute, Payame Noor University in Iran, measured language learners' perception with respect to humour (Farnia and Mohammadi, 2020). Language learners reasoned that having a sense of humour is one of the important qualities a language teacher should possess.

Their findings are that teachers and language learners acknowledged the positive effects of humour such as reducing the distance between teachers and learners, lowering learners' anxiety, boosting learners' retention of the lesson, as well as increasing their concentration and motivation (Farnia and Mohammadi, 2020).

In South Africa Moloi, Dzvimbo, Potgieter, Wolhuter and Van der Walt (2010) were searching for methods to improve school success. Some historically disadvantaged schools manage to do quite well despite their circumstances, such as dire poverty (Moloi *et al*, 2010). Their aim was to analyse and develop some of the causal factors regarding the effectiveness of three schools in deep rural Mpumalanga, by tapping the perceptions of their learners.

They have concluded what contributed to the perceptions of disadvantaged learners in those area was educational effectiveness, which might also be understood in terms of hierarchical insights and awarenesses. According to Moloi *et al* (2010) the ontological basis, which means to show the relations between concepts and categories in this case in mathematics, appears to be successful pedagogical dialogue. There was consensus among the researchers regarding the success and effectiveness of these schools could be attributed to their adherence to authentic pedagogic dialogue, an indispensable feature of authentic pedagogy (Moloi *et al* 2010).

Although the results of their study reflect the perceptions of senior secondary learners as to what may contribute to the schools' success, confirms, augments and consolidates the findings of, for example, Jencks *et al*. (1972), Steyn *et al*. (2003), Creemers *et a*l. (2002), Creemers et al. (2008a), Creemers and Kyriakides (2008b; 2009 and 2010). The themes that were identified from the data of Moloi *et al* (2010), suggest that the learners and teachers find themselves in a secure pedagogical relationship, one in which educator and learner are intrinsically connected to each other. Moloi *et al* (2010) state that both teachers and their learners' actions demonstrate purposivity and intentionality.

Moloi *et al's* (2010) results lead to the conclusion that the perceptions of impoverished, disadvantaged learners in deep rural schools in the Mpumalanga Province of South Africa with regard to what contributes to their school success may also be understood in terms of hierarchical, stacked insights and awarenesses, the ontological phenomenological basis of which seems to be successful pedagogical dialogue, with mutual acceptance as its wellspring (Moloi *et al*, 2010).

Additionally, Kane and Staiger (2012) also noted that learner perception surveys, which serve as feedback tools, can be powerful complements to other instruments. However, these

surveys can present their own set of challenges and considerations (Kane and Staiger, 2012, pp. 2-3). Kane and Staiger (2012, pp. 3) indicate that not every survey produces meaningful information on teaching well-designed learner perception surveys. Therefore, great care has to be taken when collecting data on the perceptions of learners of teaching of mathematics specifically.

2.2.2 Learners' perceptions of teaching of Mathematics

Adu, Adu and Chikungwa, (2017) focused on the learners' perceptions on the importance of utilizing teaching resources in mathematics. Their study revealed the efficacy of teaching resources for mathematics and how these resources help the educators and learners to achieve their target goals. The study concluded that effective teaching of mathematics is through availability of resources and recommended that the school should endeavour to provide more recent resources that are technologically inclined.

2.2.2.1 South African learners are underperforming in mathematics

South African learners are underperforming in mathematics throughout the schooling system. (Mullis and Martin, 2019, Reddy *et al* 2016, Department of education, 2001), Research that tries to explain the underperformance of learners in South Africa suggests that teachers generally lack both content knowledge and pedagogical skills to teach mathematics in an effective and meaningful way (Schollar, 2008). Schollar (2008) suggests that South Africa requires teachers equipped with both the necessary content and pedagogical knowledge to teach mathematics, because this has a direct effect on the learners' perceptions and feedback on the teaching of mathematics.

Therefore, if, according to Sam (2002) many learners are scared of mathematics and feel powerless in the presence of mathematical ideas, this may have alarming consequences. Consequently, according to Adeeba and Naoreena (2010) mathematics teachers should therefore not only be well-trained and qualified, but especially be motivated to activate positive attitudes among learners and deliver high-quality teaching.

In conjunction with the previous paragraph, Makgato and Mji, (2006, p. 254) also indicate that it has been reported by the DoE (200l) that outdated teaching practices and lack of basic content knowledge have resulted in poor teaching standards. According to them, some schools who offer mathematics on further education and training (FET) level do not have qualified teachers who would practice effective teaching.

Spaull (2012) states that achievement in mathematics in South Africa is abnormally poor. Furthermore, a study done by De Villiers (2007) suggests that mathematics in South Africa is perceived as a difficult subject, accessible only to the few, and that there is a critical shortage of individuals that are qualified in mathematics in South Africa.

From the foregoing descriptions, I investigated an approach, intentional teaching, that could reverse these negative perceptions and myths of mathematics and the teaching of mathematics by involving learners to be productively engaged with mathematics. This engagement with mathematics is called mathematicalness**.** At a LEDIMTALI session mathematicalness was defined as follows:

> Mathematicalness is more about competencies to do mathematics. These competencies include identifying patterns, generating examples, generating justifications, the willingness to mathematically explore, etc. So mathematicalness is developed through engagement. It comprises doing mathematics consciously. In other words, learners are conscious about their thinking process when doing mathematics, this is called metacognition: awareness and understanding of one's own thought process while being actively involved with their thoughts when they are doing mathematics. Mathematicalness is therefore required when learners are involved with deep mathematical thinking while discovering solutions to the mathematics that have been presented to them in a different manner than traditionally.

These elements form a paramount part of intentional teaching. More elements are further discussed in the next section dealing with intentional teaching.

2.3 Intentional Teaching

Intentional teaching consists of two constructs, 'intentional' and 'teaching'. In order to get a better understanding of these terms I will first describe each word.

2.3.1 Defining Intentional

According to Epstein (2011) the term "intentional" is to act purposefully, with a goal in mind and a plan for accomplishing it. She identifies that intentional acts originate from careful thought and are accompanied by consideration of their potential effects. Epstein (2011) mentions that an "intentional" teacher aims at clearly defined learning objectives for children, employing instructional strategies likely to help children achieve the objectives and continually assess progress and adjust the strategies based on that assessment. She further notes that the teacher who can explain just why she is doing what she is doing is acting intentionally—whether she is

using a strategy tentatively for the first time or automatically from long practice, as part of an elaborate set up or spontaneously in a teachable moment.

Epstein (2011) continues to say that effective teachers are intentional with respect to many facets of the learning environment, beginning with the emotional climate they create. These teachers deliberately select equipment and materials and put them in places where children will notice and want to use them. Furthermore, in planning the program day or week, intentional teachers choose which specific learning activities, contexts, and settings to use and when. And they choose when to address specific content areas, how much time to spend on them and how to integrate them. All these teacher decisions and behaviours set the tone and substance of what happens in the classroom. According to Epstein (2011) intentionality refers to how teachers interact with children.

2.3.2 Defining teaching

Epstein (2011, pp. 5-6) notes teaching is the knowledge, beliefs, attitudes, and especially the behaviours and skills teachers employ in their work with learners.

2.3.3 Intentional teaching as the approach applied in this study

"Teacher quality has become a policy concern internationally". Bradley, Sampson and Royal (2006) have made this statement since 2006 and the status quo has not improved since then. Julie (2013) and other researchers were involved in a research project, LEDIMTALI (2016 – 2021), which is underpinned by intentional teaching. Julie (2013) presented a model for teaching based on intentionality, assessment for learning and insights gained from working with teachers to develop their teaching. The evolution of the model is described and the extent to which teachers' current teaching attunes with the model is presented by Julie (2013) as follows:

> A cursory perusal of descriptions, considerations and prescriptions for improving the state of school mathematics renders that much attention is accorded to learning. This is understandable given advances in research on learning, how people come to know, the processes of how mathematical knowledge is constructed by experts for effective learning. To a certain extent deliberations on teaching have been backgrounded with the most popular notion being advanced that teaching should be some kind of facilitation.

Morrow (2007, p. 1) captures the invisibility of teaching as:

> …as our policies and plans we think very little about teaching we think that it is better to talk about 'facilitation' or 'instruction'

> …perhaps we think that teaching is no longer needed because of 'learner-centred education'
>
> … Perhaps this silence [about teaching] is due to the fact that in South Africa we no longer have any teachers, but, instead, now have 'classroom educators'.

It is time we go back to teachers, teachers who make use specifically of intentional teaching. When Epstein (2011) and Julie (2013, refer to intentional teaching, they refer to keywords and phrases like: purposes and goals of lesson, mathematical objects, the focus of the lesson must be made clear, learning intentions must be made clear and a tool providing evidence that learners understood the lesson, thinking work must be established, assessment and feedback are key elements for them.

Julie (2013) also includes spiral revision and productive practicing activities to foster mathematical thinking through appropriate questioning strategies during LEDIMTALI (2016-2021). Mathematicalness and deep mathematical thinking are terms that are now part of the vocabulary of the LEDIMTALI (2016-2021). The following paragraph will expand on other elements of intentional teaching.

2.3.4 Other elements of Intentional Teaching

In addition to the fact that teachers must act with knowledge, Epstein (2011) also notes that teachers must be determined to make sure learners acquire the skills and understanding of what has been taught. She also emphasizes that teachers always play a vital educational role by creating supportive environments and using instructional strategies to advance children's thinking to the next level (Epstein, 2011).

Another important aspect of intentional teaching is intentionality of interactions. According to Epstein (2011), intentionality refers especially to how teachers interact with children. Pianta (2003, p. 5) defines intentionality as "directed, designed interactions between children and teachers in which teachers purposefully challenge, scaffold (Julie, 2017) and extend children's skills". Berliner (1987; 1992) emphasizes that effective teaching requires intentionality in interactions with students, with an understanding of the expected outcomes of instruction. Berliner (1992, p.8) summarizes research on the relationship between classroom environment and learning outcomes in a list of elements characteristic of good intentional teaching as follows:

1. High expectations—Teachers must assume children are capable of achieving meaningful educational goals. Teachers who expect children to learn will deliberately engage in instructional activities to enhance children's knowledge and skills. Teachers' high expectations are also transmitted to children and parents, who then see themselves as active and capable participants in the learning process.

2. Planning and management—Teachers must have concrete plans to introduce subject matter and sequence children's learning. They must manage both individual behaviour and group dynamics. While guiding the class toward defined objectives, teachers remain open to pursing related topics that arise and capture children's interest.

3. Learning-oriented classroom—Children, as well as teachers, must value the classroom as a place where learning occurs. When adults act with the intention of teaching, children [will] act with the intention of learning.

4. Engaging activities—Teachers must understand how children learn and that activities and ideas connected to children's own experience are more likely to capture their interest. They must understand also that tasks pegged too far above or below children's current capabilities can undermine children's self-confidence in their ability to learn.

5. Thoughtful questioning—Teachers must pose questions to get insight into what children are thinking and to stimulate their thought processes. Rote questions and the thoughtless recitations they evoke, by contrast, not only fail to further children's learning but can derail it through boredom, resentment, or discouragement.

6. Feedback—Children naturally look to teachers for supportive and evaluative feedback, and effective teachers know when and how to provide it. Presenting information, making comments, asking questions, identifying contradictions in children's thinking, and posing "what if" challenges are hallmark strategies of intentionality. Evaluative feedback focuses on learning rather than judgment (Berliner, 1992, p. 8).

The last mentioned element, namely, feedback, is the element we elaborate on more in the following section.

2.4 Feedback

Feedback is one of the elements that contributes largely to the improved performance of learners in mathematics (Hattie, 2007). A core aspect Epstein (2007, p. 9) illuminates in her theory is feedback. She refers to feedback as follows

> Children naturally look to teachers for supportive and evaluative feedback and effective teachers know when and how to provide it. Presenting information, making comments, asking questions, identifying contradictions in children's thinking, and posing "what if" challenges are hallmark strategies of intentionality. Unlike praise or criticism, which merely indicates "right" or "wrong" and may be interpreted as a sign of the teacher's personal (dis)approval of the child (e.g., "I like the way you solved that problem"), evaluative feedback focuses on learning rather than judgment ("Your idea to carry the cup on a tray solved the problem of water spilling on the floor"). (Epstein, 2007, p. 9)

In the following subdivision I am expanding on the meaning of feedback.

2.4.1 The Meaning of Feedback

According to Hattie and Timperley (2007) feedback is conceptualized as information provided by an agent (e.g., teacher, peer, book, parent, self, experience) regarding aspects of one's performance or understanding. A teacher or parent can provide corrective information, a peer can provide an alternative strategy, a book can provide information to clarify ideas, a parent can provide encouragement, and a learner can look up the answer to evaluate the correctness of a response. Feedback thus is a "consequence" of performance. According to Sadler (1989), feedback needs to provide information specifically relating to the task or process of learning that fills a gap between what is understood and what is aimed to be understood.

Feedback has no effect in a vacuum; to be powerful in its effect, there must be a learning context to which feedback is addressed (Hattie & Timperley, 2007). It should be part of the teaching process and is that which happens second—after a student has responded to initial instruction—when information is provided regarding some aspect(s) of the student's task performance. Hattie and Timperley (2007) state it is most powerful when it addresses faulty interpretations, not a total lack of understanding. Under the latter circumstance, it may even be threatening to a student: "If the material studied is unfamiliar or abstruse, providing feedback should have little effect on criterion performance, since there is no way to relate the new information to what is already known" (Kulhavy, 1977, p. 220). However, as just mentioned by

Hattie and Timperley (2007), feedback can be very powerful when it addresses situations appropriately. Hence we expand on the power of feedback in the following section.

2.4.2 The power of feedback

According to Hattie and Timperley (2007) feedback is one of the most powerful influences on learning and achievement, but this impact can be either negative or positive. They are of the opinion that the purpose of feedback is to reduce discrepancies between current understandings/performance and a desired goal. Another discrepancy is between students and teachers: The students can reduce the first mentioned discrepancy by increasing their effort and employment of more effective strategies, or abandoning, blurring, or lowering the goals. On the other hand, the teachers can provide appropriate challenging and specific goals as well as assisting the students to reach them through effective learning and feedback. However, in order for a teacher to be able to do this a knowledge of the different types of feedback is required.

2.4.3 The different types of feedback

According to Stone and Heen (2020), there are three different types of feedback based on purpose: evaluation, appreciation and coaching. They are of the opinion that evaluation feedback needs to be done "in the moment" to help the person receiving the feedback know where they stand. However, appreciation and coaching should be given on a daily basis to help inspire and motivate the person to continue doing their best and improving their selves.

On the other hand, Stenger (2016) identifies five different types of feedback:

1. *Motivational feedback:*

   It is used to reward and support positive behaviour e.g. when an employee, or a learner in this study, performs well. A learner is also shown appreciation for school work done.

2. *Developmental feedback:*

   It is given when a particular area of performance needs to be improve e.g. highlighting the areas of your subordinates or learners' performance which needs improvement.

3. *Constructive Feedback:*

   It is given to encourage the development of the individual towards which it is directed.

4. *Intrinsic feedback*

   It is feedback from one's own self e.g. a person engaged in thinking and pondering over ideas, evaluating options and assessing their outcomes.

5. Extrinsic feedback

It is feedback which a person receives from others. Stenger (2016) also refers to negative, positive, immediate and delayed feedback. Although it is important to have knowledge about feedback, it is more important to provide learners with meaningful feedback as well. Here follows a breakdown of meaningful feedback.

2.4.4 Teachers provides the learner with meaningful feedback

Stenger (2014) mentions five research-based tips for providing students with the kind of feedback that will increase motivation, build on existing knowledge, and help them reflect on what they've learned, namely: be specific about the feedback as possible, gave feedback as soon as possible, address the learner's advancement toward a goal, present feedback carefully and involve the learners in the process.

2.4.4.1 Be as specific as possible

Stenger (2014) and Timperley and Hattie (2007) highlight the importance of supplying learners with specific information about what they are doing right or wrong. They say that some feedback like "Great job!" doesn't tell the learner what s/he did right, and likewise, a statement such as "Not quite there yet" doesn't give her any insight into what she did wrong and how she can do better the next time around.

2.4.4.2 The sooner the better

Stenger (2014) says that numerous studies indicate that feedback is most effective when it is given immediately, rather than a few days, weeks, or months down the line. She refers to a study that looked at delayed vs. immediate feedback and it was found that participants who were given immediate feedback showed a significantly larger increase in performance than those who had received delayed feedback. She also found that another research project from the University of Minnesota showed that students who received lots of immediate feedback were better able to comprehend the material they had just read. Of course, it's not always possible to provide students with feedback right on the spot, but sooner is definitely better than later (Stenger, 2016).

2.4.4.3 Address the learner's advancement toward a goal

According to Stenger (2014) and Hattie & Timperley (2016) effective feedback is most often oriented around a specific achievement of a goal that students are (or should be) working toward. They say when giving feedback, it should be clear to students how the information they are receiving will help them progress toward their final goal.

2.4.4.4 Present feedback carefully

The way feedback is presented can have an impact on how it is received, which means that sometimes even the most well-meaning feedback can come across in the wrong way and reduce a learner's motivation (Stenger, 2014). In addition, Deci (1971) identified three situations in which feedback could be counterproductive:

1. When learners feel too strictly monitored: If learners feel that they are being too closely monitored, they might become nervous or self-conscious, and as a result, disengaged from learning.
2. When learners interpret feedback as an attempt to control them: Learners may sometimes interpret feedback as an attempt to control them or tell them how they should be doing something rather than guidance on how to improve.
3. When learners feel an uncomfortable sense of competition: Feedback shared in a group setting could cause learners to feel like they have to compete with their peers. This can be another source of disengagement in learning.

However, to avoid the situations, Deci (1971) suggests the purpose of any monitoring, and ensuring that learners understand how the feedback is meant to help them compete against their own personal bests rather than each other needs to be completely explained.

2.4.4.5 Involve learners in the process

The importance of involving learners in the process of collecting and analyzing performance-based data cannot be understated. Stenger (2014) is of the opinion that when students have access to information, they develop an awareness of their learning, and are more easily able to recognize mistakes and eventually develop strategies for tackling weak points themselves.

Furthermore, researchers suggest that taking the time to provide learners with information on what exactly they did well, and what may still need improvement as well as telling the learner what he is doing differently than before can be helpful for the learner (Stenger, 2016). She also advises to monitor whether the student's performance changed or improved since the last time you assessed him/her and to let the learner know about it, even if the learner still has a long way to go.

2.5 Conclusion

This study focusses on the feedback from the learner to the teacher. Perceptions of learners have a direct impact on the learners' mathematics performance. Intentional teaching is one of the approaches that can change learners' perception when it comes to the teaching of mathematics. Different elements need to be taken into account like the aim of the lesson, interaction with learners including feedback. I have discovered that intentional teaching is an approach that entails all these elements. Therefore, this study is underpinned by intentional teaching and is concerned with learners' perceptions of teaching mathematics and feedback. The following chapter (chapter 3) will discuss the research methodology of the current study.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents the methodological aspects of this study and is based on the following aim: To Explore the effect of implementing an intentional teaching strategy on grade 9 learners' perceptions of the teaching of mathematics. This chapter will describe the participants and location, sampling, a description of the survey design, including its strengths and weaknesses, instrument development, data collection and analysis of the data, validity and reliability and ethical considerations.

Creswell (2014, p. 3) states there are three research approaches, namely: qualitative, quantitative and mixed methods. Historically, social scientists have favoured quantitative methods over qualitative methods according to Blanche, Durrheim and Painter (2010). They were of the opinion that researchers believed that there were innumerable facts in the world to be collected by means of quantitative measures. They rejected qualitative measures initially, because they claimed it was open to biased interpretations. However, later Blanche *et al* (2010) realised that qualitative measures provide relevant information about the experience of poverty depression and peoples' perceptions of the poor and depressed. Nevertheless, there are many good reasons for using quantitative data. They are of the opinion that good quality quantitative data and statistics allow researchers to make comparisons regarding different situations (Blanche, 2010).

On the other hand, Welman, Kruger and Mitchell (2005) are of the opinion that the type of research design is dependent on the nature of the research that will be executed. According to Creswell (2014, p. 4) quantitative research is an approach for testing objective theories by examining the relationship between variables. He states that these variables, in turn, can be measured typically with instruments, so that numerical data can be analysed using statistical procedures. Therefore, in this study, I followed a quantitative research methodology targeting grade 9 mathematics learners.

3.2 Participants and location

The participants in this study were 68 learners from two grade 9 mathematics classes based at a historically and currently disadvantaged school in the Metropole East Education District, a subdivision of the Western Cape Education Department. Compared to "non-disadvantaged" schools, the academic performance, especially mathematics performance, of

disadvantaged schools in this particular area are poorer for many social reasons, but the social factors, ranging from primary factors (lack of food) to tertiary factors (lack of drive, vision and dreams) are not the focus of this study, but rather how I as a teacher can make the difference in the classrooms of these learners, irrespective their circumstances by getting to know their perspective of my teaching. This might sound insensitive, however, this is actually to research how I can assist this group of learners.

3.3 Sample

The sample for this study was non-random (conveniently selected) (Creswell 2014, p. 168), because I made use of the two grade 9 mathematics classes, which I taught at the time.

3.4. Survey Design

A survey design which is situated in the quantitative research tradition, was adopted in this study. This section is mainly underpinned by the research notions of Babbie and Mouton (2001). However, the researcher also included research from Creswell (2014); Smith, Julie and Gierdien (2020) and others. According to Smith *et al*, (2020), survey research is generally geared towards establishing trends or individual opinions.

Babbie and Mouton (2001) state that survey research is a very old technique. A survey was used after the plague in Egypt and is evidenced in the following scripture: Numbers 26:1-2, New Kings James (NKJV) version, p. 186)

> "And it came to pass, after the plague, that the Lord spoke to Moses and Eleazar the son of Aaron the priest, saying: "Take a census of all the congregation of the children of Israel from twenty years old and above, by their father's houses, all who are able to go to war in Israel…"

Another incident which made use of surveys in the Bible was when Joseph, the father of Jesus, and Maria, went to Egypt to participate in a Roman census. (Luke 2:1 - 6, NKJ, p. 1229)

> "And it came to pass in those days that a decree went out from Caesar Augustus that all the world be registered. This census first took place while Quirinius was governing Syria. So all went to be registered, everyone to his own city".

According to Babbie and Mouton (2001) a survey was attempted among French workers in 1880 to determine the extent of their exploitation by employers. Babbie and Mouton (2001) cite Shell (1994, p. 439) that the history of survey research in South Africa dates back to the late seventeenth century when demographic data were collected in the Cape.

Babbie and Mouton (2001) state that survey research is perhaps the most frequently used research design in social sciences and one of the most common types of study. There are issues that are contested regarding the use of a survey in South Africa. One example is that most textbooks on research methodology prescribed at tertiary institutions, assume that the reader lives in a developed country. Babbie and Mouton (2001) argue that the different problems which arise in the context of developing countries like South Africa are not always sufficiently addressed**.** Terre Blanche, Durrheim and Painter (2010) edited a textbook: Research in Practice that is rooted in the South African context. This chapter will not however allow for these issues to be addressed within the context of this study.

3.4.1 Topics appropriate to survey

Surveys may be used for descriptive, and exploratory purposes (Babbie and Mouton, 2001). According to them, it is probably the best method to the social scientist describing a population that is too large to observe directly. Surveys are also excellent vehicles for measuring attitudes and orientations in a large population. These are some of the purposes of surveys, but one must keep in mind that there are also pitfalls that can result in useless and even misleading information (Babbie and Mouton, 2001). Therefore, researchers are making use of guidelines to assist them, which will be described in the next sub-section.

3.4.2 Guidelines for asking questions

The reason for having asked learners, in this study to respond to questions, was a way of extracting data for analysis and interpretation (Babbie and Mouton, 2001). They refer to the process as operationalization. According to Babbie and Mouton (2001) this is always the case in survey research and such "self-report" data are often collected in experiments, field research and other types of research. The questions can be asked by an interviewer, written down and given to the participants for completion. In this study, questionnaires were used to collect data.

Babbie and Mouton (2001, p. 233) state: "Questionnaires represent a common and concrete illustration of the operationalization process…" Below are some of the options available when constructing questionnaires:

3.4.2.1 Questions and statements

A questionnaire might have as many statements as questions. Babbie and Mouton (2001) mention that often a researcher is interested in determining the extent to which participants hold a particular attitude or perspective. The manner in which the statement is used is that the attitude

is summarized in a fairly brief statement and then the participants are asked whether they agree or disagree with the statement.

3.4.2.2 Open-ended and/or close-ended questions

Researchers have two options when asking questions, namely: open-ended and/or close-ended questions. In the case of open-ended questions, the participants are asked to provide his or her own answer to the question. Additionally, open-ended questions require coding before they can be processed for computer analysis. The coding process requires the researcher to interpret the meaning of responses. Babbie and Mouton (2001) argue that this can result in the possibility of misunderstanding and researcher bias. This in turn can lead to incorrect interpretations. Participants can also give answers that are irrelevant to the researcher's intent.

On the other hand, in the case of close-ended questions, the participants are asked to select an answer from among a list provided by the researcher. Babbie and Mouton (2001, p. 233) state: "Close-ended questions are very popular because they provide a greater uniformity of responses and are more easily processed."

Close-ended responses can also be transferred directly into a computer format. However, the shortcoming of close-ended questions would be the researcher's structuring of responses. The researcher's structuring might overlook important responses (Babbie and Mouton, 2001). Another manner in which to ensure that all responses are included in a specific question, researchers can add a category labelled for example, Other: _____. (Please specify: _____) (Babbie and Mouton, 2001, p. 234).

Furthermore, the answer categories must be mutually exclusive. "The [participant] should not feel compelled to select more than one." (Babbie and Mouton, 2001, p. 234). They state that it is useful to add an instruction to the question asking the participant to select the single best answer, unless the researcher requires the participant to choose more than one option. The best approach is for the researcher to consider each combination of categories carefully to prevent the participant to choose more than one option when not required to do so (Babbie and Mouton, 2001).

3.4.2.3 Make items clear

Questionnaire items should be clear and unambiguous. Although the opinions and perspective of some topics might be clear to the researcher as a result of his or her involvement, it might not be clear to the participant. I quote Babbie and Mouton (2001, p. 234): "Questionnaire

items should be precise so that the [participant] knows exactly what the researcher is asking." Preventing unclear and ambiguous questions will be advantageous to the participant, but more so for the researcher. (Babbie and Mouton, 2001)

3.4.2.4 Avoid double-barrelled questions

Avoid double-barrelled questions that refer to two issues, but only allow one answer. This might happen when the researcher is faced with a difficult question. Babbie and Mouton (2001, p. 236) write: "As a general rule, whenever the word "and" appears in a question or questionnaire statement, you should check whether you are asking a double-barrelled question. Babbie and Mouton (2001).

3.4.2.5 Respondents must be competent to answer

The researcher must make sure whether the participants are able to provide correct information and it must be reliable (Babbie and Mouton, 2001).

3.4.2.6 Respondents must be willing to answer

When respondents are not willing to participate, there will be a greater probability for them to provide incorrect answers and the results will not be useful. The reasons for this can vary from political reasons to giving an impression that might not be the real situation (Babbie and Mouton, 2001). Therefore, respondents must be willing to participate in a survey.

3.4.2.7 Questions should be relevant

Questions in a questionnaire should be relevant to most participants to ensure that useful data is collected. When questions are not relevant, participants might express attitudes that they may never have thought about and may give data that is misinterpreted (Babbie and Mouton, 2001).

3.4.2.8 Short items are best

Participants should be able to read the items in the questionnaire quickly, understand the content and select or provide an answer (Babbie and Mouton, 2001).

3.4.2.9 Avoid negative items

Refrain from negations in the questions (Babbie and Mouton, 2001).

3.4.2.10 Avoid biased items and terms

Questions that encourage the participants to answer in a certain manner are biased and this should be avoided. Different forms of question words can have a subtle impact on the participants' answers. However, the biasing effect of particular wording is often difficult to anticipate. Therefore, the construction of the questions must be done in a careful manner (Babbie and Mouton, 2001).

3.4.2.11 Translation(s) in multilingual societies for example South Africa

Participants must answer questions in a language with which they feel comfortable. Therefore, questionnaires need to be translated into the different languages if it is distributed in multilingual societies like South Africa. Translations are time consuming, expensive and can be a difficult process. Back-translation is sometimes used to achieve lexical equivalence. Another important aspect that needs to be taken into consideration is knowledge of the area or grouped that will be questioned (Babbie and Mouton, 2001).

3.4.3 Strengths and weaknesses of survey research

The following are considered strengths of surveys. Surveys can create refined descriptive assertions about a student body, city, country or any large population. Surveys make large samples feasible, especially where several variables are to be analysed simultaneously. It gives flexibility in the analysis of the data. Finally, standardizing questionnaires is an important strength, because the researcher is bound to ask the same questions of all subjects impute the same intent to all participants (Babbie and Mouton, 2001).

Survey research also has its weaknesses. According to Babbie and Mouton (2001), the standardization of questionnaires, items results in representing the least common denominator in assessing people's attitudes, orientation, circumstances and experiences. You may miss what is most appropriate to most participants according to them. Therefore, they claim surveys may be artificial in their coverage of complex topics. In addition, survey research can seldom deal with the context of social life, because the researcher seldom develops the feel for the life situation in which the participants are thinking and acting to the degree that the participant observer can (Babbie and Mouton, 2001). With surveys, the initial study design remains the same and new variables cannot be added. Participants can give conservative answers and / or prejudiced answers. Therefore, it is difficult to gain a full sense of social processes in their natural settings through the use of surveys (Babbie and Mouton, 2001)

Based on the above-mentioned information, a survey design was utilized for this study. A description of the development of the instrument follows.

3.5 Instrument development

There are many instruments designed to measure learner and student attitudes towards mathematics (Fennema & Sherman, 1976; Marsh (1936, 1981, 1982b, 1984, 1987). Firstly, I give a view of some researchers on learner evaluation instruments. I referred to Marsh and Hocevar (1991, p. 11) and Julie, Holtman and Mbekwa (2011, p.1). Then I gave descriptions of instruments I researched for this study's purpose. The measure effective teaching (MET) instrument tool (Kane and Staiger, 2012) that was used in the Bill and Melinda Gates Foundation study was considered first, but was not suitable. Finally, the Students Evaluating Accomplished Teaching-Mathematics (SEAT-M) (Irving, 2004) instrument was researched and accepted.

Marsh and Hocevar (1991, p. 11) suggested that the general procedure for the careful design of a SET instrument should follow the following steps: 1. the development of a large pool of items (from literature reviews, existing instruments, interviews with students and teachers); 2. trials involving these items with students providing feedback about the items on the pilot instruments, and 3. consideration of the psychometric qualities of the items during several revisions.

According to Julie, *et al* (2011, p.1) there are times when it is necessary to assess the functionality and quality of questionnaires used to ascertain affective domain issues. They state that in terms of affective domain issues, the survey instruments are normally concerned with a latent trait or variable which is operationalised through the questionnaire items. Researchers like Julie *et al* (2011, p. 2) and Deselle (2005) agree that the functioning of an instrument is defined as to whether (1) the instrument represents a single trait or construct; (2) the items form a hierarchy; (3) there are persons and items that do not contribute towards the construct being operationalised; and (4) the items comprising the questionnaire are unique (there are no redundant items).

Initially the Measures of Effective Teaching (MET) instrument seemed like an appropriately relevant instrument, because the instrument tool was used to measure primary and secondary school learners' perceptions of teaching (Kane and Staiger, 2012). The project was designed to find out how evaluation methods could best be used to tell teachers more about the skills that make them most effective and to help districts identify and develop great teaching. The researchers in the project figured that learners spend hundreds more hours in each classroom

than any observer ever will. They are of the opinion that before the onset of the MET project, school improvement efforts have seldom sought systematic learner feedback at the classroom level. At that time one of the impediments was that learners were unable to provide valid and reliable responses about the quality of the teaching which they had experienced. However, they had confidence that the MET initiative of the Bill & Melinda Gates Foundation would determine that well-crafted learner surveys and could play an important role in evaluating teacher effectiveness (Kane and Staiger, 2012). For the purposes of this study, this instrument was too time consuming and not applicable for our sample due to time constraints.

Despite the many instruments designed to measure learners' and students' perceptions and attitudes to mathematics (Fennema & Sherman, 1976 and Marsh (1936, 1981, 1982b, 1984, 1987), none of it could have been used 100% in our local situation, because some of these instruments were developed for students at tertiary institutions and the participants in this study are grade 9 learners. The language would have been problematic as well as the length of the questionnaires. Therefore, instrument had to be adapted for purposes of contextual relevance.

In this study a pilot was run with a survey of 24 questions. The first survey was issued to the learners after obtaining permission from the parent(s) or guardians). However, the level of the questions was too high for the learners I changed some questions and/or made the question easier for understandability by the participants. Some changes were made based on learner feedback.

The Students Evaluating Accomplished Teaching – Mathematics (SEAT-M) instrument, became the chosen tool, however the amount of questions was decreased from 24 in the pilot to 17 questions due to time constraints, because the learners had to complete the questionnaire during school hours. The adapted instrument, in English and Afrikaans, used is given in Appendix I.

3.6 Data Collection

The data collection procedure for this study followed the same approach as the pilot study.

In this study data was gathered, utilizing the questionnaire and it was completed voluntarily. The questionnaire consisted of 2 sections. Section 1 contained questions regarding personal information and required that the learners to complete it. Section 2 contained 17 questions for which the learner had to tick the appropriate box or number, making use of a scale from 1 to 4 where: 1 = Never

2 = Mostly not

3 = Mostly

4 = Always

I also used this values when capturing the data for statistical purposes to calculate the total score in Chapter 4 in *Table 2*.

An independent individual administered the questionnaire and then the data were analysed by me.

3.7 Analysis of data

The data was captured on an *Excel* spreadsheet and was analysed using descriptive statistical methods and the means were used to rank the items.

The total score can be high or low. If the total score is high, the learners' perception of the teacher's ability of a specific action, is positive and therefore does not need any adjustments or may need minor adjustments. However, if the total count is low, then the learners' perception of the teacher's ability can be used to improve the skills in the area that the total count is low. The following paragraph will entail the use of means.

Norman (2010) argues using means for ordinal data, is a controversial and highly debated issue. The conflict arises from the fact that means assume equal intervals between the responses and the normal distribution of the data, which are the conditions for the use of parametric procedures are not necessarily equal (Smith *et al*, 2020). They argue that it cannot be assumed that the intervals between the responses to the survey are equal and hence parametric procedures cannot be employed. On the other hand, Norman (2010) argues that parametric procedures can be used with ordinal data. For this study, the mean is used for its robustness to create a ranking of the responses (Smith *et al*, 2020). The actual outcomes (and their interpretations) remain within the realm of ordinal data, where frequencies play the crucial role.

The data were also subjected to Rasch analysis, as is done in rating scale analysis. Julie *et al* (2011, p. 13) states:

> Rasch analysis has been used to analyse the robustness of instruments in a variety of settings. It has also been used in various educational projects, such as the large-scale assessment projects [such as]: TIMSS, teacher professional development studies, learner performance on school tests, as well as in medical education and other health-related studies.

The data was also subjected to Rasch analysis, as is done in rating scale analysis. This was done as a measure of control. The analysis was done by an independent person and I only received and worked with the outcomes of the analysis.

It is important that the validity and reliability of measurements can be trusted when performing data analysis, otherwise incorrect finding and interpretation will follow consequently.

3.8 Validity and Reliability

Validity is defined as the extent to which a concept is accurately measured in a quantitative study (Heale and Twycross, 2015, p. 1). The second measure of quality in a quantitative study is reliability, or the accuracy of an instrument. In other words, the extent to which a research instrument consistently has the same results if it is used in the same situation on repeated occasions (Heale and Twycross, 2015, p. 1).

Creswell (2014, p. 174) speaks about threats to validity. He recognizes that there are several threats that will raise questions about an experimenter's ability to conclude that the intervention affects an outcome and not another factor. Creswell (2014, p. 174) maintain there are two types of threats to validity:

1. internal threats and
2. external threats

Creswell (2014, p. 174) states that internal validity threats are experimental procedures, treatments or experiences of the participants that threaten the researcher's ability to draw correct inferences from the data about the population in an experiment. External validity threats arise when experimenters draw incorrect inferences form the sample data to other persons, other settings and past or future situations Creswell (2014, p. 176)

Potential validity threats in this study can include both internal and external validity threats. A strategy was thus adopted to assess the accuracy of the researcher's findings as compiled by Creswell (2014, pp. 201 – 202) by minimizing the bias the researcher brings to the study. An independent person administering and analysing the questionnaire is an example what I did to decrease the effect of internal threat.

3.9 Ethical considerations

The primary ethical emphasis of this study was obtaining consent, outlining the risk of potential harm to the subjects, confidentiality and anonymity of the participants. A short description of each of these aspects is provided below.

3.9.1 Informed consent

Ethics approval from the Senate of Higher Degrees Ethics Committee of the University of the Western Cape was obtained prior to the study. Permission to administer the questionnaire to learners was given by the school's management team and the Western Cape Education department.

A letter of consent had to be signed by each learner who would complete the questionnaire. An additional letter had to be signed by their parent/caregiver who gave permission for the learner to participate in the questionnaire. All the questionnaires were completed and returned. This will be followed by the analysing of the data.

The study involved grade 9 learners, registered at an urban high school in the Western Cape. The learners were informed that the completion of the questionnaire is voluntary and they could at any time decide to discontinue completing it. All stakeholders—the school management team, learners and parents/caregivers —were provided with an information sheet explaining the purpose of the study. Consent was given by parents/caregivers via learners delivering consent letters to their parents/caregivers to complete. In case where the consent form of the parent/caregiver did not return, the *loco in parentis* rule was adhered to, which means the administration class teacher in this case, acted on behalf of the parent/caregiver. A form was completed by the researcher to do the research at the school and a letter was send to the school management where the research was executed.

3.9.2 Risk of potential harm to the subjects

There were no threats for the participating learners, because they were taught a topic from the curriculum as scheduled in the Curriculum and Assessment Policy Statement (CAPS) of the Department of Basic Education. However, there was an explicit focus on intentional teaching.

3.9.3 Confidentiality

The information collected in this study was kept strictly confidential and stringent measures taken to protect confidentiality. The researcher undertook to make the results of the study available to the relevant stakeholders on conclusion of the research. Only the researcher

will have access to the learner's database and it will be deleted five years after the submission of the main study.

3.9.4 Anonymity

The questionnaires were anonymous, so there was no way to connect a particular learner's response with a particular response sheet. The learners were informed of their right to omit the demographic section of the questionnaire if they felt it was too intrusive. Parents/Learners/caregivers were informed that their data would only be used for the purpose of this study and would be kept safe. After a period of five years, after the completion of the main study, the data will be deleted. This included permission to access the learner's database to obtain any data related to the study.

3.10 Conclusion

This chapter contained the design framework for this study and the motivations for its contextual adaptation. It described the survey and outlined its strengths and weaknesses, Chapter 3 consisted of all of the methodological aspects of the research process, including participants, sampling, data collection procedure, data, instrument development, method, validity and reliability and ethical considerations. Chapter 4, provides the results of the quantitative data analysis.

CHAPTER 4

PRESENTATION and DISCUSSION of RESULTS

4.1 Introduction

The presentation and discussion of the research results are contained in this chapter which summarizes the functioning of the instrument and the ranking of the items. Both the functioning of the instrument and its rankings were derived at using Rasch analysis (Winsteps 3.42). Chapter 4 consists of: Presentation of the demographic data, the functioning of the instrument and the discussion of the results and the conclusion of this chapter.

4.2 Demographic Data

Table 1 contains the demographic information of the grade 9 learners who completed the instrument related to their perceptions of teaching of mathematics underpinned by intentional teaching.

Table 1: Demographic Information

Group	Number of learners (n)	Mean age	Male : Female
Grade 9	68	15.6	31:29 (8 missing)

This is a presentation of the number of male and female participants, mean age and total number in the research group. Eight learners did not indicate the gender section at all or chose both the male and female section.

Of the total of 68 learners, 60 learners' data was all completed. Their average age was 15,6 years and there was no a statistical difference between the gender regarding their perceptions of teaching.

4.3 Instrument functioning:

Instrument functioning indicates whether the instrument that is used to measure the trait, learners' perceptions of teaching in this instance, operates in a way so as to provide valid measures for each respondent. The functioning of the instrument was determined using Rasch analysis. (De Roos and Allen-Meares, 1998, pp. 95-96). They describe the Rasch model as:

> …a normative model for constructing interval-level unidimensionality of data on a group of subjects for a set of items they have completed. The placement of items on a line that indicates greater and lesser amounts of the variable being measured constitutes operationalisation of the variable. The Rasch model defines the ideal delineation of items that would constitute an objective, interval-level measuring instrument.

Rasch analysis is a statistical approach to the measure of human performance, attitudes and perceptions. It is named after its inventor, the Danish mathematician Georg Rasch. It was conceived as a psychometric tool for use in the social sciences. In the last 2 decades it has become increasingly applied to measurement studies. In order to understand the general principles of Rasch analysis, asking what to measure should precede asking how to measure.

According to Tesio (2003) Rasch Analysis is a statistical approach to measure human performance, attitudes or perceptions. He states that the general principle of Rasch analysis is "asking *what* to measure should precede asking *how* to measure."

For a polytomous rating scale data, such as under discussion in this thesis, the model is

$$log\ \frac{P_{nij}}{P_{ni(j-1)}} = B_n - D_i - F_j \qquad \text{where}$$

P_{nij} is the probability that person n, encountering item i, is observed in category j,

B_n is the "ability" measure of person n,

D_i is the "difficulty" measure of item i, the point where the highest and lowest categories of the item are equally probable.

F_j is the "calibration" measure of category j relative to category j-1, the point where categories j-1 and j are equally probable relative to the measure of the item (Linacre, 2006, p. 13).

Table 2 presents the results of the outcome after subjecting the research data to Rasch analysis.

Table 2: Results from the Rasch analysis

Item	Total Score	Count	Measure	Model S.E.	Infit		Outfit	
					MNSQ	ZSTD	MNSQ	ZSTD
10	191	65	0.51	0.16	1.31	1.8	1.28	1.5
8	196	67	0.36	0.16	0.91	-0.5	0.89	-0.6
7	201	65	0.29	0.17	1.03	0.2	1.14	0.7
9	207	65	0.15	0.17	0.87	-0.6	0.76	-1.2
12	207	66	0.08	0.17	0.91	-0.5	0.84	-0.8
1	211	66	0.08	0.2	0.92	-0.3	0.93	-0.3
2	215	66	0.08	0.18	0.9	-0.4	0.85	-0.7
4	211	67	0.05	0.17	0.96	-0.2	0.88	-0.6
13	217	68	0.05	0.18	1.05	0.3	1.04	0.3
16	214	66	0,00	0.18	0.98	-0.1	0.9	-0.5
5	212	66	-0.12	0.18	1.05	0.3	1.05	0.3
17	225	67	-0.15	0.17	0.93	-0.3	0.95	-0.1
3	218	67	-0.18	0.18	0.99	0,0	0.93	-0.3
6	212	65	-0.18	0.18	1.02	0.2	1.23	1.1
11	225	68	-0.23	0.18	1	0	1.02	0.2
15	226	66	-0.35	0.19	1.12	0.6	1.05	0.3
14	238	68	-0.43	0.18	1.03	0.2	0.92	-0.2
MEAN	213.3	66.4	0	0.18	1	0	0.98	0
S.D.	11.2	1	0.24	0.01	0.1	0.5	0.14	0.7

Some of the elements in this table are used to determine whether the instrument used in this study is functioning in an expected manner.

"Never" has a value of 1, this is an indication of the learners' perception of a particular item that should be actioned and remedied in order to correct that particular item if that value is chosen. "Always", the value is equal to 4 which is an indication that for this particular item the learners have a positive perception.

Julie *et al* (2011) and others point out that in a useful scale the items operationalising the abstract construct under discussion should form a hierarchy, so that it is possible to conclude which of the items respondents would find easy and which they would find difficult to endorse. With Rasch modelling three values can be determined to ascertain the hierarchical property of a scale: the measure of an item, the infit mean square and the outfit mean square values respectively (Julie *et al,* 2011). The measure of an item is the location on the scale. For a rating scale it indicates the level of difficulty for endorsing the item. The difficulty of endorsement 'of an item is defined to be the point on the latent variable at which it's high and low categories are equally probable' (Linacre, 2008, p. 221).

Reeve and Fayers (2005) state that for the criterion for the spread of items to be deemed acceptable the measures should be in the range -2 to +2 logits. With the range for the instrument in this study being -0.43 to 0.51, as given in Table 2, this criterion was fulfilled. In Rasch analysis, mean infit and outfit squares (see Table 2) are calculated to indicate 'items which do not contribute to the definition of a coherent and useful variable' (Julie *et al,* 2011). For items to have a good fit to the Rasch model, the decision criteria are: "values greater than 2.0 degrades measurement; values greater than 1.5 neither constructs nor degrades measurement; values from 0.5 to 1.5 are productive of measurement and those less than 0.5 misleads us into thinking we are measuring better than we really are." (Linacre, 2006. 221−222). From table 2 it can be observed that the infit mean square ranges from 0.9 to 1.31 and the outfit mean square ranges from 0.9 to 1.28. This is an indication that both the infit and outfit mean square values for all the items fell within this acceptable range and are therefore productive of measurement.

4.4 Ranking order of the items

The ranking of items is based on the Rasch analysis and the ordering of the items are in terms of the means of the items. This ordering is presented in Table 3 below and graphically presented in Figure 1.

Table 3: Means of each item.

Item	Mean
14	3.500
15	3.424
17	3.358
11	3.309
6	3.288
2	3.258
3	3.273
16	3.242
5	3.212
1	3.197
13	3.191
9	3.185
4	3.242
12	3.138
7	3.092
10	2.938
8	2.925

The means of the items are in descending order.

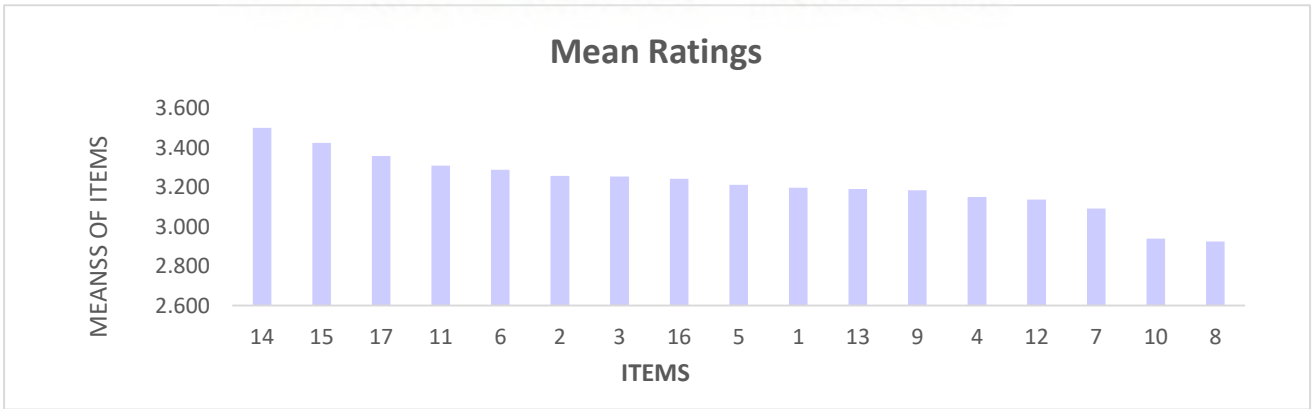

Figure 1: The means of the items

Table 4: Clusters of data: teacher commitment, pedagogy and learner engagement.

Item	Mean		
	Teacher Commitment	Pedagogy	Learner Engagement
1.			3.197
2.			3.258
3.	3.273		
4.	3.242		
5.	3.212		
6.		3.288	
7.	3.092		
8.			2.925
9.	3.185		
10.			2.938
11.		3.309	
12.	3.138		
13.		3.191	
14.		3.500	
15.	3.424		
16.		3.242	
17.		3.358	
Mean	**3.224**	**3.281**	**3.080**

Of the three clusters the mean of the pedagogy cluster is the highest and the learner engagement is the lowest.

4.5 Discussion

The discussion will entail the findings at first glance, but with further investigation, the researcher embarked on the means of the items individually as well as in cluster format. In order for any reader to understand the calculations that I am focusing on, a short explanation will be offered how the total score was done, although the statistics was done electronically. I made use of a scale from 1 to 4 where:

1 = Never

2 = Mostly not

3 = Mostly

4 = Always

I also used this values when capturing the data for statistical purposes to calculate the total score in Chapter 4 in Table 2.

An important component of the statistical method was the calculation of the total score. I summarised a general formula as follows:

$$S_T = SUM\ (\boldsymbol{v_i} \times \boldsymbol{x_i})$$

Where: S_T = Total Score

v_i - Value of option (v_i can be equal to 1, 2, 3 or 4, depending on the option the learner choose, depending on whether the learner chooses never, mostly not, mostly or always respectively.

x_i = amount of learners who chose a specific option (the *i* represent the specific option as indicated above.

OR

$$Total\ Score = (value\ of\ never \times amount\ of\ learners) + (value\ of\ mostly\ not \times amount\ of\ learners) + (value\ of\ mostly \times amount\ of\ learners) + (value\ of\ always + amount\ of\ learners) equation\ here.$$

Let's use item 10 to illustrate how to calculate the total count, although it was done automatically, because this will give any reader a better understanding of the findings of the study.

21 learners chose option 4, 26 chose option 3, 11 chose option 2 and 7 chose option 1

$$Total\ Score = (value\ of\ never\ \times amount\ of\ learners) + (value\ of\ mostly\ not\ \times amount\ of\ learners) + (value\ of\ mostly\ \times amount\ of\ learners) + (value\ of\ always\ \times amount\ of\ learners)$$

$$Total\ Score = (1\ \times 7)\ +\ (2\ \times 11)\ +\ (3\ \times 26)\ +\ (4\ \times 24) = 191$$

This implies that the teacher did not give the learners enough time or any time at all, to work on their own. What I have observed is that the learners are not in the habit of thinking through and solving problems. The reason for this might be more complex than it appears. I was under the impression that I was giving the learners the time to work on their own. However, according to the learners' evaluation this was not sufficient. From my perspective, it might appear as if I am not sympathetic towards the learners, but this a false impression and needs to be addressed.

Other factors like there is only a certain amount of time allocated per lesson or per year to complete the curriculum. The issue about the packed curriculum has been raised by teachers, but it appears as if it is falling on deaf ears. There is also the matter of learners who are not goal orientated. It is not all learners, but unfortunately, it covers a large portion of the spectrum. Even if all the above-mentioned factors are not having a direct impact on the perception of the learners for this particular item, there is still one factor that I would like to touch on.

The highest score implies that the learners embrace the teacher's method of teaching of mathematics, the most. Consequently, the learners' perception regarding my ability to encourage learners to place a high value on mathematics is rated in a positive light.

However, an interesting observation emerges when the total scores in table 2 is compared with the mean values in table 3 and figure 1. The reason for this phenomenon can be seen in table 4 below.

Table 5 Total scores, counts and means for items 8 and 10.

Item	Total Score	Count	Mean
10	191	65	2.938
8	196	67	2.925

The mean is affected by the total score and the count.

The formula to calculate the mean is: $\boldsymbol{Mean = \frac{Total\ Score}{Count}}$

Only 65 learners answered item 10, while 67 learners answered item 8, consequently decreasing the mean as it can be seen in the figure 1, because the count is used to divide in the formula; this increases the answer when the count is small and decreases the answer when the count is large. Therefore, when referring to the means of each item, the learners' perceptions regarding the teacher's ability to make learning mathematics satisfying and stimulating for learners is the lowest and this is item 8. However, these two results are categorised in the same group, namely: the learner engagement group, when using the Irving student evaluation teaching scale mentioned by Hattie (2012).

These two items actually can go hand-in-hand. It can indicate that when the teacher makes learning mathematics satisfying and stimulating, learners will be challenged to think through and solve problems, either by themselves or together as a group. However, it can also have separate impacts on the learners' perceptions. As part of the purpose of this study, the clustering component is also investigated as combined as per the *Irving Student Evaluation of Accomplished Teaching Scale (Hattie, 2012). Hattie (*2012, p. 124) states:

> About 70 per cent of what happens between [learners] is not seen or known by the teacher. This must surely give us pause for thought about the usefulness on teacher reflection on what they *think* happened, and the value of professional learning circles that retrospectively confirm what teachers saw. Why contemplate only the 30 percent that was seen? We need to pay much more attention to evidence about the effect that we have on [learners], and make adjustments to our thinking, teaching, expectations and actions in light of this evidence. Such evidence, from multiple sources, needs to be the source of our reflection and professional critique.

Since an adapted SEAT-M) instrument was used in this study, the three identical clusters that was used in the SEAT-M instrument, were used in this study, namely: (1) teacher's commitment to learners and their learning, (2) pedagogy in mathematics and (3) engagement with the curriculum. As indicated in table 4, pedagogy in mathematics, ranked the highest, while the cluster, student engagement, ranked the lowest of the three clusters. This imply that I did communicate a sense that mathematics has a high value, but I should also allow the learners to work more individually or in groups. Due to the fact that both these items fall in the same cluster, could indicate that this is an area that I need development in.

Item 9 is about whether the learners perceive that the teacher provides time for the learners to reflect and talk about the mathematics they are learning. Item 11 refers to the learners'

perception as to whether the teacher encourages learners to try different techniques to solve problems. Item 12 refers to the learners' perception as to whether the teacher is committed to the learning of all learners and item 3 is about the learners' perception regarding the teacher's ability to enable learners to develop confidence and self-esteem in mathematics. These items fell between the highest and lowest value and is therefore not discussed in this study. However, these are potential areas that can be researched in the future

The last factor that appears to me that could cause this low score is the assumption that I am making regarding what the learners' needs and wants are, without communicating to them in an effective manner to acquire the required response. Although I could have given the learners time to work on their own or in groups, this should be emphasized by me to the learner when I get to this particular phase of the lesson,

4.6 Conclusion

In essence this chapter explained the analyses of the data responding to the effect of implementing intentional teaching strategy on grade 9 learners' perceptions of the teaching of mathematics and the discussion thereof. Rasch Analysis includes the total score, the means of each item and the Irving clustering system were utilized. These three analyses techniques indicate overlap and thus strongly suggest that the measurement tool was effective. The results in the three clusters: teacher commitment, pedagogy in mathematics and learner engagement is significantly noteworthy. The cluster: learner engagement, scored the least, compared to the other two clusters. This could be attributed to the general factors like time constrains, packed curriculum, discipline, socio-economic factors. However, I embarked on a sensitive nerve which could be that I was focussing on what I thought the leaners needed instead of enquiring from the learners what they needed. In general, the options of all the clusters were option 3 (mostly) and 4 (always) and this unequivocally implied that grade 9 learners' perceptions of mathematics teaching were positive as a result of having applied intentional teaching as a strategy. Overall recommendations, based on research findings and the conclusion follows this chapter.

CHAPTER 5

SUMMARY, RECOMMENDATIONS AND CONCLUSION

5.1 Introduction

In this final chapter I will present a summary, recommendations and the conclusion of the study. The primary question driving the research is, "What are the perceptions of grade 9 learners of the teaching they experience in Mathematics?" The research quest was to answer the afore-mentioned question. A summary of the results is firstly presented. This is followed by recommendations of improving teaching using regular feedback from learners, the limitations of the study and possible future research. The chapter concludes with some concluding comments.

5.2 Summary of results

Learners ranked the teacher's ability to encourage them to place a high value on mathematics (item14) the highest. This implies that I motivated and inspired the learners to come up with methods that will ensure that they will do well. I am of the opinion that if learners are to do well in mathematics, then in teaching, attention should be given to encourage learners to highly value mathematics. Intentional teaching of mathematics might contribute towards this quest.

The item, "The teacher's ability to challenge learners to think through and solve problems, either by themselves or together as a group" (item 10) was ranked the lowest by the cohort of learners. From this I surmise that I did not necessarily focus on what the learners wanted to focus on. I focused on what I thought is necessary for the learners and not on what the learners needed to enable them to be mathematical. This disconnect between my intention and the learners' perceptions would not have been made apparent without feedback and thus underlines the importance of feedback in altering the learners' experience regarding the teaching of mathematics.

The instrument that was used, was a survey questionnaire consisting of 17 items. Firstly, the total score of each item was used and afterwards the three clusters from the adapted SEAT-M instrument. The three clusters are: (1) teacher's commitment to learners and their learning, (2) pedagogy in mathematics and (3) learner engagement with the curriculum. The mean of the cluster, Pedagogy in mathematics, ranked the highest, while the mean of the cluster, learner engagement, ranked the lowest of the three clusters.

The research done by the South African researchers like Moloi *et al* (2010), compared well with this study. They also researched learners in disadvantaged schools. In both cases there is consensus that the success and effectiveness are attributed to the adherence to authentic pedagogic dialogue. Therefore, I suggest that there should be a quest for authentic pedagogic dialogue as an antidote for an often empty, unfulfilled, meaningless and directionless method of teaching of mathematics.

5.3 Recommendations of improving teaching using regular feedback from learners

One recommendation for improving teaching using regular feedback has been alluded to in the last sentence of the preceding section. This revolves around authentic pedagogic dialogue between learners and teachers. Such dialogue will assist teachers "to challenge learners to think through and solve problems, either by themselves or together as a group", which was ranked the lowest by the learners. Authentic dialogue should be encouraged between learners themselves so that they can engage one another so as to enhance their understanding of mathematics.

A second recommendation is linked to the highest ranked item dealing with motivation and encouragement to learn mathematics. From a personal perspective, learners from low socio-economic status backgrounds are often viewed as not being able to cope with mathematics. In contrast to learners from middle- and high socio-economic status backgrounds there are many times a lack by teachers to motivate and encourage learners from low socio-economic status backgrounds. The last-mentioned learners thus are bombarded with negative messages from both outside—their environment—and inside the school. This has the likely effect that learners "switch off" from wanting to engage with mathematics. Schools are for these learners about the only place where their appetites for mathematics can be wetted. I thus strongly recommend that all role-players—teachers, curriculum advisors and staff of projects to improve achievement in mathematics by these learners—vigorously search for implementable ways and means to motivate and encourage learners to engage with mathematics. I also strongly recommend that all role-players and teachers develop skills of pedagogical dialogue, which promotes effective, intentional, dynamic teaching, effective and dynamic learning.

Lastly, I recommend a well-structured approach to teaching. Intentional teaching was the purposeful approach which produced the pedagogical context in which the study was done. The teaching approach to mathematics does not have to be intentional teaching, but it must at least contain teaching elements that will ensure learners that they understand mathematics and will be able to recall the knowledge when writing high-stakes examinations or assessment tasks.

5.4 Limitations of the study

In this study I only focussed on grade 9 learners in two classrooms in one particular school. Therefore, generalisations to other grades cannot be done. The practical part of the research was done in 2018 and I was promoted to another school in 2019. This affected the long-term impact the study could have had if the research was extended for another year to other classes at the same school. Time is also a constraining factor, because the questionnaire was executed during school time, therefore the questionnaire was shorter and covered less items. This limited the exercise, because more topics could have been included.

Due to the fact that this technique can be intimidating, teachers might not be keen to necessarily adopt and apply this technique. And even if the technique is applied, there might still be the possibility that some learners can interpret the questions wrongly or purposely give the wrong answer.

5.5 Possible future research

Based on the limitations the following issues should be further researched.

1. The regular use of a shortened version, as the seven items version questionnaire given by Hattie (2012, p. 160), of the instrument by practising teachers. Central to this research is how teachers adapt their teaching in order to foster learners' engagement with mathematics and how this impact on learners' achievement.
2. Linked to ways and means how a school's mathematics department uses a shortened version of the questionnaire in their departmental deliberations and planning for the development of quality of teaching of mathematics should be researched.
3. In addition, the continued monitoring and possible refinement of the shortened instrument should be pursued to ensure the ecological relevance and seamless practical implementation of the tool should be pursued.

5.6 Concluding Comments

My research rendered some significant findings. Some of the teaching aspects on which I felt I had concentrated, were not congruent to the learners' perceptions of what they had perceived as important. A positive example was that learners perceived that I have encouraged them to place a high value on mathematics because I was focussing on them understanding the mathematics.

An interesting observation is that the learners' perceptions regarding teacher-learner engagement turned out to score the lowest of the three clusters: teacher commitment, pedagogy in mathematics and learner engagement, previously identified. This implies that learners have the perception that the teacher did not engage them to their fullest potential. As a teacher, this was insightful, as I was of the opinion that learners do not want to be mathematically engaged.

However, this study indicated that learners want to be more engaged in mathematics. In Afrikaans is a proverb: "Jy het dit uit die bek van die perd gehoor". The English translation is that you have heard it from where it matters the most and the learners themselves are acknowledging that they want to be more engaged in practicing mathematics. These learners come from previously and currently disadvantaged schools and through this research were given a voice of expression to which teachers must heed. This would be that teachers teaching in disadvantaged schools should not assume a limited mind-set while teaching mathematics and project this onto the learner, based on how disadvantaged they perceive their mathematics learners to be. Teaching and learning should be the exchange of the same energy, the quality of teaching should produce the quality of learning. There are also other methods that teachers can employ to increase their levels of teaching efficacy.

Other methods which teachers can apply to improve their strategy are: peer feedback, learners' test and examination performance and reflective self-evaluation. These are some of the methods of which teachers can utilise. Further professional teacher development can also entail: attending workshops, conferences or additional courses to improve their methods of teaching mathematics. The latter are however more expensive. I do not claim that the list is complete, but this gives one a good starting point.

Learner perceptions and their experience of the teaching of mathematics and their attitude towards the subject will not positively change unless teachers become more accurately responsive to learners' needs, collectively and individually. This study has demonstrated that learner feedback, through the use of an adapted questionnaire after intentional teaching was applied for a period of 8 months produced insights which, if applied could further improve their experience in learning mathematics and ultimately their mathematics performance.

The study also suggests that I further improve my teaching of mathematics and elicit periodic learner feedback to consciously increase my levels and quality of learner engagement, to develop their "mathematicalness" and enrich their deep mathematical thinking and thus their learning experience.

When an electronic version of an adapted tool becomes available, it can be used by teachers more broadly nationally and internationally for developing the quality of teaching of mathematics.

Last, but not least, although teacher content and pedagogical knowledge are imperative elements of this study, social influences such as truancy, drugs, and unwillingness to learn are factors that the LEDIMTALI project had a contradicting approach towards it by focusing on what we as teachers can do, despite all these social influences. Other factors like large class sizes, under-resourcing schools, excessive teaching loads are issues that I am daily bombarded with as a teacher, I do not have a lot of control over it, but I have control of what I can do in my classroom. This is the main reason why I am still part of the LEWDIMTALI project. Therefore, the learners' perception regarding my ability to challenge them to think through and solve problems, either by themselves or together as a group, will definitely be addressed, in my mathematical class along with making learning mathematics satisfying and stimulating.

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APPENDIX I

Questionnaire

UNIVERSITY of the WESTERN CAPE

Learner Report on Teaching of Mathematics

We are interested in your experiences and feelings about the teaching of Mathematics you receive. Please complete the following about yourself by marking the appropriate block with a cross (**X**).

School: ……

Grade	8	9	10	11	12

Gender	Female	Male

Age	12	13	14	15	16	17	18	19

The grade I obtained for the last examination was

Grade	7	7	8	9	10	11	12

What are my Mathematics symbols that I obtained in the previous year?

Examination	Symbol	1	2	3	4	5	6	7
	End-of-year							

Please turn over for the questionnaire about your experience of the teaching of mathematics.

PTO

Evaluation of Mathematics Teaching

Learner Questionnaire

Please indicate the EXTENT of your disagreement/agreement with the following statements about your experiences of the teaching of Mathematics you receive by marking the appropriate block with a cross (**X**). There are no correct answers. We are only interested in your honest responses.

My teacher		Never	Mostly not	Mostly	Always
1	Makes mathematics come alive in the classroom				
2	Shows us interesting and useful ways of solving mathematical problems				
3	Enables us to develop confidence and self esteem in mathematics				
4	Creates a positive atmosphere in class where we feel part of a team of learners.				
5	Adjusts the lesson if we experience difficulties in learning				
6	Helps us construct an understanding of the language and processes of mathematics				
7	Uses assessment results to provide extra help/extension to appropriate students				
8	Makes learning mathematics satisfying and stimulating				
9	Provides time for us to reflect and talk about the mathematics we are learning				
10	Challenges students to think through and solve problems, either by themselves or together as a group				
11	Encourages us to try different techniques to solve problems				

12	Is committed to the learning of all the students in learning				
13	Knows and caters for the problems we commonly encounter in learning new topics.				
14	Encourages us to place a high value on mathematics				
15	Tells us what the purpose of each lesson is.				
16	Encourages us to test mathematical ideas and discover mathematical principles				
17	Develops our ability to think and reason mathematically, and have a mathematical point of view				

Thank you for your co-operation.