BALANCING MATHEMATICS ASSESSMENT TASKS TO ACCOMMODATE PROBLEM-SOLVING IN GRADE 7 CLASSES

by

NOMTHANDAZO MOUREEN BHEKISWAYO

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Supervisor: Dr M.M. Moleko

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DECLARATION

I declare that the dissertation, **BALANCING MATHEMATICS ASSESSMENT TASKS TO ACCOMMODATE PROBLEM-SOLVING IN GRADE 7 CLASSES** hereby handed in for the qualification of Magister Educationis at the University of the Free State, is my own work and that I have not previously submitted the same work for a qualification at/in another University/faculty.

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N.M Bhekiswayo

December 2023

DEDICATION

This dissertation is dedicated to God, my Lord and Saviour. I would like to thank God for His never-ending love, for His protection and for granting strength to finish this study.

To my parents – I thank you mom and dad for loving and praying for me. I know love because of you. I thank you for teaching me great values and leading me to Christ.

Mama no baba ngiyabonga

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I thank you

ABSTRACT

The present South African mathematics curriculum, The Curriculum and Assessment Policy Statement, requires that learners be given the opportunity to acquire the ability to be systematic, generalise, solve problems, and think critically. These goals necessitate the use of assessment tasks that encourage learners' engagement in the development of mathematical thinking and reasoning. This means that teachers must exercise caution while designing assessment tasks and developing assessment strategies. Teachers must also be aware of the cognitive demands and nature of tasks and should include all in their assessment tasks. This study focused on to exploring how teachers balance mathematics assessment tasks to accommodate problem-solving and high-order cognitive demand in Grade 7. The model of mathematical task progression was adopted as a conceptual framework of this study. The selection of the model of mathematical tasks progression provided a lens through which the researcher could analyse the data and generate the empirical findings.

The research followed a qualitative approach guided by a descriptive case study. The study was carried out in five schools, four township schools and a school in an urban area. Data were collected through semi-structured interviews, lesson observations document analysis. Social constructivism underpinned this study as it enabled the researcher to observe the participants in their own social settings. Through the use of thematic data analysis, the researcher was able identify themes. The findings revealed that teachers lack pedagogical content knowledge, that is, knowledge and skills in balancing their own assessments tasks; secondly, the study revealed that teachers excluded problem -solving in their assessment tasks as their understanding of problem-solving was limited; thirdly, teachers used textbooks as their source of assessment tasks and insufficient time was given to learners to work on tasks; fourthly, high-order questions were excluded during learning assessment and low-level cognitive demands were dominant in all the assessment tasks. Finally, teachers used only a teacher-centred approach and used teacher-learner dialogue as their teaching and assessment strategy. The challenges that emerged from the study had implications for assessment and thus required the assessment of mathematics in Grade 7 to be approached differently to enable learners to engage more in meaningful and balanced assessment tasks. Further training for teachers is needed in order to address the complexities that exist within the balancing of mathematics assessment tasks to include problem-solving.

Keywords: assessment strategies, balancing, cognitive demands, mathematics tasks problem-solving, teaching strategies.

LIST OF ABBREVIATIONS

ATP	Annual Teaching Plan
CAPS	Curriculum Assessment Policy Statement
DBE	Department of Basic Education
HCF	Highest Common Factor
MLSC	Mathematics Learning Study Committee
MPSKT	Mathematics Problem-Solving Knowledge for Teaching
NCTM	National Council of Teachers of Mathematics
NRC	National Research Council
PCK	Pedagogical Content Knowledge
PPK	Pedagogical Problem-Solving Knowledge
SAGM	Subject Assessment Guidelines for Mathematics
SAT	School Assessment Team
SCK	Subject Content Knowledge
UFS	University of the Free State
USA	United States of America

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CHAPTER 1

OVERVIEW OF THE STUDY

1.1 INTRODUCTION AND BACKGROUND

Assessment tasks that require learners to use reasoning skills, representations and make connections (Stein, Smith, Henningsen & Silver, 2009) provide an intellectual challenge for enhancing learners' mathematical development and understanding and encourage growth in learners (NCTM, 2014). Problem-solving is considered such an assessment task and relates to higher order cognitive levels (Wakhata, Mutarutinya & Balimuttajjo 2023). Wakhata et al. (2023) believe that problem-solving is included in mathematics because of its potential to promote higher order thinking which challenges learners' intellectual capacity. Problem-solving assessment tasks offer learners the opportunity to participate in such tasks (NCTM, 2014) which encourages hard work and requires learners to think deeply (Cai, Mok, Reddy & Stacey 2016).

Although problem-solving assessment tasks help learners to develop critical thinking and analytic skills (Henningsen & Stein, 1997), most learners are deprived of an opportunity to engage in such tasks. According to a study conducted in Malaysia by Zulkifli, Razi & Mohammad (2021), teachers lack knowledge and skills of balancing assessment tasks hence they exclude problem-solving tasks in their assessments. Zulkifli et al. (2021) further discovered that teachers in Malaysia frequently worry about meeting their own demands, such as a test that learner will be able to pass and obtain good results. In Canada, it was found that the reason problem-solving was excluded in assessment tasks was due to teacher's inadequate knowledge of problem-solving. When teachers do not have knowledge of what problem-solving is, it becomes difficult for them to assess it (Barham, 2020). Barham (2020) further revealed that teachers had a negative attitude towards problem-solving which led them not to include it in their assessment tasks.

One of the major challenges in South Africa was that teachers were found to be using ineffective teaching and assessment strategies in their classroom to assess problem-solving. Teacher used teacher-centred approaches and lecturing styles in their classrooms which prevented them from engaging their learners in problem-solving tasks (Mahlangu, 2021). Additionally, Mahlangu (2021) indicated that the selection of tasks and sources of assessment were also found to be a reason that learners are deprived of the opportunity to participate in more problem-solving tasks.

According to Ukobizaba, Niseyimana and Mukuka (2021), the failure of teachers to include problem-solving in their tasks is a serious issue as teachers are responsible for fostering creativity, critical and analytical thinking by engaging their learners in problem-solving assessment tasks. In doing so, learners' achievement has the potential to improve and the desire for lifelong learning may be cultivated (Ukozibaba et al. (2021). Nagle and Styers (2015) caution that the exclusion of problem-solving in assessment tasks could have a negative impact on learners' learning. Nagle and Styers (2015) emphasise that in order to effectively include problem-solving in their assessment tasks, teachers need to be well equipped with the skills and understanding to deal with any challenges that they may encounter in the inclusion of problem-solving tasks.

Being aware of the importance of the inclusion of problem-solving in assessment tasks and the role it plays in the development and growth of a learner is critical. In line with this, the study aimed to explore how teachers balanced their mathematics assessment tasks to accommodate problem-solving in Grade 7 classes.

As an experienced mathematics and primary school teacher, on the daily basis the researcher is exposed to curriculum meetings, briefings and teacher development workshops. One particular complaint that principals, subject advisors and senior teachers have raised is the poor performance of Grade 8 learners, specifically in mathematics. Grade 7 learner performance is deemed as best however, as soon as they transition to Grade 8 their performance in mathematics drops (Department of Basic Education, 2021). In one of the staff briefings, the principal and the School Assessment Team (SAT) co-ordinator stressed that in one of the principal meetings the analysis of results shows that learners in Grade 8 failed to effectively perform in problem-solving cognitive level, an issue as the blame is placed on Grade 7 mathematics teachers. This was the motivation to explore teacher practice in Grade 7 mathematics classes. In exploring these challenges, this study argued that the findings may empower Grade 7 teachers and learners and raise awareness on how teachers can balance their assessment tasks.

1.2 RESEARCH PROBLEM

The Curriculum and Assessment Policy Statement (CAPS) Mathematics states that it aims to produce learners that are able to identify and solve problems and make decisions using critical and creative thinking (DBE, 2011). This means that problem-solving is considered a crucial task of learning mathematics. Previous research has shown the benefits of including problem-solving tasks in daily assessments and enabling learners to develop problem-solving cognitive skills (Esterhuyse, 2015). The curriculum has long recognised the importance of balancing assessment tasks to accommodate cognitive problem-solving levels and promote more critical thinking (DBE, 2018). The challenge is that teachers have difficulty designing assessment tasks that accommodate problem-solving (Stadler, Herborn, Mustafić & Greiff, 2020), which means that these types of tasks are not included in daily assessment.

In the cluster where this study was conducted, it was found that learner performance in Grade 8 mathematics was very poor compared to their performance in in Grade 7. After the evaluation of the question papers for both the Grades 7 and 8, it was revealed that the Grade 7 papers did not include mathematical problems which were considered to be at 'problem-solving' level as opposed to Grade 8 papers, which mainly consisted of these problems (DBE, 2021). To some extent, this explained in the gap in achievement between Grades 7 and 8. The fact that teachers did not pay attention to problem-solving tasks in Grade 7 should not call for the assumption that they do not know how to balance the assessment tasks by including these problems in the assessment tasks. There could have been 'valid' reasons for their exclusion, notwithstanding the fact that lack of knowledge of balancing the assessment tasks could have been one of the reasons. It is against this brief background that the study sought to explore how teachers balance mathematics assessment tasks to accommodate problem-solving in Grade 7.

1.3 PURPOSE OF STUDY

One of the most essential pedagogical decisions that a teacher takes is which assessment tasks to apply in the classroom (Mahlangu, 2021). Learner engagement in mathematical problems conveys a message about the nature of mathematics and influences their knowledge of ideas and processes (Doyle, 1988; Stein, Grover &

Henningsen, 1996). As a result, how teachers balance assessment tasks is critical yet sometimes underestimated by teachers themselves. Sokhanvar, Salehi and Sokhanvar, (2021) stated that selection and balancing of assessment tasks were all essential aspects of lesson planning. Based on this therefore, this study aimed to explore how teachers balance their assessment tasks to accommodate problem-solving in Grade 7.

1.4 RESEARCH QUESTIONS

The following section presents the main research question and sub-research questions of the study. The primary research question was: *How do teachers balance mathematics assessment tasks to accommodate problem-solving in Grade 7?*

The primary research question necessitated the development of sub-research questions:

1. What knowledge and skills do Grade 7 mathematics teachers have in terms of balancing mathematics assessment tasks?
2. Which assessment strategies do teachers use to assess mathematics problem-solving in Grade 7?
3. How do mathematics teachers use their knowledge of assessment to include problem solving in their assessment tasks?

1.5 RESEARCH AIM

The study aimed to explore how teachers balance mathematics assessment tasks to accommodate problem-solving in Grade 7. The research objectives were:

1. To describe teachers' skills and knowledge about balancing assessment tasks for learners in Grade 7 mathematics.
2. To determine which assessment strategies teachers use to assess mathematics problem-solving in Grade 7.
3. To explore how mathematics teachers use their knowledge of assessment to include problem-solving in their assessment tasks in Grade 7.

1.6 CONCEPTUAL FRAMEWORK

A conceptual framework, according to Varpio, Paradis, Uijtdehaage and Young (2020) is a tool that drives data analysis and collection. The aim of this research was to investigate into how teachers balance mathematics assessment tasks in Grade 7 to accommodate problem-solving. Henningsen and Stein's (1997) model of mathematical task progression was adopted as this study's conceptual framework. The relationships between the three factors are described in this model: the learner, the teacher, and the mathematical assessment tasks. Thus, the conceptual framework is built around the following pillars namely: the mathematics assessment tasks (that is, the cognitive demands and the nature of tasks), and teachers-specific factors (that is, the teaching strategies and approaches), as well as how these two pillars influence classroom engagement and time spent on tasks.

The figure below shows the conceptual framework adapted from Henningsen and Stein (1997)

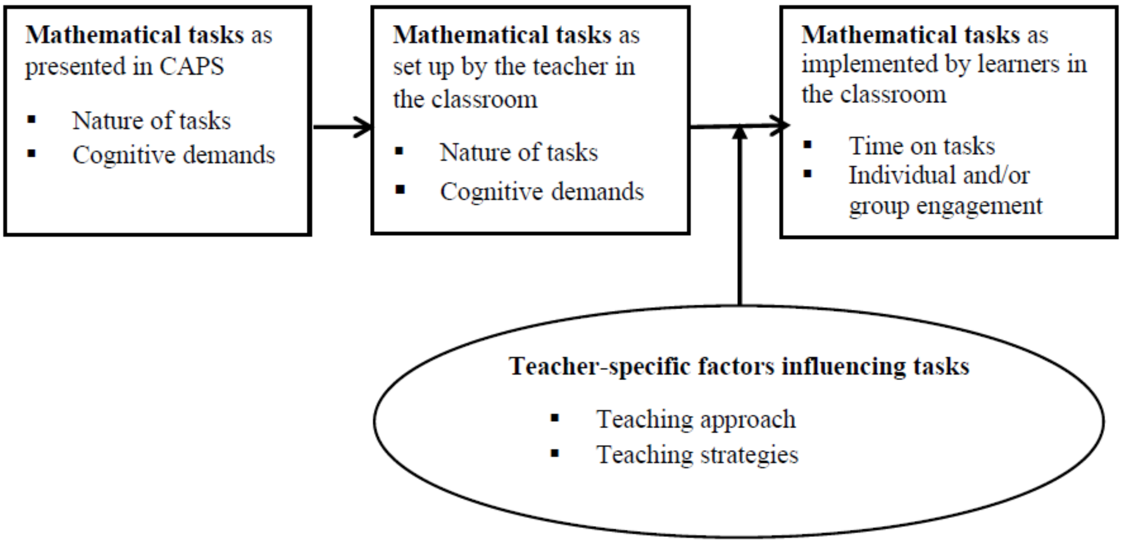


Figure 1.1: Model of task progression

1.7 RESEARCH METHODOLOGY

In this section a brief outline of the research methodology and design is given.

1.7.1 Research Paradigm

This study utilised a social constructivist research paradigm. According to this paradigm, reality is socially constructed rather than objectively defined (Nieuwenhuis, 2016). A social constructivist perspective holds the belief that there are multiple realities, leading researchers to aim for a broader comprehension of a situation by examining diverse individuals' viewpoints and experiences in selected case studies. Case studies are chosen deliberately to analyse the intricate nature of complete scenarios (Easterby-Smith, Thorpe & Jackson, 2012). The goal is to understand how members of a social group enact their particular realities and assign meaning to them through their participation in social processes, and to demonstrate how these members' meanings, beliefs, and intentions help to explain their social action (Orlikowski & Baroudi, 1991).

For the reasons mentioned above, the researcher attempted to understand the knowledge and skills teachers have in balancing their assessment tasks for Grade 7 Social constructivism was used to understand how teachers use their knowledge of assessment to include problem-solving in their assessment tasks.

1.7.2 Research Approach

A qualitative research approach was used in this study. Creswell (2014) describes qualitative research as a situated activity where researchers study things in their natural settings, attempting to make sense of, or interpret, a phenomenon in terms of the meaning people bring to it. The use of a qualitative research approach was inspired by the fact that it allows the researcher to explore the mathematics tasks that teachers used in their classrooms.

A qualitative research is characterised as a true-to-life technique due to its emphasis on regular situations where collaborations occur (Maree, 2016). Collaborations in this study were conducted through interviews and observations between the researcher and teachers.

1.7.3 Research Design

In this study, a descriptive case study research design guided the study. According to Creswell (2014), a descriptive case study research design is a detailed exploration of a bounded system based on broad data collection. Maree (2016) allude that a descriptive case study is used to explain an everyday context or situation. The descriptive case study was implemented in this study because its enabled the researcher to concentrate and gain insight into a particular occurrence by offering details to provide a deeper knowledge of the problems at hand (Leedy & Omrord, 2010). The researcher thus implemented a descriptive case study since it permitted a comprehensive study on how Grade 7 mathematics teachers set or design assessment tasks to accommodate problem-solving in their natural context.

1.7.4 Research Methods

1.7.4.1 Research Site, Population and Sampling

This study's population was Grade 7 mathematics teachers at public South African primary schools. A set of Grade 7 mathematics teachers from five participating schools in the Gauteng North area were chosen using a purposeful sampling procedure. The five schools were chosen using a convenience sample method owing to their accessibility and physical proximity to the researcher while the teachers were purposefully chosen based on their professional experience and availability.

1.7.5 Data Collection

The data collection process in this study consisted of three primary stages of data collection namely: semi-structured interviews, classroom observations and document analysis. The subsequent briefly sections discuss the instruments used to collect data based on the specific question(s) aimed at generating valid data.

Stage 1: Semi-structured interview

Ritchie, Lewis, Nicholls and Ormston (2013) define a semi-structured interview as purposefully gathering data in a structured, guided discussion. Interviews enable the researcher to probe the participants' views and perspectives (Maree, 2016). The semi-structured interview asked questions about balancing mathematics assessment tasks to accommodate problem-solving. Questions were phrased in an open manner that allowed for clarification and probing in an attempt to describe the knowledge and skills Grade 7 teachers have in balancing mathematics assessment tasks.

Stage 2: Classroom observations

Classroom observation is an important data collection strategy because it provides the researcher with an exclusive standpoint on group behaviours and dynamics in a variety of contexts (Maree, 2016). Through personal experience, the researcher studied and reflected on how classroom environments are communally formed according to the communication lines, power, language and discourses (Nieuwenhuis, 2016). Through the use of an observation tool, the researcher observed how teachers carry out mathematics assessment tasks, time spent on tasks by the learners during the assessment and lesson, and teaching and assessment strategies used by the teacher in a classroom to assess problem-solving. This data collection tool aimed at determining which assessment strategies teachers use to assess mathematics problem-solving in Grade 7.

Stage 3: Document analysis

As part of the data collection process, documents such as learners' workbooks and teacher examples from the board were evaluated and analysed. According to Nieuwenhuis (2016), while employing documents analysis as a data collection approach, the researcher would look at all sorts of written texts that might throw light on the phenomena under inquiry, such as assignments, mathematical problems, projects, classwork, and homework. The tool was used to explore how do teachers use their knowledge of assessment to include problem-solving in their assessment tasks.

1.7.6 Data Analysis

Data analysis, according to Maimela (2015), is the process of categorising data and organising the prearranged data into relevant themes categories. The researcher used thematic data analyses for this study because this data analysis approach assists in finding patterns and categorises data based on the key themes that emerged from the data collecting instruments (Grbich, 2013). To analyse the data, the researcher used Braun and Clarke's (2006) six steps of thematic analysis which includes becoming familiar with the data, generating initial codes, searching for themes, reviewing themes, defining themes and finally, using the findings for the write-up. These steps are discussed in-depth in Chapter 3.

1.8 SIGNIFICANCE OF THE STUDY

This study aimed to make a substantial contribution to mathematics assessment and the incorporation of problem-solving in teachers' assessment tasks. The use of the model of mathematical task progression (the conceptual framework behind this study), which is often used in studies of this type, is the study's strength. This model requires that teachers include all the cognitive demands and nature of tasks in their assessment tasks. Subsequently, the model of task progression will enable teachers to use different teaching and assessment strategies to balance their assessment tasks. Furthermore, this model enables learners to become critical thinkers as they engage in meaningful and balanced assessment tasks. The empirical findings of this study could contribute as a diagnostic tool in designing balanced assessment tasks to accommodate problem-solving in specific grades. It could also be resourceful for facilitators when conducting workshops for teachers.

1.9 TRUSTWORTHINESS

A study must be trustworthy in order to be of high academic quality. This indicates that the study must be conducted ethically and that the findings reflect as nearly as feasible what was discovered in the Gauteng Province's selected primary schools. The approaches described by Schwandt, Lincoln and Guba (2007) were applied to improve the study's trustworthiness: dependability, credibility, transferability and confirmability. These processes included the researcher's longer involvement with the teachers and learners in the school, numerous viewpoints for gathering and pondering data and data member check.

1.10 ETHICAL CONSIDERATIONS

The research was carried out in accordance with the University of the Free State's (UFS) Code of Research Ethics. Before beginning the study, the Ethics Committee of UFS acquired ethical approval. The study's ethical approval number is UFS-HSD2022/1740/23. In addition, approval was secured from the Department of Basic Education (DBE). Principals and teachers were given letters that outlining their duties and requesting their consent. The teachers were advised that their participation was entirely optional and that they may opt out at any time (Strydom, 2014). The learners were given letters of consent informing them of the goal of the study, which would include observing their classes and analysing their classwork books. Teachers were advised that this research would be made available on request to all participants so that they may evaluate the collected data and study outcomes. Finally, teachers were notified that the research would not utilise their real names.

1.11 DEFINITION OF THE KEY CONCEPTS IN THE STUDY

The following sections provide definitions of the key concepts of the study. This is to ensure that these definitions are understood in context as the pillars and anchors of the study.

Assessment is viewed as a method of acquiring, explaining and documenting information regarding the learner's work (Lambert & Lines, 2000). Le Grange and Reddy (1998) explain that assessments demonstrate the collecting, analysis and arranging of information that helps teachers and/or individuals make judgements regarding the learner's work.

A mathematics assessment task, according to Bayazit (2013), is a mathematical problem or activity created by teachers to provide learners with necessary information, expertise, abilities and skills. Mathematics assessment tasks include activities provided to learners during and after teaching (Adams, 2015).

*A balanced mathematics assessme*nt task can be defined as an assessment task that maintains high-level cognitive demands and that attends to learners' thinking and is vested in developing intellectual authority in mathematical reasoning (Stein & Kaufman, 2010).

Mathematical problem-solving is defined as mathematical tasks with the capacity to pose intellectual stimulation for improving learners' mathematical understanding and development (Wakhata et al., 2023).

Teaching strategy refers to teaching styles adopted by teachers to accommodate varied abilities of learners (Ismail, Shahrill & Mundia, 2015)

Assessment strategy refers to the many methods and procedures used by teachers to assess their learners (Mehta, 2023) to determine learners' strengths and weaknesses.

1.11 CONCLUSION

This chapter provided the background and context to the study. The purpose of the study is captured clearly in this chapter. Furthermore, the research problem and research aim, which are derived to help in responding to the main comprehensive research question, were highlighted. The research methodology and design, the significance of the study, trustworthiness and ethical considerations were also highlighted in this chapter. The basis of this chapter was to highlight balancing assessment tasks to accommodate problem-solving and to indicate the need to include problem-solving in daily assessment tasks. In this study the use of Henningsen and Stein's model of tasks progression framework, which has proven to be an effective assessment framework dealing with high cognitive tasks like problem-solving, was introduced. The next chapter focuses on the review of literature and the study's conceptual framework underpinning this study, as well as outlining and defining operational concepts used throughout the study.

CHAPTER 2

LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

2.1 INTRODUCTION

This study aimed to explore how teachers balance assessment tasks to accommodate problem-solving in Grade 7 mathematics classes. This chapter based on the aim of the study, presents a review of literature on the the inclusion of problem-solving assessment tasks in mathematics assessment tasks. The conclusion will be a discussion of the conceptual framework by Henningsen and Stein (1997) that directed this study.

2.2 BACKGROUND

Having taught mathematics for seven years, the researcher has observed how learners enjoy engaging in meaningful assessment tasks. The researcher has learnedthat if a learner-centred approach is used with problem-based learning , learners become motivated, active and engaged in their learning. Furthermore, when when they are engaged in problem-solving assessment tasks, it motivates them to do better and work towards solvingthe problem. However, some learners struggle to understand or grasp basic mathematical concepts. This study argues that lack of learners' active engagement during a mathematics lesson could be one of the reasons why learners are not performing competently. The study argues that teachers use teacher-centred approaches and lack of competency in teachers when balancing their assessment tasks is one of the reasons learners struggle with mathematics, as also observed by Stephan (2020).

Assessment referred to as the process of determining a learner's achievement (Burkhardt & Schoenfeld, 2019), is integral to the teaching and learning process (Wiliam, 2011). For example, a topic cannot be assessed if it has not been taught.

The quality of education has been affected by significant political and social changes that have coincided with the implementation of various types of assessments (Burkhardt & Schoenfeld, 2019)., where the teacher's choice of assessment tasks and strategies plays a major role in whether learner knowledge will be deep or superficial.

In fact, whatever skills learners spend time working on in class or out of class, sets the boundary for whatever knowledge learners will have the opportunity to acquire. That boundary is based on what mathematical concepts and mathematical practices teachers implement during classroom assessment process (Georgius, 2014).

Bevecic (2023) states that little research has been conducted with teachers' test construction taking into account how teachers address curriculum requirements in their assessment tasks, what they pay attention to how they choose topics and how they construct the assessment tasks. Research by Gao, Li, Shen and Sun (2020) suggests that assessments set at schools are problematic, especially in grades below Grade 12. Many teachers, particularly those teaching mathematics in the Intermediate and Senior Phases (Grades 4-9), appear to have an uncertain understanding of what is needed when setting their mathematics assessment tasks (Gao et al., 2020).

In line with the above statements, the following sections are aligned to three research aims of this study as indicated in Chapter 1. The first section highlights the balancing of mathematics assessment tasks, while the second looks at implementing assessment strategies to assess problem-solving, while the third sections examines teachers' knowlegde and skills of assessment to include problem-solving. Lastly the chapter provides the conceptual framework which guides this study..

2.3 CREATING A BALANCE IN MATHEMATICS ASSESSMENT TASKS

As previously indicated assessment is an integral part of the teaching and learning process (Wiliam, 2011) and can either be baseline, diagnostic, formative or summative. During the course of the year, assessments are either formative or summative with formal assessments comprising a number of school-based assessment (SBA) and end of year examinations. The SBA should take various forms such as tests, projects, assignment, investigations and examinations (DBE, 2011:154-155). To ensure balance in the assessment task, teachers are guided by a minimum requirements framework which offers descriptions of the cognitive levels, see Table 2.1.

Table 2.1: Description and examples of cognitive levels

DESCRIPTION AND EXAMPLES OF COGNITIVE LEVELS		
Cognitive levels	**Description of skills to be demonstrated**	**Examples**
Knowledge (≈25%)	• Estimation and appropriate rounding of numbers • Straight recall • Identification and direct use of correct formula • Use of mathematical facts • Appropriate use of mathematical vocabulary	1. Estimate the answer and then calculate with a calculator: $\frac{62\,816}{325+279}$ **[Grade 7]** 2. Use the formula A = πr^2 to calculate the area of a circle if the diameter is equal to 10 cm. **[Grade 8]** 3. Write down the y-intercept of the function $y = 2x + 1$ **[Grade 9]**
Routine procedures (≈45%)	• Perform well-known procedures • Simple applications and calculations which might involve many steps • Derivation from given information may be involved • Identification and use (after changing the subject) of correct formula • Generally similar to those encountered in class	1. Determine the mean of 5 Grade 7 learners' marks if they have respectively achieved 25; 40; 21; 85; 14 out of 50. **[Grade 7]** 2. Solve x in $x - 6 = 9$ **[Grade 8]** 3. R600 invested at r% per annum for a period of 3 years yields R150 interest. Calculate the value of r if $SI = \frac{Pnr}{100}$. **[Grade 9]**
Complex procedures (≈20%)	• Problems involving complex calculations and/or higher order reasoning • Investigate elementary axioms to generalize them into proofs for straight line geometry, congruence and similarity • No obvious route to the solution • Problems not necessarily based on real world contexts • Making significant connections between different representations • Require conceptual understanding	1. Mr Mnisi pays R75 for a book which he marks up to provide 20% profit. He then sells it for cash at 4% discount. Calculate the selling price. **[Grade 7]** 2. A car travelling at a constant speed travels 60 km in 18 minutes. How far, travelling at the same constant speed, will the car travel in 1 hour 12 minutes? **[Grade 8]** 3. Use investigation skills to prove that the angles on a straight line are supplementary. **[Grade 9]**
Problem solving (≈10%)	• Unseen, non-routine problems (which are not necessarily difficult) • Higher order understanding and processes are often involved • Might require the ability to break the problem down into its constituent parts	1. The sum of three consecutive numbers is 87. Find the numbers. **[Grade 7]** 2. Mary travels a distance of km in 6 hours if she travels at an average speed of 20 km/h on her bicycle. What should be her average speed if she wants to cover the same distance in 5 hours? **[Grade 8]** 3. The combined age of a father and son is 84 years old. In 6 years time the father will be twice as old as the son was 3 years ago. How old are they now? **[Grade 9]**

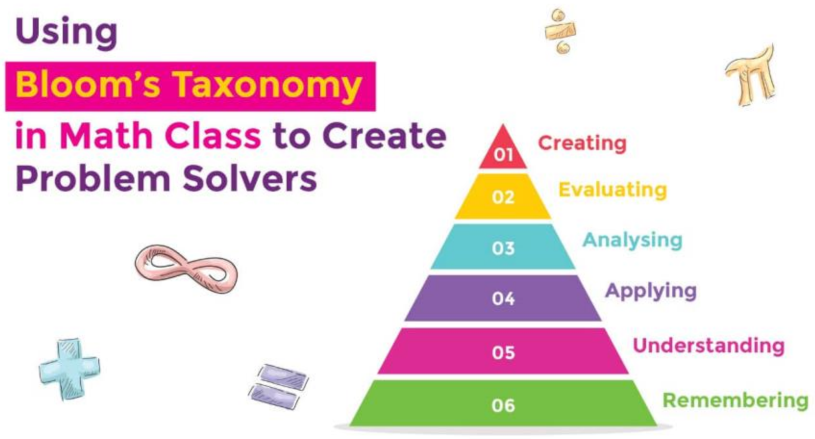
(Source: DBE, 2011: 157)

Although teachers are guided by such a framework, teachers' ability to balance assessment tasks that accommodate problem-solving is a challenge identified in mathematics teaching and learning. Veldhuis and Van Heuvel-Penhuisen (2020) observed that teachers face the challenge of balancing assessment tasks that sufficiently test learning outcomes while promoting the development of problem-solving skills among learners. Tekkumru-Kısa and Stein (2015) indicate that teachers often choose tasks dependent on procedural skills or memorised knowledge. This means that teachers turn problem-solving assessment tasks into routine mathematical exercises that rely on procedural skills as they are challenged in balancing assessment takes. Based on this introduction, the following section discusses various challenges experienced by teachers in balancing assessment tasks.

2.3.1 Knowledge and Skill in Balancing Assessment Tasks

Teachers' knowledge and skills on balancing assessment tasks strongly influence the assessment practices in the classroom (Mehta, 2023). According to Reyneke, Meyer and Nel (2010), it is crucial that teachers possess knowledge and skills of balancing assessment tasks. However, a detailed study conducted by Mnisi (2013) revealed that teachers tend not to design their own assessment tasks; they rely solely on the textbooks for classwork and homework to give to learners. However, Jäder, Lithner and Sidenvall (2020) discovered that teachers rely on textbooks for task selections because it was the only resource available for them and that using textbooks as a source for tasks helps them save time or they prefer to alter existing activities from a textbook or past question papers rather than create their own. This discovery supports the recommendation made by Hadar and Ruby (2019) that teachers should not only rely on mathematics assessment tasks from textbooks, but also employ their ingenuity in creating assessment tasks that engage learners.

In order to design effective assessment tasks, teachers need to have the knowledge and skills of balancing assessment tasks (Mnisi, 2013). Teachers should use assessment taxonomy (for example Bloom's Taxonomy) as a guide in order to enhance their assessment tasks.



(Source: Chauhan, 2020)

Figure 2.1: Bloom's taxonomy

Becevic (2023) explains that taxonomies are utilised to ensure that assessment contains a range of questions with varying levels of complexity to test different concepts and skills. Another study by Ulusoy and Incikabi (2020) indicated that teachers recommended textbooks as their source of assessment because they believe textbooks help develop their (teachers') knowledge. However, a study conducted in South Africa by Mkhathswa and Doerr (2016) found that textbooks used in schools were either outdated or not appropriate. They suggested that the selection of relevant textbooks should be treated more seriously by allowing for more time for examination and trialling finding the most appropriate for the context. The greater the diversity of textbooks that are routinely produced makes the process of selecting textbooks for teachers rather difficult. As a result, many teachers restrict themselves to using only one or two textbooks. With this, Mkhathswa and Doerr (2016) recommend that teachers do not rely only textbooks as their source of mathematics assessment.

Within line with Mkhathswa and Doerr (2016), Bellens, Van den Noortgate and Van Damme (2020) also dispute the use of textbook as a primary source. They encourage teachers to use their own knowledge to balance assessment tasks, and further stress that assessment tasks must represent the way in which learning had taken place of which the teachers are the only people who know what has been going on in their classrooms. According to Henningsen and Stein (1997), there is frequently a gap between the intended curriculum of the curriculum (CAPS in the South African context) and how the intended curriculum is implemented and endorsed by the textbooks, particularly the assessment tasks.

Rezat, Fan and Pepin (2021) revealed that textbook assessment tasks are well structured even those that involve problem-solving and word problems that invoke a supposed real-world context. In contrast, Jamaludin and Hung (2017) discovered that textbook problem-solving tasks are restricted in their capacity to give opportunities for learners to practise crucial components of twenty-first century competencies and abilities that are badly required to face chronic global concerns. Both Rezat et al. (2021) and Jamaludin and Hung (2017) believe that teachers need to be very careful of their choice of textbooks to source their assessment tasks and should learn to balance mathematics assessment tasks with their own task which support high-order thinking like problem-solving and transformation.

Mathematics assessment tasks should and must encourage higher order thinking, as required by the curriculum, which includes complex abilities like analysis and synthesis (van den Berg, 2004). However, higher-order thinking is unlikely to occur unless tasks as specifically designed for learners to engage in activities that promote this kind of thinking (van den Berg, 2004). Mnisi (2013) proposes that teachers should be guided by the mathematics assessment task hierarchy (MATH) when creating and developing their mathematics assessment tasks. According to Mnisi (2013), this hierarchy is a good guide to utilise since it assures that assessment activities that foster higher order thinking are included. Furthermore, Mnisi (2013) argues that the MATH was established to serve as a tool for producing tests that evaluate a wide range of talents and knowledge while also allowing learners to reflect on their learning. A further example of an assessment task hierarch is given by in the Subject Assessment Guidelines for Mathematics (SAGM) taxonomy where it is anticipated that cognitive level increases with the type of mathematical task; that is, memorisation has the lowest cognitive level, then routine procedures, then complex procedures, then problem solving (Berger, Bowie & Nyaumwe, 2010).

2.3.2 Knowledge of Problem-Solving

According to Usmonov (2021), the use of problem-solving skills is important in how learners master the general method of problem analysis and how they learn the tools to help them solve problems on their own. Teachers' knowledge of problem-solving plays an important role as it guides learners to understand the process of problem-solving and helps in guiding learners to solve problem-solving assessment tasks (Csíkos & Szitányi, 2020). According to Csíkos and Szitányi (2020) teachers are expected to understand problem-solving and to be able to solve problems themselves before they teach learners. This means that they need to have a high level of mathematical common content knowledge (Csíkos & Szitányi, 2020).

Although teachers' knowledge of problem-solving is significant, a detailed study conducted by Siswono, Kohar and Hartono (2019) revealed that teachers had inadequate knowledge of problem-solving and what problem-solving entail, which has a not so good impact on their teaching and assessment of problem-solving. They discovered that teachers found it difficult to create problem-solving tasks for learners, which hindered the development learners' problem-solving skill proficiency and critical thinking skills (Siswono et al., 2019). Son and Fatimah's (2020) research discovered that mathematics teachers and learners achieved low marks in solving tasks that had problem-solving questions which indicated that both learners and teachers do not have a good comprehension of problem-solving. It is thus vital that teachers engage in professional development to ensure that subject and pedagogical content knowledge is developed.

In the United State of America, Monarrez (2017) conducted a study and discovered that teachers had challenges solving tasks of higher-level cognitive demands, like problem-solving. Stein et al. (2009) established that teachers in their professional development workshop had challenges in categorising tasks at Level 3 (complex procedure) or Level 4 (problem-solving), they were only able to categorise Level 1 (knowledge) and Level 2 (routine procedure) tasks. Teachers in research by Bardy, Holzäpfel and Leuders, (2021), had difficulties categorising their own assessment tasks, and they frequently identified a task as a Level 3 when it was a Level 2.

The findings of Bardy et al. (2021) concur with the findings of Boston (2013), which indicate that teachers had difficulty in categorising tasks at each of the four levels. Boston (2013) suggested that more research needs to be done to understand the differences between problem-solving tasks and complex procedure tasks and to examine how teachers should construct problem-solving tasks as per each level. Thus, engaging teachers in a discussion about the differences between a procedural task and a problem-solving task should be part of professional development.

Research conducted in South Africa by Sepeng and Madzorera (2014) discovered that, while problem-solving was described as the capacity to read and answer mathematical issues, teachers were unable to cultivate this skill in their learners since they themselves were unable to solve word problems. As a result, learners are unable to build a good understanding of mathematical principles buried in word problems. Sepeng and Madzorera (2014) suggest that teachers should engage in professional development in terms of teaching problems solving to ensure that they have the relevant knowledge and skills (subject and pedagogical content knowledge) to empower them to aid learners develop cognitive and effective skills to assist in solving problems.

2.3.3 Problem-Solving included in Assessment Tasks

Mathematics assessment tasks are what learners do in a classroom (Mason & Johnston-Wilder, 2006) but are considered more than just items utilised to transmit information; they also steer learners to specific mathematical concepts and develop vital skills (Stein, Grover & Henningsen, 1996) such as reasoning, mathematical thinking and problem-solving, as required by the South African Department of Basic Education (DBE). The consistent inclusion of problem-solving in teachers' assessment tasks has been shown to develop learners' conceptual understanding of mathematics (Stein & Lane, 1996). According to Taley (2022), teachers use problem-solving tasks to strengthen learners' mathematical calculation skills which also promote higher-order thinking skills. This indicates that the inclusion of problem-solving tasks is critical and teachers should include them in their assessment tasks.

Despite the argument that support the importance of problem-solving tasks in teachers' assessment, as discussed above, teachers often struggle to include problem-solving in their classroom assessment tasks (Parrish & Bryd, 2021). A study conducted by Mdladla (2017) indicated that teachers excluded problem-solving in their assessment tasks, rather including lower-order tasks and tasks that did not prompt mathematical thinking. Mdladla's findings are consistent with those of Mahlangu (2021), who discovered that teachers mostly assigned routine procedure and recall-type questions using pure mathematics, which are characterised as lower-order thinking tasks. This means that when teachers do not include allow problem-solving questions in their assessment tasks; they do not give learners in the opportunity to develop higher-order skills.

Zohar's (2004) study, conducted in Israel, examined classwork, homework, and tests set by teachers. Zohar analysed these assessments using Blooms taxonomy and found that in all the tasks problem-solving was excluded. Furthermore, teachers changed the problem-solving task to procedural tasks. Adding to Zohar's findings, King (2019) discovered that teachers changed the problem-solving tasks to procedural tasks for their learners to perform better. They found that teachers prefer tasks that are easy to score. However, when teachers decrease the complexity of the tasks, the anticipated purpose of the task is lost as well.

The underperformance of learners in problem-solving tasks is confirmed by Osman, Yang, Abu, Ismail, Jambari, and Kumar (2018) who found that in Malaysia learners performed poorly in problem-solving tasks because they failed to understand the mathematical language. The researchers thus advised teachers to stop using traditional teaching methods and teacher-centred approaches. They recommended that teachers need to come up with strategies that will improve problem-solving skills in learners so that they perform well in problem-solving assessment tasks.

2.3.4 Teachers' Beliefs about and Attitudes towards about Problem-Solving

Developing mathematical assessment tasks that focus on problem-solving is imperative for developing learners' understanding of mathematical concepts (Ahmad & Duskri, 2018). According to Nggaba (2019) the inclusion of problem-solving tasks provides solid benefits on learners and as mentioned in previous sections (Section 2.3.2 and Section 2.3.3), higher-order thinking skills are evoked through problem-solving tasks which help learners to perform better in mathematics. Some studies reveal that teachers have a negative view of problem-solving tasks. Bullock (2015) found that problem-solving tasks are the most feared, disliked and dreaded assessment tasks. A study conducted by Murray (2012) revealed that teachers are concerned about including problem-solving tasks in their assessment because learners tend dislike them and become anxious when they have to solve them. Teachers' beliefs and attitudes matter because they influence teachers' assessment techniques (Martínez-Sierra, García-García, Valle-Zequeida, & Dolores-Flores 2020) As a result of knowing how beliefs and attitudes impact assessment practice, it is critical to take note of the teaching process (Martínez-Sierra et al., 2020).

Beliefs and attitudes are crucial in shaping pedagogy in particular subject areas (Watson & Ohtani 2015). A study conducted in Spain by Lera and Piquet (2014) found that teachers' beliefs and attitudes to problem-solving were negative, which resulted in them avoiding engaging learners in problem-solving assessment tasks. Lera and Piquet (2014) discovered that these beliefs and attitudes were strongly associated with the training programmes that teachers underwent during their first education stage. Additionally, these opinions were also closely related to teachers' teaching experiences and lack of proper training on problem-solving in their pre-service training.

A study conducted in Ghana by Taley (2022) indicated that high school teachers appreciated the importance of problem-solving tasks. Still in Ghana, another study discovered that teachers view mathematics problem-solving both positively and negatively (Armah & Robson, 2018). Armah and Robson found that teachers who had a negative attitude towards problem-solving avoided including the problem-solving tasks and indicated that their learners face challenges when solving the tasks, which is also the case in South Africa as reflected in the study conducted by Sepeng and Madzorera (2014). Alsuhaibani (2019) claimed that teachers' beliefs about learners' learning are critical. Alsuhaibani (2019) found that teachers believed their learners were not ready for problem-solving tasks reducing the cognitive level of the tasks by changing tasks form problem-solving to routine procedures. This again indicates that teachers' beliefs strongly influence their assessment practices.

A study conducted by Palraj, DeWitt and Alias (2017) in rural secondary schools in Malaysia indicates that teachers believe that problem-solving is important and useful for learners' development. However, there were contradictions in to this as teachers in their classroom practices excluded problem-solving task and emphasis was put on memorisation of facts. This indicates that there are challenges in teaching and assessment practices with calls for the Malaysian education system to be amended for learners to be on equivalence with learners from other countries (Abdullah & Peters, 2015).

2.4 ASSESSMENT STRATEGIES TO ASSESS PROBLEM-SOLVING

As indicated earlier, assessment strategies used by teachers can take various forms such as informal daily assessments through discussions, learner-teacher conferences, observations, practical demonstrations and informal classroom interactions (DBE, 2011: 156). The following sections discuss the use of assessment strategies to offer learners the opportunity to engage in high level

2.4.1 Teaching Strategies used by Teachers

Being able to implement effective teaching strategies is central in the teaching and learning process (Szabo et al., 2020). Teachers must be able to change their ways of teaching based on learners' needs and be able to use different teaching strategies that promote problem-solving skills in a mathematics classroom. Although there are numerous teaching strategies that can be utilised in mathematics classroom to promote problem-solving, research indicates that teachers use traditional teaching methods and teacher-centred approaches (Szabo et al., 2020). These teaching methods deprive learners of using their thinking skills throughout the lesson.

In South Africa research revealed that teacher-centred approach teaching strategies are dominant (Mahlangu, 2021). According to Mahlangu (2021), teachers frequently practice direct teaching, which is a teaching strategy that do not allow learners to learn from each other but the teacher passes the skills and information to the learners. According to Wijaya, Van den Heuvel-Panhuizen, Doorman and Veldhuis (2018), the teacher just positions himself or herself in front of the learners like a preacher and delivers the lesson during this technique. As a result, learners are expected to attentively follow directions. This style denies learners the chance to partake in problem-solving activities. The method also encourages memorisation and recitation. Mdladla (2017) discovered that learners were denied the chance to solve and engage in problem-solving activities because teachers concentrated on drill and practice teaching strategies. According to Mdladla (2017), this strategy is unproductive since it does not develop a profound degree of learner knowledge because the teacher becomes a primary source of information.

A study by Lee and Kim (2005) conducted in the United State of America (USA) found that teachers in their mathematics lessons were the predominant source of information as they frequently used traditional lecturing as their teaching strategy, which is a strategy where a teacher introduces the lesson, develops it and reviews it. Similar findings were also found in Ireland by Pehkonem, Naveri, and Laine (2013) who revealed that teachers were the only ones talking and writing on the board (using chalk-and-talk method) and learners had to listen. Traditional lecturing and chalk-and-talk methods normally promote memorisation and deprive learners from engaging in problem-solving skills which can be applied to their lives (Akhter, Akhtar & Abaidullah, 2015).

Akhter et al. (2015) conducted research that revealed that the dominant teaching strategy used in Pakistan is a traditional lecturing method. They further discovered that teachers used this method because of time and dependence on textbooks. Their research revealed that teachers do not have enough time to cover all the content required by the curriculum. Overcrowding was also one of the justifications that teachers offered about using teaching strategies that develop problem-solving skills in learners.

Moreover, “problem-solving is not accommodated properly in the curriculum that relies too much on textbooks and an assessment system overburden with formal examination that reinforce recall skills” (Akhter et al., 2015: 4).

2.4.2 Assessment Strategies used by Teachers

Bosica, Peyper and Macgrager (2019) assert that the assessment strategies used by teachers to assess problem-solving assessment tasks are essential and drive the learning process. Neppl (2019) claims that mathematics teachers and the learner should engage with one another and that learners should also engage with other learners during the learning and assessment process. Neppl (2019) further suggests that when teachers assess problem-solving questions in mathematics assessment tasks, they should engage with their learners because the three-way interaction that an individual learner has with the teacher and other learners may be critical in improving learners' achievements in problem-solving mathematics assessment tasks. Gertrude (2015) agrees that learners in a collaborative learning environment develop higher-level thinking skills and recall information longer than those who work silently as individuals. Additionally, the active exchange of ideas within small groups increases interest among learners and promote critical thinking.

Even though the arguments above support the use of effective assessment strategies in a mathematics classroom, research indicates that teachers do not use assessment strategies that effectively assess problem-solving as teachers lack knowledge of assessment strategies for problem-solving (Chew, Shahril & Li 2019). A study conducted in Sweden by Palm, Andersson, Boström and Vingsle (2017) discovered that learners’ poor performance in problem-solving was caused by the assessment strategies that teachers used to assess learners. They discovered that the assessment strategies were ineffective and did not help improve the achievement of learners.

Chew et al. (2019) discovered that teachers during assessment do not engage with learners. Furthermore, they show learners examples of how to solve a problem and let the learners to find the solutions on their own without engaging with them. Wei et al. (2020) explained that in everyday classroom activities especially in a problem-solving task, it is imperative that the teacher observe what learners are doing and then help them to become aware of their misconceptions or omissions.

A study conducted in Singapore by Fan and Zhu (2007) discovered that during their classwork activities, teachers wrote a problem to solve on the board without offering learners an explanation and then asked learners to work out a problem on their own. Additionally, teachers looked at the textbook to find the problems there. Fan and Zhu (2007) argued that teachers need to help learners understand the problem, to assist them in coming to a decision about a possible plan of action that may lead to a solution, to encourage them to 'carry out the plan of action' and to persist with the plan if it is leading to an appropriate solution; but to discard the plan and try a new one if the initial plan does not lead to a solution. Furthermore, a teacher might encourage learners to reflect on the plausibility of their solution and make judgments where necessary.

Similar findings emerged in South Africa when Molotja (2008) revealed that teachers in disadvantaged schools explained the problem to the learners and code-switched to their home languages so that learners could develop a better understanding. It was observed that learners had to work on the problem on their own and problems were sourced from a textbook. Teachers walked around the classroom during classwork activities but did not assist the learners. Furthermore, Sethusha (2012) observed that overcrowding deprived teachers of incorporating assessment strategies like verbal arguments, written explanations, group work, planning, and interpretation of solutions. Teachers' stress that using group work, verbal interactions and interpretation of solutions during mathematics assessment results in their classes being uncontrollable and chaotic. However, Henningsen and Stein (1997) argue that it is imperative that when teachers work on a problem-solving task, they use an assessment strategy that allows learners to reason and think critically. Thus, teachers should be exposed to different assessment strategies that they can incorporate in their assessments so that it is effective.

2.4.3 Inclusion of Higher Order Questions in Assessment Tasks

The questions that a teacher asks in a classroom can promote mathematical discourse (Tambunam, 2019). Good questions can support good mathematics classroom practices, encourage learners to actively participate in assessment tasks, promote mathematical conversations and assist learners in constructing their own mathematical meaning (Mdladla, 2017). Furthermore, good questioning helps learners to have an improved understanding of mathematics, enriching their experience in mathematics. Researchers indicate that it is imperative that teachers ask good questions in their mathematics classroom as what happens in a mathematics classroom is closely influenced by the teacher's questions (Tambunan, 2019). However, research by conducted by Baskoro and Retnawati (2019) indicates that when teaching and assessing mathematics in their classroom teachers exclude higher order questions like problem solving, further indicating that teachers change higher order questions to low-order questions. Teachers tend to ask low-order questions to save time and to ensure that learners do not to struggle with answering questions (Baskoro & Retnawati, 2019). They indicated that they spend too much time explaining and learners will struggle to solve those tasks hence they resort to asking questions that would be easy for learners to tackle. They argue that too many easy questions deprive learners from engaging in an active learning environment.

A study conducted in the USA by Garret (2008), which aimed to find how teachers create an active learning environment through questioning, corresponds with the findings of Baskoro and Retnawati. Garret discovered that teachers believe that asking short question like "do you understand?" "Can you see how I got the answer?" which require learners to give a direct answer, are good for maintaining disciplining in learners and covering all the work required on time. Mdladla's (2017) study conducted in South Africa discovered that teachers during their lesson seemed to be in a rush to finish a lesson on time and be on par with the Annual Teaching Plan (ATP) as they set short amount of time for learners to work on a task and did not engage learners in questioning that required them to reason. Additionally, 97% of questions asked in a classroom required learners to answer yes/no. Furthermore, teachers spent most of the time explaining and did not allow the learners to think and engage in meaningful mathematics problems. According to Henningsen and Stein (1997) this type of questioning does not stimulate higher-order thinking among learners.

Another study conducted in South Africa by Jina and Brodie (2008) found that teachers are conscious of the significance of asking high-order questions but did not engage learners in questions that promote problem-solving or reasoning. Jina and Brodie (2008) further explain that even though teachers allowed learners to work in groups, they did not encourage learners to communicate and discuss the problems but rather only to do pure mathematics. The questions that the teachers asked did not provoke learners into becoming critical thinkers. Concurring with Jina and Brodie (2008), is Hsu (2013) who conducted a study in Taiwan. Hsu (2013) found that teachers used a large number of closed-ended questions and learners were deprived of the opportunity to demonstrate their thinking of how they reached the solution to the problem. Hsu (2013) thus argues that when teachers use group discussions in a mathematics classroom it requires learners to use high-order thinking, while closed-ended questions require low-order thinking. Howe et al. (2019) believes that during group discussions teachers should ask learners questions such as “How did you…?” and “what if…?” because these questions require high-order thinking and help learners become critical thinkers. They further explain that questions like “give an example of…?”, “Is it true that…?” are higher-order questions and teachers should ask such questions during their assessments.

2.5 TEACHERS’ KNOWLEDGE OF ASSESSMENT

When learners are engaged in all type of assessment tasks that reflect various cognitive levels, they become engaged and more active in their learning (Tekkumru-Kisa, Stein & Schunn, 2015). However, teachers’ ability to use their knowledge of assessment tasks to balance the nature of tasks and cognitive demands is important in the learning and teaching of mathematics. This assessment knowledge is related to Shulman's (1986) subject content knowledge (SCK), which is the mathematics knowledge that teachers should have in order to teach a specific concept of mathematics and includes conceptual and procedural understanding of specific mathematical ideas (Shulman, 1986). Teachers frequently fail to deliver concepts for students' understanding when they lack in-depth knowledge of a particular concept (Ball, Thames, & Phelps, 2008) and do not know how to represent the idea and make it comprehensible and understandable (Shulman, 1986). This element is concerned with pedagogical content knowledge (PCK).

2.5.1 Types of Mathematical Assessment used in Classrooms

According to Parrish and Martin (2020), a task may be characterised as a mathematical challenge created by teachers to provide learners with appropriate information, skills, and abilities. Burkhardt and Schoenfeld (2019) stated that mathematics assessment tasks involve tasks given to learners during and after teaching; in and out of the classroom. These activities may include homework, classwork, investigations, projects, examinations, problem-solving and problem posing tasks and are highly commended as supportive tools in recognising learning objectives (Yu & Singh, 2018). Even though research highly recommends the administering of classwork and homework in a mathematics classroom (Yu & Singh, 2018), a study conducted in Jerusalem by Dandis (2013) indicated that teachers mostly use written examinations to assess their learners. They reported using some alternative assessment methods, but on occasion, the teachers expressed dissatisfaction with the methods they use and preferred direct observation to assess their learners. However, studies conducted in South Africa and in the USA by Mahlangu (2021) and Yu and Singh (2018) respectively indicate that teachers have sufficient knowledge of these assessments and it was found that in their classrooms they administered homework and classwork daily. Diagnostic and baseline assessments were found to have been administered at the beginning of the year.

2.5.2 Teachers' use of Knowledge of Assessment to Balance the Nature of Tasks

Wijaya et, al (2018) identified that the nature of tasks could relate to contextual, numerical and problem-solving tasks. Below is a table that distinguishes the nature of tasks and their examples in fractions.

Table 2.2: The nature of assessment tasks

Nature of Task	Explanation	Examples
Contextual tasks	These tasks are characterised by contexts that is experientially real (Wijaya et al. (2018).	1. The product of two fractions is $\frac{9}{14}$. What could they be?
Numerical tasks	These tasks are easy and learners need to recognise the rules to solve the problem and learners participate in rote memorisation. They are low-order thinking (Hiebert, 2013).	Add the following fractions: a). $\frac{5}{6} + \frac{4}{6}$
Problem-solving tasks	These tasks can be represented by diagrams, symbols and real-life situations and are high-order thinking tasks (Wijaya et al., 2018).	1. A baker uses $1\frac{4}{5}$ of 10kg bag of flour each day. How much flour does he use? a) In a day b) In a week

(Source: Wijaya et al., 2018)

According to Coles and Brown (2016), the form of the mathematics assessment problem has a significant influence on mathematics teaching and learning. According to the type of assignments can influence and systematize learners' thinking (Henningsen & Stein, 1997 and Viseu & Oliveira, 2017). Furthermore, it broadens learners' perspectives on mathematical tasks that they are exposed to throughout mathematics classes. According to Wijaya et, al (2018), mathematics assessment tasks such as classwork and homework and those administered out of classroom, must be numerical, problem-solving and contextual in nature. Even though the above researchers (Coles & Brown 2016 and Wijaya et, al 2018) support the balancing of the nature of tasks in an assessment task, studies indicate that teachers do not create a balance as they may not have adequate knowledge of assessment.

A study conducted by Ubuz, Erbaş, Çetinkaya, and Özgeldi (2010) in Turkey aimed to provide a standpoint on the nature of the mathematics assessment tasks in an elementary school (primary school). The focus was only on algebra assessment tasks. The findings discovered that 60% of algebra assessment tasks were numerical and had low cognitive demands. Concurring with the findings of Ubuz et al. (2010), is a study in South Africa conducted by Mahlangu (2021) which indicates that teachers focused only on numerical (pure mathematics) tasks in their learning assessments tasks (classwork and homework). According to Wood (2017), all of these activities generate information that may be utilised to alter teaching and learning during and after an assessment. In agreement with Ubuz et al. (2010), Blum (2015) believes that each assessment task must be relevant and beneficial in order for learners to build mathematical knowledge and abilities.

2.5.3 Teachers' use of Knowledge of Assessment to Balance the Cognitive Demands

Stein and Kaufman (2010) define an assessment task's cognitive demand as the cognitive processes required to complete the mathematics task successfully. Estrella, Zakaryan, Olfos and Espinoza (2020) define balanced mathematics assessment tasks as those consisting of a range of cognitive demands. Teachers may plan lessons and assessment that involve learners' thinking developments and eventually lead to improved knowledge of mathematical subject if they are aware of and balance these cognitive demands appropriately (Stein & Kaufman, 2010). Lower- and higher-order thinking are two types of cognitive demands recognised in the literature that should both be included throughout mathematics assessment tasks. A lower-order thinking cognitive level is characterised by information recall, learners are required to perform simple mathematical operations and solve problems that they are familiar with, while higher-order thinking cognitive level is characterised by problem-solving tasks and require learners to think critically (Martalyna, Isnarto, & Asikin, 2018).

When teachers select tasks with a range of cognitive levels, they help learners to develop skills required for understanding basic mathematics (Martalyna et al., 2018).. If mathematical activities involve a high degree of cognitive demand, these assessment tasks should develop high-level cognitive processes in learners, such as thinking about the mathematics ideas involved, formulating justifications, problem-solving, and so on. According to National Research Council (NRC) and Mathematics Learning Study Committee (MLSC) (2001) assessment tasks requiring high cognitive levels help learners to think critically and it develop problem-solving skills.

It is imperative that teachers balance both cognitive demands (low-order and high-order) in their mathematics assessment tasks to grasp both levels of learners' capability in comprehending mathematics ideas, concepts and information (Russo and

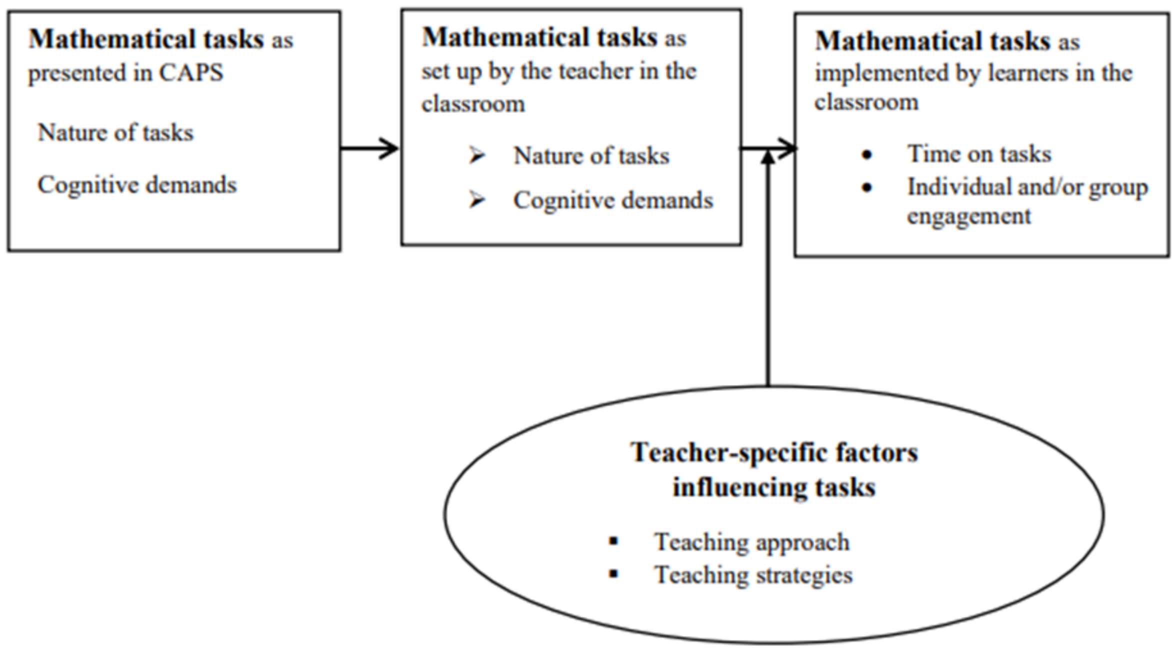
Hopkins, 2017). Balancing these two cognitive levels is important, as they give learners a chance to solve problem-solving assessment tasks and teachers get to observe how learners react when they are given tasks that are challenging so that they can find ways to address those challenges (Russo & Hopkins, 2017).

Even though the above arguments call for the balancing of cognitive levels, research indicates that teachers do not balance the levels in their mathematics assessment tasks. Researchers (Jina & Brodie, 2008, Tekkumru-Kisa, Stein & Schunn, 2015; Mdladla, 2017; Mahlangu, 2021) have found that the majority of tasks were pitched at low order cognitive levels and easy for learners to perform. Research conducted by Aziz and Kharis (2021) found that teachers conceptualised their assessment tasks by changing high-order cognitive level tasks to low-order cognitive levels when they saw that learners were frustrated and not making progress in their assessment tasks. Stein et al. (2000) found that teachers change their problem-solving tasks from high-order cognitive levels to procedures without connection to meaning. They further explain that teachers justified their act by stating that when they allow their learners to work on the high-order cognitive demands tasks their learners spend too much time working on task and end up failing to finish the task. However, the Department states that the cognitive demands stipulated in CAPS Senior Phase document should be included in the assessment tasks so that meaningful learning can take place (DBE, 2018).

2.6 CONCEPTUAL FRAMEWORK

According to Van der Waldt, (2020) a conceptual framework is a structure of theories, concepts, expectations, beliefs, and assumptions that supports and enlightens research. The role of a conceptual framework is that of demonstrating how the research fits to what is known (Varpio et al. 2020).

In this study, Henningsen and Stein's (1997) model of progression of mathematics tasks is adopted as a conceptual framework underpinning the study. This framework will support in the establishment of the perspectives through which the researcher can view the problems related to assessment and inclusion of problem-solving in assessment tasks. In this study, the model of progression for assessment tasks is utilised to offer the researcher's point of view on challenges related to the topic at hand. The progression model is depicted in the figure below.



(Source: Henningsen & Stein, 1997)

Figure 2.2: Model of task progression

According to Henningsen and Stein's (1997) model of progression, the mathematical activities are represented by two pillars namely: Pillar Number 1 containing the mathematics tasks (represented by the three boxes in the above figure) and Pillar Number 2 containing the teacher specific factors (represented by the oval shape in the above figure).

Pillar Number 1 has three stages through which the mathematics activities progress. The three stages, intended curriculum, the interpreted curriculum and the implemented curriculum, and how the teacher-specific factors affect the stages are discussed below:

The *first stage* is how the task is initially represented in the curriculum, in the South African context in the Curriculum and Assessment Policy Statement (CAPS), taking into consideration the nature of task and the cognitive demand (Parrish & Martin, 2020). Firstly, regardless of where the work began, there is a low likelihood that the task will be executed as balanced if it does not start off as cognitively challenging (Stein & Kaufman, 2010). Secondly, the nature of task refers to the opportunities for learner engagement and reasoning that are impacted by a task's presence of multiple solution strategies, its degree of flexibility to multiple representations, and its emphasis on justification and explanation (Stein et al., 1996).

The *second stage* is the mathematical task as set up by the teacher in the classroom, which is how the assessment task is introduced by the teacher (Jackson et al., 2013). How the task is introduced may vary from simply telling learners they can get started, to more elaborate explanations of the task requirements, available resources and context (Stein & Kaufman, 2010). Although the degree to which teachers present tasks may vary, Russo and Hopkins (2019) identified two key ways which impact the implementation of an assessment task. Firstly, how the assessment task is presented will directly influence which learners can engage with it and how. Secondly, how the assessment task is introduced influences the sort of work the teacher does throughout task implementation, such as assisting learners while they work on the task. Two criteria (the nature of tasks and cognitive demands) from Henningsen and Stein's (1997) model of task progression should be taken into account which will assist teacher in indicating or promoting the cognitive demands and nature task (Stein et al., 1996). For example, although a task may require learners to solve the problem using at least two different representations, the teacher might reduce this requirement during the launch and only require learners to solve the task using one representation.

The *third stage* is mathematical task as implemented by learners in the classroom, which is how learners interact with the assessment task. Both the cognitive demand and the nature of task correspond to how learners are really interacting with the task's material throughout task implementation (Boston & Smith, 2009). For instance, in terms of cognitive demand, do learners genuinely analyse and reason with the task's mathematics content as expected? Are learners genuinely employing numerous solution options given the nature of the task?

Pillar 2 represents teacher-specific factors that influence tasks which relates to how teaching strategies and teaching approaches influence mathematics tasks as designed by teachers and implemented in the classroom (Attard & Holmes, 2022). The teaching strategies and approaches that teacher choose influences the nature of tasks, the cognitive demands of tasks, the time spent on tasks by learners and learner involvement in a mathematics task.

The sections below further explain the mathematics assessment tasks and how they are influenced by the cognitive demands, nature of tasks and teaching approaches and strategies as well as the teacher-specific influencing aspects of teaching approach and strategies.

2.6.1 Mathematics Assessment Tasks

- **The nature of the tasks**

The nature of tasks affects mathematics teaching and learning in so many ways, for instance it affects the concepts and ideas presented, it affects the learning of mathematics by learners, and the learners' attainment of mathematical skills and knowledge (Coles and Brown, 2016). Homework, classwork, investigation, projects and assignment are assessment tasks that teachers can give to learners and are expected to have different nature of tasks. Additionally, these mathematics assessment tasks support teachers to improve abstract understanding of the learners in line with the curriculum requirements (Spaull, 2013).

- **The cognitive demand of the tasks**

The emphasis on mathematical assessment tasks affects the motivation for learners to study since they set a specific level of cognitive demands on learners (Henningsen & Stein, 1997). According to Henhaffer (2014) the phrase "cognitive demands" speak of to the types of thought procedures involved in problem resolution. Teachers may be able to construct assessment tasks that engross learners' cognitive processes and eventually learners' achievement will improve if they are aware of these expectations.

2.6.2 Teacher-Specific Factors Influencing Tasks

- **Teaching approach**

According to Ko & Sammons (2013) the manner of teaching and assessment affects learning outcomes. Teachers' methods of teaching in the classroom, whether learner-directed, teacher-directed or a hybrid of the two, are frequently a straight reflection of their views about mathematics. As a result, teachers' pedagogical strategies are inseparably linked to how they select and balance their tasks (in class and out of class). This implementation procedure has the ability to either inhibit or improve learners' mathematical understanding.

- **Teaching strategies**

Mathematics requires a good foundation to equip learners with problem-solving skills (Mehta, 2023). Effective teaching is far more about the learning environment created in the classroom by the teacher than it is about the teacher's behaviour (Saleem et al., 2013). The classroom atmosphere is influenced by teaching strategies such as cognitively driven teaching, discussion-based collaborative learning and engaging classroom demonstration (Ismail et al., 2015). What learners know about mathematics is nearly entirely determined by their regular classroom experiences.

- **Learner engagement and time on task**

According to Brezovszky et al. (2019) efficient time management and some level of learner involvement inside the classroom are required for optimal learning. Teachers should design their classes so that learners have enough time to actively participate in solving these problems, either in groups and individually.

2.7 CONCLUSION

This chapter provided a critical exploration of perspectives on topics such as knowledge and skills of balancing of assessment tasks, the nature and purpose of mathematical problems, and how teacher-specific influences and setting of assessment tasks impact learner involvement and engagement. The final section presented the conceptual framework that underpins the research. The research methodology section is discussed in the next chapter.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter outlines the research methodology utilised in this study to answer the research question: *How do teachers balance mathematics assessment tasks to accommodate problem-solving in Grade 7?* The chapter begins with a description of the research paradigm that underpins this study. Furthermore the study engages in a discussion of the epistemological and ontological assumptions of this study. The choice of using a qualitative research approach is discussed as well as the choice of using a descriptive case study to guide the study. Research methods such as study setting, population and sampling as well as data collection and data analysis is described and justified. The final sections of the chapter refer to ensuring the quality of the study in terms of trustworthiness and ethical considerations.

3.2 RESEARCH METHODOLOGY

3.2.1 Research Paradigm

A paradigm is a shared world perspective that represents a discipline's beliefs and values (Chilisa & Kawulich, 2012). Chilisa and Kawulich (2012) further explain that a paradigm gives instructions on how to handle glitches within a specific discipline. Another definition by Poni (2014), states that a paradigm is an outline that contains all of the generally recognised interpretations about the route of research and how it should be carried out. The underlying paradigm of this research study is social constructivism.

Human beings socially engage in all contexts, according to social constructivists (Burr, 2015). In order to make sense of the universe, social constructivism maintains that truth is created rather than discovered (Berger & Luckmann, 2023). While meanings are socially constructed, individuals are born into a world of meanings, learning to accept some while resisting others. The majority of the time, people are ignorant of the constructed nature of these meanings and accept them as natural (Weinberg, 2014). However, individual sharing and receiving impact cognitive processes, and thus the nature of reality is associated with how the world is known through such interactions.

Because learning is social, social constructivism founded this study, which claims that meaning is socially produced via learners' participation in the process of teaching and learning. According to this view, meaning and understanding are formed in partnership with other individuals (Amineh & Asl, 2015). Jung (2019) defines social constructivism as being built on three assumptions: reality, information and learning. According to Boyland (2019), reality is generated by many actions that a person come across and actively engages in within a certain setting. The second premise is that knowledge emerges through observed cultural and social acts (Jung, 2019).

Another assumption is that learners create their own sense throughout the learning process. Teaching, assessment task types and prior understanding of the content all contribute to the construction of meaning (Boyland, 2019). When these three assumptions are taken into account, social constructivism sees learners as distinctive, with distinctive knowledge, social background and needs.

3.2.2 Paradigmatic Assumptions

Ontological and epistemological assumptions are the two assumptions that founded this study. Ontological assumptions are preoccupied with the definition of reality (Scotland, 2012). According to Guba and Lincoln (1989), ontological assumption is concerned with the world that the researcher is exploring and the nature of its reality This study's ontological assumptions addressed the following questions: what exist in the Grade 7 mathematics classroom in terms of assessments teachers give to learners, that is, the cognitive demands of assessment tasks and the nature of tasks, and what the essence of representativeness is as perceived and created by Grade 7 teachers in Gauteng North District schools? The two questions show that the researcher took a nominalist stance which allowed the researcher to comprehend reality through the words of teachers, their experiences and practices, and the creation of their specific awareness (Edirisingha, 2012), when conducting this research.

The epistemological assumption is concerned with the character of information gained during the classroom lesson (Al-Ababneh, 2020). The information the researcher acquired during the classroom observation came from teachers' insights. The essential epistemological assumption is that the researcher was able to get subjectively engaged in comprehending the studied phenomena by seeing teachers in their social situations and doing document analysis of work written on the board and discovered in learners' books (Scotland, 2012).

3.3.3 Research Approach

A qualitative research approach was used in this study, which, according to Nieuwenhuis (2012), examines interactions in natural environments, which is considered a naturalistic approach. Using teaching approaches and tactics, mathematics teachers are able to support their assessment tasks in a ‘natural setting’, the classroom environment in which they teach. The mathematics assessments as well as interactions between teachers and learners occurred during this study.

Because of the interaction with the teachers, the researcher was able to produce an in-depth description of the occurrence without necessarily generalising results (Rashid et al., 2019). Furthermore, a qualitative research is a method for studying society's inner feelings and knowledge of their own world, agrees Silverman (2016). The researcher examined the teachers' knowledge and skills in balancing assessment tasks to suit cognitive level problem solving. The researcher examined the assessment tasks assigned to learners in the classroom, and the cognitive levels of the assessment tasks assigned by teachers. This enabled the researcher to describe the phenomenon in depth and in detail using the qualitative method (Queirós, Faria & Almeida, 2017).

3.3.4 Research Design

According to Yin (2003), a research design is a general plan outlining how one anticipates conducting an investigation or study. The design is used to structure research and show how all the major components of the study (measures, methods, programmes and samples or groups) work together to achieve key research goals (Yin, 2003). The aim of a good research design, according to McMillan and Schumacher (2006), is to produce results that are regarded as credible. Maree (2016) further maintains that a study design is an approach that departs from the straightforward theoretical hypothesis by insisting on the inclusion of a variety of assistants, information-gathering procedures to be used and information inquiry. The research design allowed the researcher to select the conceptual lens of the study and the technique of data collection and analysis (Mukherjee, 2017).

Nieuwenhuis (2010) elucidates that the adoption of the research design is built on the assumptions of the researcher, skills as well as observations and moreover, it impacts the mode in which information is composed. Because the researcher agreed with the above-mentioned objectives and purposes of research design, a descriptive case study was chosen as the research design. A descriptive case study is designed to describe natural events that occur within the data under consideration (Siedlecki, 2020); for instance, in this study, the knowledge and skills of Grade 7 mathematics teachers in balancing assessment tasks was described. Furthermore, the way teachers use their knowledge and skills of assessment to balance their assessment tasks were explored.

The descriptive case study was adopted in this study because it enabled the researcher to concentrate and gain insight into a particular occurrence by offering details to provide a deeper knowledge of the problems at hand (Creswell & Garret, 2008). The researcher thus employed a descriptive case study as it permitted a comprehensive study of how Grade 7 mathematics teachers balance their assessment tasks to accommodate problem solving in their natural context. Furthermore, descriptive case study was adopted because of its strength of using various data collection instruments (Creswell & Garret, 2008), henceforth this study used multiple data collection instruments namely: semi-structured interviews, observations and document analysis.

3.4 RESEARCH METHODS

3.4.1 Research Site, Population and Sampling

The population, according to Leedy and Ormrod (2005), is essentially a large group of individuals who serve as the major focus of a scientific inquiry. Projects of research are carried out for the benefit of the general population. In this study, the population were the Grade 7 mathematics teachers at public South African primary schools. Researchers cannot evaluate every person in a community since it is time consuming and expensive (Taherdoost, 2021), which was the situation for this research, due to the comparably huge size of population. As a result, the researcher relied on scientific sampling techniques to contain the sample size (Pickard, 2007).

Because of the selected schools' accessibility and physical closeness to the researcher, convenience sampling (Etikan, Musa & Alkassim, 2016) was used to select five public schools in Bronkhorspruit which falls under the Gauteng North District as study sites to collect the qualitative data.

Researchers seek out information-rich examples or informants in qualitative study, according to Hardon, Hodgkin and Fresle (2004). Cases that are information-rich can be used to learn details about matters that are crucial to the study's goal. The process of choosing such individuals is referred to as 'purposeful sampling'; a method commonly used in qualitative research projects (Palinkas et al., 2015).

The teachers in this study were chosen using purposive sampling as they have a qualification specialising in mathematics, had an experience of five years teaching Grade 7 mathematics and had expertise teaching Grade 7 mathematics. Teachers' availability and readiness interest in the research and certain ethical problems were also factors to consider when choosing participants (Moodley, 2013). Five teachers were sampled based on particular factors, as shown in the subsequent table. Teachers with diverse backgrounds were chosen not to be compared, but to obtain comprehension into how distinct teachers set mathematics assessment tasks in order to accommodate problem-solving cognitive level mathematics in their Grade 7 classes.

Table 3.1: Participant inclusion and exclusion

Inclusion	Exclusion
• Taught mathematics in Grade 7 for more than 5 years • Teaches in a public school in Gauteng North District • Male or female • Different race and language • Holds a Bachelor of Education qualification majoring in Mathematics Senior Phase	• Non-government school • Not a Grade 7 mathematics teacher • Less than 5 years of teaching mathematics

3.5 DATA COLLECTION

Qualitative data collection techniques are critical in giving useful and rich information to address research queries (Anyan, 2013; Taherdoost, 2021). The data on how teachers balance their mathematics assessment tasks to accommodate problem-solving in Grade 7 classes was collected through the use of semi-structured interviews, observations and document analysis. The subsequent section discusses the data collections tools followed by a data collection timeline.

3.5.1 Semi-Structured Interview Schedules

The teacher semi-structured interview schedules were designed first to gather data from participating mathematics teachers on the research sub-questions listed below:

1. What knowledge and skills do Grade 7 mathematics teachers have in balancing mathematics assessment tasks?
2. Which assessment strategies do teachers use to assess mathematics problem-solving in Grade 7?
3. How do mathematics teachers use their knowledge and skills to assess Grade 7 in balanced problem-solving tasks?

3.5.1.1 The reliability of semi-structured interviews

In qualitative research, reality must be grasped through the eyes of those who are engaged in the event of interest (Merriam & Tisdell, 2015). To guarantee that the results cohere with reality, the intricacy of human behaviour must be revealed in a contextual framework, understood, and presented holistically (Merriam & Tisdell, 2015). These researchers clarify that because humans are the main data collectors and analysts, interpretations of reality are directly evaluated through their observations and interviews (Merriam & Tisdell, 2015).

To guarantee credibility of the interviews in this research, triangulation was used, which is the process of comparing numerous data sources in search of similar patterns, to support the veracity of the research findings (Merriam & Tisdell, 2015). Face-to-face and casual meetings, and discussions with all participants, in-depth semi-structured interviews (which were digitally captured and noted), and notes were all used to collect data. These various data sources enabled the researcher to compare and verify the information gathered in pursuit of commonalities. Creswell (2013) believes that this method of triangulation entailed verifying evidence from various sources to cast light on a subject or viewpoint, with the emphasis in this research being the instructors' numerous views and facts.

Traditionally, reliability refers to measurement consistency - the degree to which study results can be reproduced with comparable participants in similar settings (Merriam, 1998). According to Merriam and Tisdell (2015), qualitative research is done to characterise and explain the world as those who live in it experience it, with many views of what is occurring. In other words, reliability in qualitative research is concerned not with whether a study's findings will be discovered again, but with whether the study's findings are dependable and consistent with the data gathered (Merriam & Tisdell, 2015). Henceforth, to ensure that this study is dependable, the researcher constantly monitored the quality of the recordings and transcriptions of the semi-structured interviews.

3.5.1.2 Piloting the semi-structured interview

Malmqvist et al. (2019) postulate that there are several dangers to the authenticity of instruments that may be reduced by doing preliminary research that includes a practice run prior to real data collection. A trial study was conducted in one school to test whether the tool (semi-structured interviews) would assist the researcher in answering the research questions in the other five sampled schools. The researcher found that the instruments were not consistent. The observation schedule and semi-structured interview questions were inconsistent they did not answer the research questions of the study. Subsequently, the researcher had to redesign further semi-structured interview questions that would elicit the relevant data (see Appendix G). This finding is based on the information that the pilot study which gave the researcher the opportunity to ascertain whether study would produce meaning to the research aim and objectives.

3.5.2 Observation Schedule

According to Chemagosi (2020), observation is a significant data gathering strategy because it gives the researcher an inside viewpoint of group interactions and behaviours in a variety of scenarios. This strategy is delicate and needs interaction with participants (Taherdoost, 2021). A planned observation schedule was employed during classroom observations as a data gathering approach for this study (see Appendix H). This strategy was created ahead of time founded on the conceptual framework, research questions and aims that underpin the investigation.

Observation allowed the researcher to explore how teachers use their knowledge and skills to assess Grade 7 learners in balanced problem-solving assessment tasks and how they develop and use mathematics assessment tasks. It also enabled the researcher to reflect on how Grade 7 mathematics teachers' teaching strategies and approaches impact learners' opportunities to build mathematical knowledge through particular mathematics assessment activities. The teachers were observed in their normal contexts, allowing the researcher to collect data such as their behaviour, the way they communicate with their learner, their questioning styles, the examples they write on the board, as well as the activities administered during lesson. The researcher gained insight into what happens in their classes by observing teachers in their natural contexts (Kawulich, 2012).

The observed lessons ranged in length from 30 to 60 minutes. The researcher employed a digital speech recording equipment to record the lesson during the observations. The purpose of documenting the lessons was to guarantee that the researcher remembered what happened in class. While executing the pre-planned observation schedule, the researcher photographed the assessment tasks set up and answered on the chalkboard and handed to learners to solve as homework and classwork. In addition to the observation of the teacher, the researcher took field notes of anything seen in the classroom that might have added to the value of the findings. This data collection tool helped the researcher respond the following research question which aimed to determine the assessment strategies teachers use to assess mathematics problem-solving in Grade 7.

3.5.3 Document Analysis

In order to extract meaning, develop insight and generate empirical knowledge, document analysis demands the inspection and interpretation of data (Morgan, 2022). It is in fact used to get information that might not be accessible during the interviews and/or from observations. The researcher analysed all written information that may enlighten the phenomenon studied. Data was collected from written sources such as learners' mathematics classwork and homework books, and previous mathematics question papers set internally, pre-moderations of the question paper, item analysis, diagnostic, and summary statistics.

This analysis allowed the researcher to investigate a specific study aim, namely if the chosen assessment tasks accommodate problem-solving and whether they fulfilled the mathematics curriculum requirements according to the cognitive demands and the nature of the assessment tasks. This data collection tool helped the researcher explore how mathematics teachers use their knowledge of assessment to include problem-solving in their assessment tasks in Grade 7 (see Appendix I). The researcher requested the exercise books of the learner and took pictures of the classwork and homework activities. Finally, the researcher made observational field notes.

The data collection timeline for this study is shown in Table 3.2 below, indicating the date, venue, number of learners.

Table 3.2: Data collection timeline

1st Meeting	Data Collection Tools	Date	Time Allocated	Number of Learners	Venue
Teacher A	Semi-structure interviews (see Appendix G)	22/02/2023	20 minutes	48	School Library
	Observations (see Appendix H)	22/02/2023	60 minutes		Grade 7
	Document analysis (see Appendix I)	22/02/2023	30 minutes		Grade 7
Teacher B	Semi-structured interviews	23/02/2023	25 minutes	52	Staff room
	Observations	23/02/2023	45 minutes		Grade 7
	Document analysis	23/02/2023	20 minutes		Grade 7
Teacher C	Semi-structured interviews	24/02/2023	15 minutes	56	Staff room
	Observations	24/02/2023	60 minutes		Grade 7
	Document analysis	24/02/2023	20 minutes		Grade 7
Teacher D	Semi-structured interviews	25/02/2023	25 minutes	45	School library
	Observations	25/02/2023	60 minutes		Grade 7
	Document analysis	25/02/2023	10 minutes		Grade 7
Teacher E	Semi-structured interviews	26/02/2023	18 minutes	51	Grade 7 classroom
	Observations	26/02/2023	45 minutes		Grade 7
	Document analysis	26/02/2023	20 minutes		Grade 7
2nd meeting					
Teacher A	Observation	20/04/2023	60 minutes	47	Grade 7
	Document analysis	20/04/2023	15 minutes		Grade 7
Teacher B	Observation	21/04/2023	45 minutes	51	Grade 7
	Document analysis	21/04/2023	20 minutes		Grade 7
Teacher C	Observation	22/04/2023	60 minutes	52	Grade 7

1st Meeting	Data Collection Tools	Date	Time Allocated	Number of Learners	Venue
	Document analysis	22/04/2023	18 minutes		Grade 7
Teacher D	Observation	23/04/2023	60minutes	54	Grade 7
	Document analysis	23/04/2023	20 minutes		Grade 7
Teacher E	Observation	24/04/2023	45 minutes	48	Grade 7
	Document analysis	24/04/2023	20 minutes		Grade 7

3.6 DATA ANALYSIS

Although there are several ways for analysing qualitative data, the researcher found Braun and Clarke's (2006) methodologies to be the most appropriate for this study. The purpose of qualitative data analysis, according to Braun and Clarke (2006), should be to arrange and order data into meaningful themes. A thematic analysis's goal is to discover themes, or significant or fascinating patterns in data, and then use these themes to answer the research question. A great thematic analysis does more than just summarise the material; it analyses and interprets it. Thematic analysis was adopted because of the six steps of data analysis that were suggested by Braun and Clarke (2006) that allowed the researcher to analyse data from the data collection tools which are: document analysis, observations and semi-structured interviews.

The following are the steps by Braun and Clarke (2006) that were relevant to the data collection tools of this study:

3.6.1 Becoming Familiar with the Data

In this step, the researcher made notes of data obtained from the observations, listened and made note from the audio tapes and then read the interview transcripts thoroughly to become more familiar with the data. Finally, the research read cautiously the notes from the data collected from the document analysis (learner’s classwork and homework books) in order to be familiar with the data.

3.6.2 Generating Initial Codes

During this step, the researcher identified recurrent themes from the full data set that may have constituted a specific code group. The coding was done by hand. The researcher took notes on the content of the study in order to identify potential topic patterns.

3.6.3 Searching for Themes

In this stage, the researcher sorted and analysed the codes, then combined them based on the commonalities discovered to produce the key themes. During this step, the researcher gained a comprehensive understanding of the unique category of topics and was prepared for the review phase.

3.6.4 Reviewing the Themes

The researcher checked the themes and revised them to be meaningful and coherent. The researcher also watched carefully for observer bias.

3.6.5 Defining Themes

The researcher recognised the essence and formed a good understanding of each of the theme's meaning. The researcher also discovered what the theme was all about and then went on to ascertain what data part each theme specifies. Finally, the researcher looked at the importance of themes and why they are interesting.

3.6.6 Write-up

The researcher, in this stage was satisfied with the themes identified and was able to wrote the final report, presented in Chapters 5 and 6.

3.7 TRUSTWORTHINESS

Research must be trustworthy in order to be of good academic quality. This means that the results of this research accurately represented how teachers from Gauteng Province's chosen primary schools planned and used mathematics assessment tasks to generate problem-solving learning opportunities. This study’s trustworthiness was ensured through credibility, transferability, dependability and confirmability as trustworthiness criteria (Schwandt et al., 2007).

To ensure credibility, the researcher used member checks. For the semi-structured interviews the researcher used an audio recorder and transcribed the data and the observation schedule was completed with researcher notes. During the member checking process, participants discussed the notes and transcripts which assisted in verifying that the researcher's engagement would not interfere with the capacity of the other participants to talk candidly about their experiences. This method was judged necessary in order to adhere to fairness norms and confirm that the researcher did not twist the statements of the participants (Campanella, 2009).

Transferability is established by showing readers how the research study's conclusions might be applied to various locations, circumstances, times, and people. Since this was a descriptive case study where five schools were selected, findings of this study cannot be generalised but they could be applicable to context which are similar to the context of the study.

To ensure dependability, triangulation of data was used. Triangulation is a strategy for gathering data from several sources while using various research methodologies and approaches. As a result, the researcher employed multiple ways of data collecting (semi-structure interviews, observations and document analysis). This strategy is significant because it helps to compensate for the limitations of one data collection method (Rulandari, 2021).

To ensure confirmability the researcher kept a reflexive journal. A reflexive journal is a record kept by the researcher to reflect on and organise data collection (FitzPatrick, 2019). The researcher kept a diary in which the personal observations and notes were recorded. Keeping a reflexive diary is seen as vital since these records aid in cross-checking data and composing the study's final report.

3.8 ETHICAL CONSIDERATIONS

When conducting a study, academics should follow a set of guidelines and professional standards, according to the word ‘ethics’ (Strydom, 2014). Maree (2016) A researcher must act morally by doing the correct thing, which comprises of handling subjects equitably and without causing damage to anyone. The ethical standards include treating participants with care and preventing exposing them to any physical harm (Labuschagne, 2016; Maree, 2016)

The study was carried out in accordance with the professional research code of ethics established by the University of the Free State (UFS). Before beginning the research, ethical clearance was given by the UFS Ethics Committee (see Appendix A). The researcher approached the Gauteng Department of Education for permission to conduct research is selected schools (see Appendix B) and was given approval (see Appendix C). Prior to field work, principals were approach to conduct research in the selected schools (see Appendix D). Once consent was given, participants were informed of the research where the goal of the research and their responsibilities as participants were described. Participants signed letters of informed consent (see Appendix E) and were notified that their involvement was entirely voluntary and that they could opt out at any time (Leedy & Ormrod, 2010)

The researcher confirmed the individuals' anonymity by using pseudonyms (De Vos, Strydom, Fouche & Delport, 2011). The researcher stated in the letters that all subjects had been told about the research goals and the methods to be used during data collecting, as well as about secrecy, privacy, and potential risk. The Grade 7 learners signed letters of consent to be informed of the objective of the study (see Appendix F). Learners were also told that the researcher would be observing the teacher as he or she presented their mathematics lesson, as well as looking at the work they completed in their notebooks. To analyse the data, no photographs of teachers and learners were captured; only photographs of mathematics assessment tasks on the board and in learners' schoolbooks were taken.

The audio recordings and the copies of learners' exercise books containing data from participants has been kept them in a secure closet during the analysis process. Only the researcher and, upon request, the researcher’s supervisor had access to the information. Cohen, Manion & Morrison (2011) highlights the significance of privacy, confidentiality and anonymity as primary considerations in conducting research. This was achieved by giving each participant and each institution where they taught a pseudonym.

3.9 CONCLUSION

An overview of the qualitative study strategy and methods was provided in this chapter. In this research, social constructivism was included as a paradigm. This study's intentions, research design and research method were all illuminated. The chapter also covered the study's participants and their duties. This chapter also detailed the instruments used to generate the data. The chapter clarified how the issues of credibility, dependability, conformability and transferability were addressed in the study. The use of thematic analysis was highlighted and its six steps of data analysis. Lastly, the chapter provided the trustworthiness of the study and the ethical considerations with respect to this study.

The subsequent chapter discusses data analysis and interpretation of the findings of this study.

CHAPTER 4

DATA ANALYSIS, PRESENTING AND INTERPRETING FINDINGS ON TEACHERS CHALLENGES IN BALANCING ASSESSMENT TASKS

4.1 INTRODUCTION

The findings and the interpretation of empirical data gathered from the five sampled Grade 7 mathematics teachers are presented and discussed in this chapter, in an attempt to answer the research question: *How do teachers balance mathematics assessment tasks to accommodate problem-solving in Grade 7?* Thus, the chapter provides a description the teachers' skills and knowledge in balancing mathematics assessment tasks for learners in Grade 7 mathematics. This is done with a view to document the knowledge and skills teachers possess to balance the assessment tasks required by the Grade 7 mathematics curriculum. The chapter further outlines the assessment strategies the teachers use to assess problem solving in Grade 7. This is done to explicate the predominant problem-solving strategies used by Grade 7 learners. Lastly, the chapter explores how the Grade 7 mathematics teachers use their knowledge and skills of assessment to include problem-solving to balance the assessment tasks. This is done to indicate how the teachers can use their knowledge and skills of assessment to formulate the Grade 7 balanced mathematics tasks.

The empirical data is presented, interpreted and discussed in relation to the three objectives as follows: The study goals are utilised to develop sub-headings for organising empirical data; a suitable opening discussion follows, with the goal of outlining excellent practices, policy-related concerns, past research findings, and theory for each sub-heading. The empirical data is then provided in written words and graphics, and it is contrasted with excellent practice or theory Henningsen & Stein's task progression and Bloom's Taxonomy, which give meaning and a deeper understanding of the data.

4.2 CREATING A BALANCE IN MATHEMATICS ASSESSMENT TASKS

The subsequent sections discuss the challenges that teachers experience in balancing assessment tasks to accommodate problem-solving in Grade 7 classes.

4.2.1 Knowledge and Skills in Balancing Assessment Tasks

According to Yang, Kaiser, König and Blömeke (2021), teachers are required to poses knowledge and skills of balancing assessment tasks, thus being competent in assessment task design, marking and analysing the task. Aside from creating assessment activities and tools, teachers must make decisions based on the results of such assessments. Balancing mathematics assessment tasks according to the Department (DBE, 2011) implies that an assessment task should cater for all the cognitive levels ensuring that it is in line with what is required by the CAPS document. Balancing the assessment tasks is imperative because it leads to the better understanding of mathematical concepts (Al Raqqad & Ismail, 2018). However, Reyneke et al. (2010) discovered that teachers appeared to be challenged and lack knowledge and skills when balancing assessment tasks. Teachers tend to leave out the problem-solving cognitive level, thus resulting in mathematical tasks being unbalanced. In addition, Reyneke et al. (2010) mentioned that many teachers tend to rely on textbooks which contain assessments for each section, which supports the findings of this study.

> *"…The sources of my assessment tasks, I mostly pinpoint examples from resources such as our DBE books, textbooks that I use Spot on premier mathematics, Today mathematics………"* **(Teacher D)**

> *"The source of my assessment task is the textbook that I use of which is platinum It's spot on as well as DBE book from the Department of Education…"* **(Teacher E)**

However, in some cases, innovative teachers use a range of sources to design their assessment tasks:

> *"… I use various sources such as when I can go check my study guides, or my textbooks, or I can go check on Google…"* **(Teacher A)**

Teacher D and Teacher E indicated that they rely largely on different mathematics textbooks at their disposal as sources of the assessment tasks they uses as well as the internet. From the remarks made above, it was obvious that many teachers lacked the knowledge and skills of balancing their own assessment tasks. They used textbooks as their primary sources to balance the mathematics assessment tasks. This means that the assessment tasks that they gave to learners were not informed by their knowledge and skills of assessment but according to the textbook knowledge. The model of task progressions by Henningsen and Stein (1997) discourages this form of assessment because there is often a modification between the suggested curriculum endorsed through textbooks and decreed curriculum (CAPS document or ATP) and the way in which the assessment tasks in the textbook are formulated. Additionally, the implemented curriculum at the learner level describes the tasks set by the teacher, taking into account the nature of the task and the cognitive demands, which tare implemented by the learner in the classroom. The model of tasks progression by Henningsen and Stein (1997) requires teachers to possess the skills and knowledge of balancing assessment tasks according to the cognitive demands or levels ad according to the nature of tasks. This means that teacher should formulate mathematics assessment tasks that include the content/topics covered in a way that learners are capable to exhibit via examination, homework, classroom or assignments their level of performance and competence. According to Zulkifli et al. (2021) teachers who lack knowledge and skills to balance the assessment prevent learners from engaging in meaningful learning and which deprives them of the opportunity to develop problem-solving skills.

4.2.2 Teachers' Knowledge of Problem-Solving

It is imperative that teachers possess the mathematical problem-solving knowledge for teaching (MPSKT) (Siswono et al., 2019), which includes understanding of pedagogical problem-solving knowledge (PPK), problem-solving assessment tasks, and effective beliefs and factors. According to Cai and Lester's (2010) research, teachers must understand problem-solving and an understanding of problem-solving in order to assist learners in becoming skilled in problem-solving. Ideally, good problem-solving involves "engaging in a task for which the solution method is not known in advance" (NCTM, 2000:52); "finding a way out of a difficulty, a way around an obstacle, attaining an aim which was not immediately attainable" (Polya, 1962:v). It is "a form of cognitive processing that one engages in when faced with a problem and do not have an obvious method of solution" (Mayer & Wittrock, 2006:287). Teachers should have knowledge of problem-solving in order to teach and assess problem-solving effectively.

Teachers must be skilled at selecting and developing mathematical problems to help learners develop problem-solving skills, which necessitates an awareness of the nature of problems. Chapman (2015) discovered that teachers' perceptions of contextual difficulties might restrict or increase how problem-solving is viewed, experienced and learned by their learners. During the semi-structured interviews, it was revealed that teachers do not have a distinctive understanding of what problem-solving is and some failed to provide an example of problem-solving assessment tasks. This was evidenced by the remarks teachers made during the semi-structured interviews:

> *"Mathematics problem solving it's where learners are given sums where they solve problems on their own"* **(Teacher A)**

> *"………..Problem solving is the questions which are much deeper, they in they went they initiate a child to think a much deeper will also show that his or her comprehension, and they develop thinking skills in a learner………..". (***Teacher C)**

> *"….. I think mathematical problem solving has to do with real life situations that are relatable to mathematics". (**Teacher D)***

When teachers were asked to give an example of mathematics problem-solving, teachers responded as follows:

> *"… The question is, I have 54 to the power of one, and 79 to the power of one. What will the total be if I add these two numbers? That's my example of a problem solving".* **(Teacher B)**

> *"…….here is an example a palindrome is a number or word that reads the same backwards and forwards. Example 101. Now, the question that are asked learners is, learners use the digits 123, and four, to find a three-digit square number, that is a palindrome? Use the very same digits 123 and four, to use a three-digit cubic number that is a palindrome……."* **(Teacher C)**

> *"……can you add the first cube root number that is smaller than 100 with the largest cubic number that is also less than 100. So they need to think of the cubic numbers as well as to think which one is below 100 And which one is greater than one but below then 100, then they add the two for an example one cubed plus six cube. So they need to add those two…….."* **(Teacher E)**

Teacher C believes that mathematical problem-solving is about giving sums to learners to solve on their own. Her response indicates that she cannot clearly distinguish between problem-solving as a cognitive level in which learners have to be assessed, problem-solving as a process, and problem-solving as a cognitive level embedded in a mathematical task. All mathematical problems (regardless of their cognitive levels) can be given to the learners to solve on their own; however, that process does not signify problem-solving as a cognitive level that is embedded in a mathematical task. The teacher responses thus exhibit a lack of knowledge of what problem-solving is. Teacher C defines problem-solving as a question that requires learners to think deeply and to show understanding to the question. On the other hand, Teacher D thinks that problem-solving is about real-life situations that are relatable to mathematics. Additionally, Teacher B gave an example of what she regards to be a problem-solving question. The example of the question provided is not a high-order question since it does not require a learner to follow a certain procedure to get to the answer. This question requires a learner to just recall laws of exponents to give the answer. Teacher C and Teacher E gave an example of a task that requires memorisation the example asks do not require understanding because learners can remember the previously provided definitions; they do not need to make sense of what these definitions mean nor how the ideas or practices could be applied in different settings. Such tasks are not cognitively demanding because what learners are supposed to produce is very clear and explicitly stated. These kinds of tasks are generally useful if the goal is retrieving basic facts and definitions. Lack of knowledge about problem-solving thus prevents teachers from being able to assist learners in understanding problem-solving. When teachers lack knowledge, that is, subject content knowledge or in this case, pedagogical problem-solving knowledge, they are unable to teach or assess problem-solving effectively. The fact that the examples that teachers gave are low cognitive order problem instead of a high order one, indicates that they lack knowledge of cognitive demands which the model of task progressions (Henningsen & Stein, 1997) requires teachers to balance the assessment tasks.

The finding above indicates that teachers lack knowledge of what problem-solving is and this concurs with Son and Fatimah's (2020) study, where they discovered that mathematics teachers teaching in primary schools found it difficult to pose problem-solving tasks to learners due to lack of knowledge of what problem-solving entails. It is, therefore, imperative that teachers understand problem-solving in order to develop and support their problem-solving proficiency. This means that the teachers' knowledge of and teaching of problem-solving must be comprehensive rather than just their general ability to problem-solve. This means that teachers need to know more than how to solve mathematical problems and should be equipped with the relevant pedagogical problem-solving knowledge and skill.

4.2.3 Problem-Solving in Assessment Tasks

Problem-solving activities may often be represented in a variety of forms, including diagrams, symbols and real-life situations (Taley, 2022). Veldhuis and Van Heuvel-Penhuisen (2020) assert that not all mathematical assessment tasks set by teachers at school accommodate problem-solving. For an assessment task to be mathematically balanced it ought to afford a challenge to learners such that hard work is exhilarated and clearly linked to mathematical concepts that requires learners to think deeply (Cai & Lester, 2010). A mathematically balanced task is a task that encompasses all the cognitive levels including problem-solving which is regarded as a difficult level and often excluded in the mathematics assessment tasks. The exclusion of problem-solving in assessment tasks was highlighted during the semi-structured interviews by the participants who remarked as follows:

> *"Sometimes I have some questions which are word problems in my assessment task…."* (**Teacher A)**

> "… *So, a certain topic that is relevant … I need to assess 10 to 15% of that calculated total that the assessment task is out of will be a problem-solving question" (***Teacher D)**

> *"…… I make sure that the 10% of the question paper is covered by the problems are solved for an example if the question pays out of the 100. So that means 10 marks it must be the problem solving or if the question is out of 25. So three marks of those questions they must be from the problem solving………"* **(Teacher E)**

From the comment made by Teacher A, problem-solving is often excluded from the assessment tasks. The adverb *"sometimes"* indicates that problem-solving is not often included in mathematics assessment tasks, thus resulting in mathematics assessments not balanced. According to Stein et al. (1999), assessment tasks implemented in the classroom should include problem-solving so that learners are challenged to think critically. Teacher D eluded that problem-solving is included in certain topics, which means that this teacher does not include problem-solving in the assessment tasks administered in class, suggesting that only certain topics allow problem-solving. Based on the allocation percentage (10 - 15%) assigned to problem-solving in the mathematics assessment tasks that she designs, it seems that she pays attention to what is prescribed in the CAPS document (DBE, 2011) re cognitive levels and the allocation percentage for assessments. Teacher E emphasizes what Teacher D believes. Teacher E also indicated that the inclusion of problem-solving is on a question paper which could suggest that the teacher prioritise the inclusion of problem-solving only in a question paper not on a daily basis during assessment in class. Henningsen and Stein's (1997) model of task progression indicates that excluding problem-solving prevents learners from engaging in high-level reasoning and thinking deeply about the mathematical concepts, thus promoting critical thinking. According to the literature, problem-solving mathematics assessment tasks allow learners to gain knowledge and describe the process that they have utilised to reach the answers, rather than just memorising and applying a set of methods (King, 2019). Hence there is a need for teachers to strive for the inclusion of problem-solving in their mathematical assessment tasks.

4.2.4 Teachers' Beliefs about and Attitudes towards Problem Solving

Teacher's beliefs about and attitudes towards problem-solving play a significant role in the pedagogy of the teachers (Watson & Ohtani 2015). In their study on teacher beliefs, Dursun, Agirdag and Claes (2023) pointed out that teachers' practices and expertise are significantly influenced by their beliefs about and attitudes towards scientific teaching and learning. Furthermore, Dursun et al. (2023) discovered that the teaching strategies for problem-solving were influenced by the teacher's beliefs. However, teachers seemed to have negative views or beliefs about problem-solving assessment tasks which resulted in the exclusion of problem-solving in their assessment tasks. These negative beliefs and attitudes thus deprive learners of the opportunity to engage in meaningful learning which will advance their learning.

During the semi-structured interviews, teachers pointed out that they believe that problem-solving is difficult and challenging for the learners. This was evidenced by the comments they made:

> *"Problem solving question is much challenging to the learners …"* **(Teacher B)**

"Because it is difficult for the learner …" **(Teacher C)**

"… It provides learners with confidence. It also provides learners with a better view of thinking and applying the knowledge to the work that we are busy with or in mathematics" **(Teacher D)**

From the remarks above, it was apparent that teachers have negative beliefs about and attitudes toward regarding problem-solving assessment tasks which affects the learners. Teacher B and Teacher C stress that the problem-solving assessment tasks are challenging and difficult for the learners. This shows that these teachers had already decided that problem-solving tasks would not be easy for their learners to tackle which led them to avoiding including these types of tasks. However, a different view was shared by Teacher D, who believes that problem-solving assessment tasks help in boosting learners' confidence. Therefore, Teacher D is likely to engage learners in problem-solving mathematical tasks whereas Teacher B and Teacher C might avoid them due to their beliefs and attitudes. According to the model of task progression by Henningsen and Stein (1997), the omission of problem-solving mathematical assessments is not good practice since it prevents the development of critical thinking and mathematical reasoning skills.

The empirical findings from the semi-structured interviews indicate that teachers' beliefs about and attitude towards problem-solving are both positive and negative. The findings align with Armah and Robson' s (2018) findings from their study conducted in Ghana which indicated that teachers view mathematics problem-solving both positively and negatively. Furthermore, teachers' beliefs and attitudes strongly influence teaching and assessment practices.

4.3 IMPLEMENTING ASSESSMENT STRATEGIES TO ASSESS PROBLEM-SOLVING

The next section discusses the challenges that teachers encounter in teaching and learning and the use of assessment strategies to assess problem-solving in Grade 7.

4.3.1 Teaching Strategies used by Teachers

Teaching strategies used by mathematics teachers plays a key role in empowering learners to be critical thinkers (Ismail et al., 2015). Effective teaching should incorporate problem-solving tasks to improve learners' critical thinking skills. Teachers must develop an environment conducive to learning in order to make learning more exciting and engaging. Departmental and research publications such as CAPS and Annual Teaching Plan (ATP) (DBE, 2011) provide guidance for effective teaching practices. Even though effective teaching strategies seem to play an important role in supporting learners to become competent in mathematics, the extracts below, from the observation of the lessons of the Grade 7 teachers, indicate that most of the teachers lack the skill of incorporating problem-solving assessment tasks in their teaching during their lessons. The lessons went as follows:

Teacher: Grade 7s today we are going to do exponential notations.

Teacher: (writes on the board) Let us see an exponential notation using a base of 10

Teacher: (writes an example on the board)

Teacher: ok Grade 7 let me do another one, remember if you have any questions, you are free to ask

Learners : yes

Teacher: (writes another example)

Teacher: so please when you get home keep on practicing

Learners: yes

Teacher: there is a hand out that I'm going to give to you and you have to do those at home.

Teacher: for now, turn on your DBEs page 32

Teacher: please do it fast so that we can do corrections

(Teacher A)

Teacher: today we will be adding fractions with a same denominator

Teacher: (writes an example on the board)

Teacher: it is very simple you just add the two numerators then bring the denominator as it is.

Teacher: do you see how I do it?

Learners: yes

Teacher: let me do another example

Teacher : (writes an example on the board)

Teacher: grade 7s can you do this on your own?

Learners: yes

Teacher: so I will give your 15 minutes to do your classwork on your own after that we will do corrections

(Teacher B)

Teacher: Good morning class

Teacher: (wipes the board)

Teacher: Today you will be learning how to simplify a mixed fractions

Teacher: I will write down some few examples on the board, please wait do not write anything down as yet.

Learners: ok

Teacher : (writes an example on the board) this is very easy

(a) $2\frac{1}{4} + 1\frac{1}{2}$

Teacher: Who can tell me how we can simplify this?

Learners: Keep quite

Teacher: Let’s do it together (the teacher explained that learners should first multiply 4 by 2 then add 1 equals 9 then bring the denominator as it is. Teacher encourages learners to do the same thing with the other fraction)

Teacher: so I will give your 2 minutes to do your simplify this on your own after that we will do it together.

(Teacher D)

Teacher A and Teacher B used a teacher-centred approach. They both employed direct teaching as a strategy of teaching. Their teaching strategy was planned, meticulously scheduled, and controlled by the teacher. This strategy can be beneficial if the learners are participating; nevertheless, both teachers stood in front of the class and showed mathematical concept to the learners using the board. Teacher A gave learners the opportunity to ask questions but learners they did not have any queries. Learners only listened, took notes, and answered short questions like ‘yes’ and ‘no’ only. Furthermore, there was no opportunity for the learners to actively participate in the lesson, which is something that could have been achieved through assessment. The observation extracts indicate that teachers did not use an effective teaching strategy. Teacher D on the other hand tried to engage learners in the lesson by allowing learners to work on their own to simplify fractions. According to Hasan and Fraser (2015), when learners actively participate in the lesson, they share ideas, discuss and logically acquire an answer to the problem.

Direct teaching, which is a strategy used by Teacher A and Teacher B, prevented learners from actively participating in the lesson and deprived them of the opportunity to creatively solve problems, share mathematics ideas, reason logically and explain their answers. These practices are against the principles of Henningsen and Stein’s (1997) task progression model which requires the teachers to use teaching strategies that allow high-level engagement from learners because it influences the expansion of problem-solving skills required to learn mathematics effectively. Therefore, teachers should make use of a variety of innovative teaching strategies that inspire learners to be competent in mathematical process skills.

4.3.2 Assessment Strategies used by Teachers

As previously indicated, assessment is an integral part of the teaching and learning process. According to Hsu (2013) assessment tasks involving problem-solving, are higher order cognitive demand assessment tasks that necessitate real understanding of ideas and concepts as well as the choice of suitable assessment strategies, including engaging in induction, reasoning, and proof, in order to solve the assessment tasks. In line with this, Wei et al. (2020) in their research, point out that mathematics assessment and teaching strategies in the classroom are key to learners understanding and development of mathematics. Teachers need to use different assessment strategies that allow learners to develop a rich and deep understanding of mathematics. However, assessing problem-solving remains a challenge to teachers because teachers lack knowledge of assessment strategies that they can utilise in the mathematics classroom (Bosica et al., 2019). The use of teacher-learner dialogue assessment strategy and following prescribed procedures from the textbook remain dominant. The predominant use of these assessment strategies signifies that learners do not get to experience various assessment strategies that could support their learning. These restrictive assessment strategies) thus deprive learners the opportunity to engage with a variety of innovative assessment tasks.

During the observations, learners listened, memorised, and took note of what was being demonstrated by seemed to have limited time to participate in assessment tasks. This meant that teachers predominantly used teacher-learner dialogue assessment strategies, which result in learners' disengagement during an assessment task and deprive learners of the opportunity for them to work in groups, collaborate and learn from each other. This was evidenced by the following extract from the lessons observed.

(**Teacher A**) *lesson on fractions.*

Teacher: Open your DBE book on page 75, there is a section there which says problem-solving, can you see it?

Learners: (yes)

Teacher: Read the problem out loud for me

Learners: (learners read the question out loud as a whole class, other learners reading the question fast others reading slowly)

2. A recipe for biscuits makes 24 biscuits. A baker needs to make $3\frac{3}{4}$ of that amount. How many biscuits will he make?

Teacher: ok, who can tell me the answer?

Learners: (no response)

Teacher: it's easy, (teacher working out the solution on a chalkboard)

Teacher: (looking at the learners) the answer is 90

Learners: (writing notes)

Teacher: can you see how I arrived to the answer?

Learners : yes

Teacher: let us do another one ... (teacher continues to work on the problem on her own and asking if the learners see how she find the answers)

(Teacher B) *lesson on fractions*

Teacher: writes on a board

(9) $\frac{3}{7} + \frac{2}{7}$

Teacher: I need you to understand and memorise how we add these fractions.

Teacher: please take note. We add the numerator not the denominator the denominator remain the same. Is that so class?

Learners: Yes sir.

Teacher: keep that in your mind do not ever forget it

(Teacher E) *lesson on fractions*

Teacher: today we are doing fractions with word problems. Open your DBE on page 92 there is a box there written problem solving. Can you find it?

Learners: yes

Teacher: alright (writes the problem on the board)

8. There are 185 learners in a Grade Seven group. $\frac{3}{5}$ of these learners are girls. How many girls are there?

Teacher: In order to find the answer of this problem you must first understand the problem, secondly make a plan, thirdly execute the plan and lastly look back and reflect. Do you understand?

Learners: yes

Teacher : before I show you how to do this I would like you to work on your own first to find the answer. Is that ok?

Learners: yes

Teacher: I will give you 2 minutes to work on this problem

Learners: (shocked) haaa

Teacher: time is ticking

Teacher: (moved around the classroom checking whether learners are working on the tasks and helping those who are struggling and marking those who find the answer quick)

Teacher: "abanye sebeyitholile"(others have got the answer)

Teacher: here is the solution pay attention how we get to the answer.

The extracts above show that teachers tended to use one type of assessment strategy and seemed to lack knowledge of different assessment strategies. Teacher A and Teacher E selected their assessment tasks from the DBE; however, Teacher A did not allow learners to work in groups or even work on their own to solve the problem. Teacher A deprived learners of the chance to work on the assessment tasks. This prevents learners from engaging in the assessment task. Whereas, Teacher E allowed the learners to work on their own, which is an individual assessment strategy, this strategy can help develop learners' self-confidence. He also helped learners develop a problem-solving strategy, *In order to find the answer of this problem you must first understand the problem, secondly make a plan, thirdly execute the plan and lastly look back and reflect,* developed by Poyla (1962). This shows that the teacher is invested in equipping the learners with the required skills to become good problem solvers. Additionally, he gave learners time to work on tasks even though the time was limited. Teacher B emphasised that learners should memorise the adding fractions with the same denominator. Teacher B focused more on ensuring that correct procedure is used than to learners reasoning. During the observations learners spent more time copying notes and examples from the chalkboard. The model of task progression by Henningsen and Stein (1997) indicates that the act of limited time of learners to work on a task and of using the teacher dialogue assessment strategy in assessing problem-solving, is not effective since it prevents learners from engaging in the learning assessment tasks that could develop their analytical and critical thinking skills.

Literature indicates that when a teacher works on high-cognitive demand tasks such as problem-solving, it is imperative that he or she uses a different assessment strategy (Stein et al., 2000). According to Reeve and Cheon (2021), learners demand more liberty to engage in and design their own learning. In order for learners to learn successfully, teachers need to be knowledgeable about various assessment strategies, which align with pedagogical content knowledge, and be able to manage time appropriately and in accordance with CAPS time allocation (DBE, 2011:7).

4.3.3 The Inclusion of High-Order Questions

It is imperative for teachers to intentionally familiarise themselves to the different requirements of their learners during assessment (Hidajat, 2021). Teachers nowadays help learners learn by asking appropriate questions, providing suggestions, suggesting modes of representation, and requesting explanations and justification (Hidajat, 2021). According to Hidajat (2021), a teacher must enable assessment task discussion at some point throughout a lesson and they must ask higher order questions. According to Stein and Kaufman (2010), the teacher's job is that of a facilitator. Teachers manage co-operation through questioning, seeking answers, and the reasons learners choose specific tactics when working on a specific problem. However, the following extracts from lesson observations indicate that teachers do not ask high-order questions during their lesson. The dialogues were as follows:

(Teacher A – lesson on Exponents)

Teacher: (After writing on a board) what is this? (Referring to an exponent)

Learner: Exponents.

Teacher: Good answer.

Teacher: And this? (Referring to the base)

Learner: (No reponse)

Teacher: 13 is a base and 2 is an exponent. So, we say 13 to the power of 2 or 13 square.

Teacher: Do you know what does the exponent tells us?

Learners: (No reponse)

Teacher: The exponent tells us how many times the base is multiplied by itself. (Teacher starts reading from the textbook)

Learners: (Quiet while taking notes).

(Teacher E - lesson on fractions)

Teacher: Today we are simplifying fractions (writes on the board an example)

Teacher: How can we simplify this fraction?

$$\frac{18}{24}$$

Learner: (quite).

Teacher: Ok class listen carefully, we make equivalent fractions by multiplying the numerator and denominator by the same number.

Teacher: Do you understand?

Learner: yes

Teacher: Or, we divide the numerator and the denominator by the same number (writes the steps of how to simplify the given fractions alone and without engaging the learners)

Teacher: Right! Can you see what I did? And can you do it on your own?

Learners: Yes

Teacher: So, I'm gonna give people 2 minutes to solve this one with their friends

Teacher C

Teacher: today we will be adding fractions with a same denominator

Teacher: (writes an example on the board)

Teacher: it is very simple you just add the two numerators then bring the denominator as it is.

Teacher: do you see how I do it?

Learners: yes

Teacher: let me do another example

Teacher : (writes an example on the board)

Teacher: grade 7s can you do this on your own?

Learners: yes

Teacher: so I will give your 15 minutes to do your classwork on your own after that we will do corrections

Teacher A involved learners by giving questions that pushed them to give quick responses rather than ones that allowed them to use reasoning and develop their mathematics terminology. Teacher A asked closed questions like, “Are we together?”; “Am I right?”; “Correct?”; “Is that clear?” at that juncture learners responded, “Yes”. The use of this style when questioning learners implies that in Teacher A mathematics classroom learning was not prioritise, because there was no shared responsibility between the teacher and learner for developing relevant real-world applications. Learners had a more passive, rather than active, role during the lessons as a result of the strategy used by the teacher. After discussing, explaining, and showing, Teacher E asked closed questions throughout the lesson that were neither hard nor interesting to the learners. Teacher E posed closed questions such, "Do you understand?" and "Is my explanation of this length correct?" at that juncture learners responded, "Yes." Teacher E’s questioning style also made the learners primarily passive listeners. What emerged from the observations is that teachers asked low-order questions, they did not engage learners to high-order questions. These findings concur with Baskoro and Retnawati;s (2019) findings, who found that a small percentage of teachers concentrated on higher-order questions that required the learners to think individualistically or to give more than one answer. In using low-order questions, teachers deprived learners of the opportunity to engage in the lesson, solve problems that allow them to think and have a conversation with a teacher, which, according to Henningsen and Stein’s (1997) task progression model is significant in enabling learners to develop critical thinking as it build learners’ mathematical knowledge via conversation and the search for common ground. The above discussion clearly shows that there is a need for teachers to formulate effective questions that include problems solving which encourage active learning and collaboration.

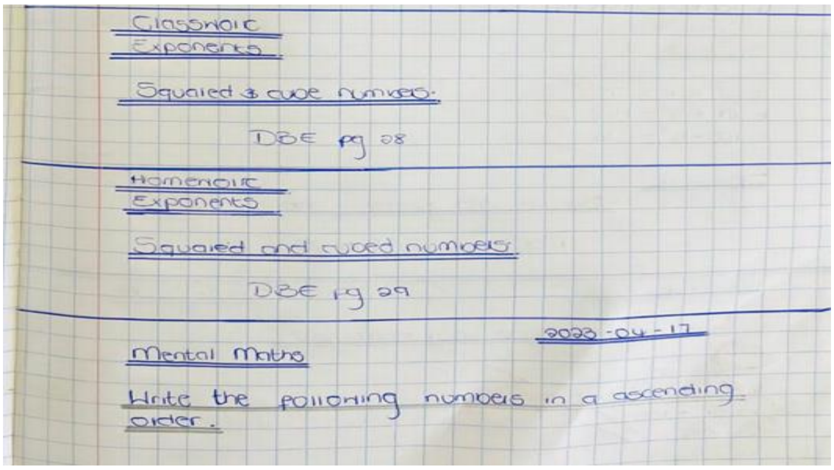
4.4 TEACHERS’ USE OF THEIR KNOWLEDGE AND SKILLS OF ASSESSMENT

The subsequent sections discuss the use of teacher’s knowledge and skills in designing assessment tasks that include problem-solving.

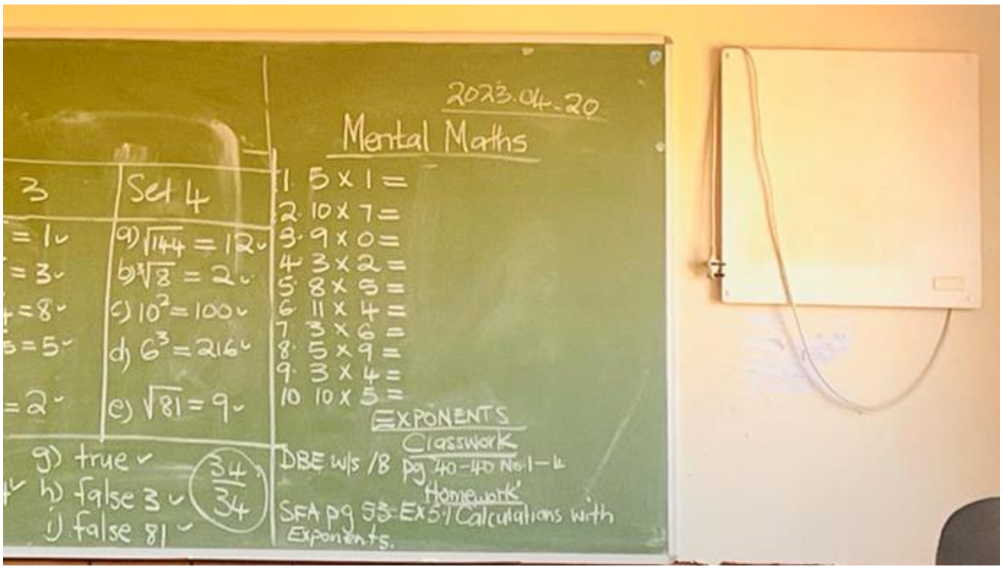
4.4.1 Types of Mathematical Assessment Tasks

Mathematical assessment tasks play a critical role in the mathematics classrooms (Burkhardt & Schoenfeld, 2019). Mathematics assessment tasks include homework, projects, assignments, investigation and classwork done by learners (Bardy et al., 2021; DBE, 2011:155). According to Stein et al. (1996), mathematical tasks lead learners to understand a particular mathematics concept. CAPS (2011) recommends that teachers use different types of assessment tasks in their lessons to help learners understand the mathematical concepts and develop mathematical proficiency.

The extract below from both document analysis and observations indicates that teachers used different assessment tasks to assess the learners. Examples of assessment tasks given to learners are as follows:



(Teacher C)



(Teacher D)

Both teachers started the lesson with mental maths, which is a mathematics task that learners perform without the use of a calculator. Mental maths is there to help exercise learners brains as well as improving their number senses. Teacher C gave learners mental maths to solve for 10 minutes then introduced the lesson to the learners, taught the content and thereafter gave learners a classwork (from the textbook) to work out in class and complete for homework. Teacher D taught the lesson first and then asked the learners to complete the mental maths exercise, do the classwork and copy the page number of the task to complete for homework. Document analysis indicated that both teachers had administered tests, baseline assessment (at the beginning of the year) and mini tests at the end of each topic. Both teachers therefore used appropriate mathematics assessment tasks as required by CAPS (DBE, 2011).

The findings of this study indicate that teacher have knowledge of assessment as they gave learners different types of assessment tasks, depending on the topic, although they seemed to rely on the use of the textbook for assessment tasks. Yu and Singh (2018) found that teachers had adequate knowledge of assessment by way of using different assessment tasks in their classrooms. According to the DBE's (2018) standards, continuous mathematics assessment tasks that are in a form of homework activities and classwork should be administered every day to evaluate learners' progress and improve their learning. However, according to the curriculum assessment tasks should take various forms and include tests, examinations, projects, assignments and investigations (DBE, 2011:155). Sullivan, Zevenbergen, and

Mousley (2013) agree that learners should be provided opportunity to interact with a variety of types of tasks: homework, classwork, investigations, mini tests, assignments and projects. Thus, teachers need to have adequate knowledge of assessment, which aligns with pedagogical content knowledge, as learners were given classwork and homework exercises that encouraged learners to work on the assessment tasks.

The discussion above indicates that teachers have knowledge of assessment types that should be administered in a mathematics classroom on a daily basis. However, when the researcher analysed the cognitive demands and nature of tasks (according to Henningsen and Stein's (1997) progression task model) set for learners to solve as homework and classwork and, it was discovered that teachers had not included problem-solving in their assessment tasks. The exclusion of problem-solving is against the principles of the model of task progression by Henningsen and Stein (1997) as it hinders learner development of critical thinking.

4.4.2 Teachers' Use of Knowledge of Assessment to Balance the Nature of Tasks

Balancing the nature of task means that all cognitive levels should be included such as knowledge, routine procedures, complex procedures and problem-solving (DBE, 2011:157) and according to Henningsen and Stein (1997), should include problem-solving, numerical and contextual tasks. Viseu and Oliveira (2017) explain that the nature of an assessment task influences and shapes how learners think. Furthermore, it can also constrain or widen learners' perceptions of the subject matter with which they interact during and after teaching. However, research by Mdladla (2017) and Mahlangu (2021) indicates that teachers select only pure mathematical tasks (numerical) in their classwork and homework. This finding concurs with the extract below which shows the nature of tasks given to the learners. [shows the snapshots of assessment tasks]

Term 1

1. The numbers above are called ______ and ______ numbers.

2. Write the following as square numbers:

Example: $13 \times 13 = 13^2$ (This 2 is the **exponent**. We say 13 squared or 13 to the power of 2.)

a. $2 \times 2 =$ b. $7 \times 7 =$ c. $5 \times 5 =$

d. $10 \times 10 =$ e. $3 \times 3 =$ f. $11 \times 11 =$

3. Write the following as multiplication sentences:

Example: $15^2 = 15 \times 15$

a. $5^2 =$ b. $9^2 =$ c. $4^2 =$

d. $2^2 =$ e. $7^2 =$ f. $12^2 =$

4. For 3^2, identify: a. the base number. b. the exponent.

5. Colour all the square numbers on the multiplication board. What pattern do you see?

×	1	2	3	4	5	6	7	8	9	10
1	1	2	3	4	5	6	7	8	9	10
2	2	4	6	8	10	12	14	16	18	20
3	3	6	9	12	15	18	21	24	27	30
4	4	8	12	16	20	24	28	32	36	40
5	5	10	15	20	25	30	35	40	45	50
6	6	12	18	24	30	36	42	48	54	60
7	7	14	21	28	35	42	49	56	63	70
8	8	16	24	32	40	48	56	64	72	80
9	9	18	27	36	45	54	63	72	81	90
10	10	20	30	40	50	60	70	80	90	100

6. Arrange these numbers in ascending order:

$2, 9^2, 5^2, 5, 6^2, 2^2, 8^2, 7^2, 12^2, 1^2, 3^2, 10, 11^2, 4^2, 10^2$

7. Arrange the above numbers in descending order:

8. Fill in <, > or =

a. 2^2 ☐ 2×2 b. 5^2 ☐ 5×2

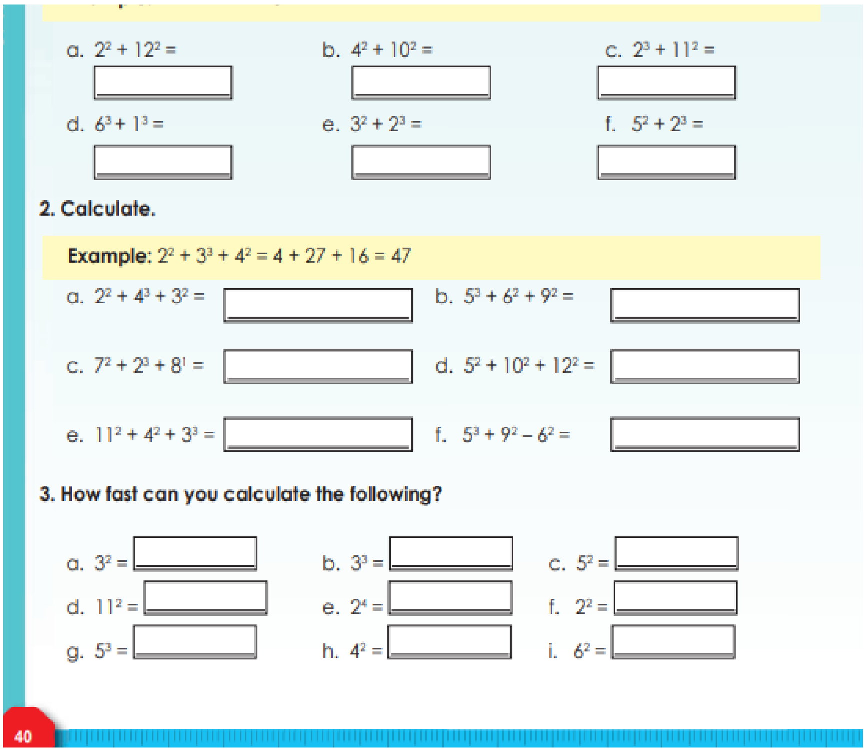
c. 9^2 ☐ 9×9 d. 8^2 ☐ 2×8

e. 11^2 ☐ 10×11 f. 3×3 ☐ 3^2

9. Numbers which have an exponent of 2 are called ______ numbers.

continued

(Teacher A homework)



a. $2^2 + 12^2 =$ b. $4^2 + 10^2 =$ c. $2^3 + 11^2 =$

d. $6^3 + 1^3 =$ e. $3^2 + 2^3 =$ f. $5^2 + 2^3 =$

2. Calculate.

Example: $2^2 + 3^3 + 4^2 = 4 + 27 + 16 = 47$

a. $2^2 + 4^3 + 3^2 =$ b. $5^3 + 6^2 + 9^2 =$

c. $7^2 + 2^3 + 8^1 =$ d. $5^2 + 10^2 + 12^2 =$

e. $11^2 + 4^2 + 3^3 =$ f. $5^3 + 9^2 - 6^2 =$

3. How fast can you calculate the following?

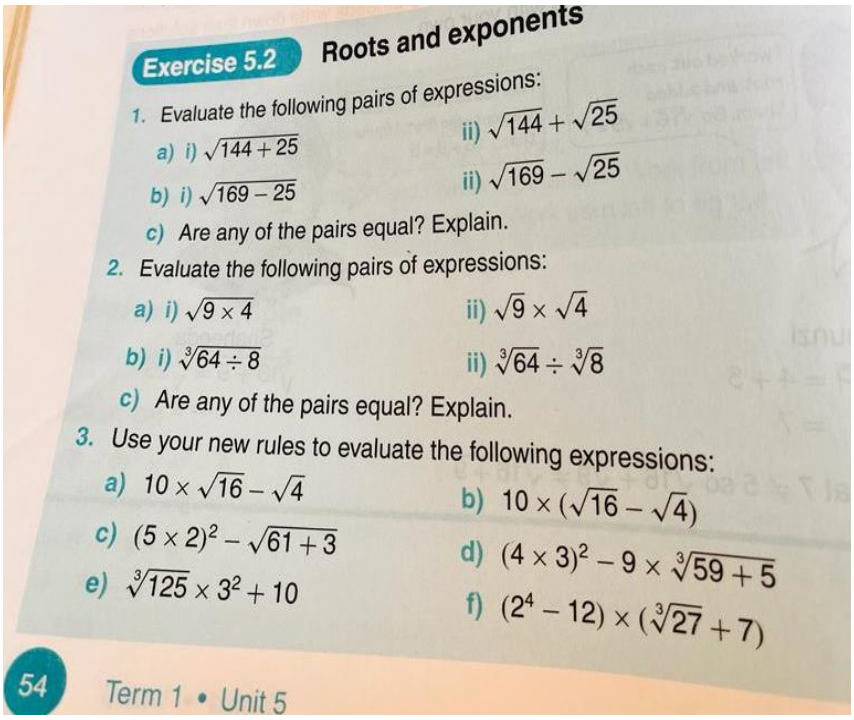
a. $3^2 =$ b. $3^3 =$ c. $5^2 =$

d. $11^2 =$ e. $2^4 =$ f. $2^2 =$

g. $5^3 =$ h. $4^2 =$ i. $6^2 =$

40

(Teacher B classwork)



Exercise 5.2 Roots and exponents

1. Evaluate the following pairs of expressions:
   a) i) $\sqrt{144 + 25}$ ii) $\sqrt{144} + \sqrt{25}$
   b) i) $\sqrt{169 - 25}$ ii) $\sqrt{169} - \sqrt{25}$
   c) Are any of the pairs equal? Explain.
2. Evaluate the following pairs of expressions:
   a) i) $\sqrt{9 \times 4}$ ii) $\sqrt{9} \times \sqrt{4}$
   b) i) $\sqrt[3]{64 \div 8}$ ii) $\sqrt[3]{64} \div \sqrt[3]{8}$
   c) Are any of the pairs equal? Explain.
3. Use your new rules to evaluate the following expressions:
   a) $10 \times \sqrt{16} - \sqrt{4}$ b) $10 \times (\sqrt{16} - \sqrt{4})$
   c) $(5 \times 2)^2 - \sqrt{61 + 3}$ d) $(4 \times 3)^2 - 9 \times \sqrt[3]{59 + 5}$
   e) $\sqrt[3]{125} \times 3^2 + 10$ f) $(2^4 - 12) \times (\sqrt[3]{27} + 7)$

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(Teacher C homework)

All teachers used a textbook for the assessments. Teacher C gave learners classwork and homework taken from pages 28 and 29 respectively, the nature of both assessment tasks is numerical. Teachers D gave learners assessment taken from page 40, numbers 1-4 but avoided number 5, the problem-solving question on page

41, which was also part of the exercise. For homework, Teacher D gave learners homework from a textbook *Solution For All* on page 53 exercise 5.1. The teacher emphasised that learners must do page 53 only as exercise 5.1 ends on page 54. If learners were allowed to do the whole exercise, they would have been exposed to tasks that are contextual. Both teachers chose tasks that were in the form of numerical in nature and were pure mathematics assessment tasks.

The observation indicates that teachers prefer to give learners assessment tasks that are numerical and easy to score, also confirmed by Klang et al., (2021) who found that teachers engage learners in tasks that require them to do calculations and avoid problem-solving tasks. This act disregards the principles of Henningsen and Stein's (1997) model of task progression, which states that numerical tasks should not be used in isolation, all nature of tasks, problem-solving and contextual, should be included in all assessment tasks in order to develop mathematics competency in learners. Therefore, it is imperative that teachers include problem-solving tasks in their assessment tasks.

4.4.3 Teachers' Use of their Knowledge of Assessment to Balance the Cognitive Demands

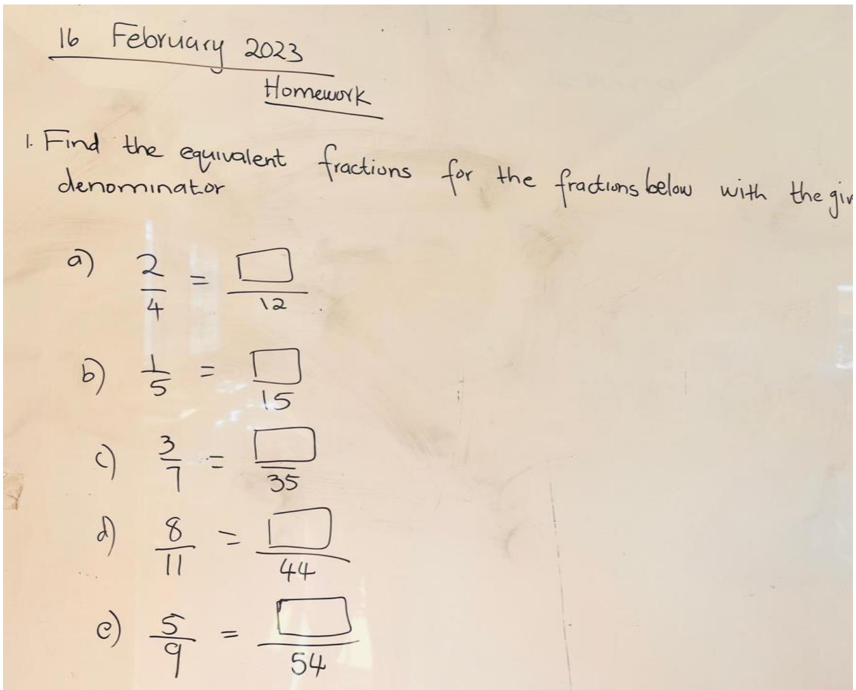
The above discussion indicated the imbalance in relation to nature of tasks given to learners by teachers. The term cognitive demands, according to Henhaffer (2014), denote the type of thinking procedures included in resolving the assessment tasks. Awareness of the cognitive demands of assessment tasks may assist in developing learners' thinking processes which has an effect on learners' achievements. Henningsen and Stein (1997) demonstrate a favourable relationship with task administration and the emphasis on high-level cognitive demands of the assessment task and learners' learning gains. According to CAPS (DBE, 2100:157), cognitive levels of tasks are knowledge (level 1), routine procedures (level 2), complex procedure (level 3) and problem solving (level 4). In providing learners with the chance to enthusiastically participate in assessment tasks that include tasks with high-level cognitive demands, teachers should be cognisant of what assessment tasks constitute as high- and low-level cognitive demands. The data collected from the semi-structured interviews indicate that teachers seem to have some knowledge and understanding of high-order cognitive demands and low-order cognitive demands.

"… the task includes all the cognitive levels, whereby it shows it allows the child to answer high order questions or low order questions…" (**Teacher A)**

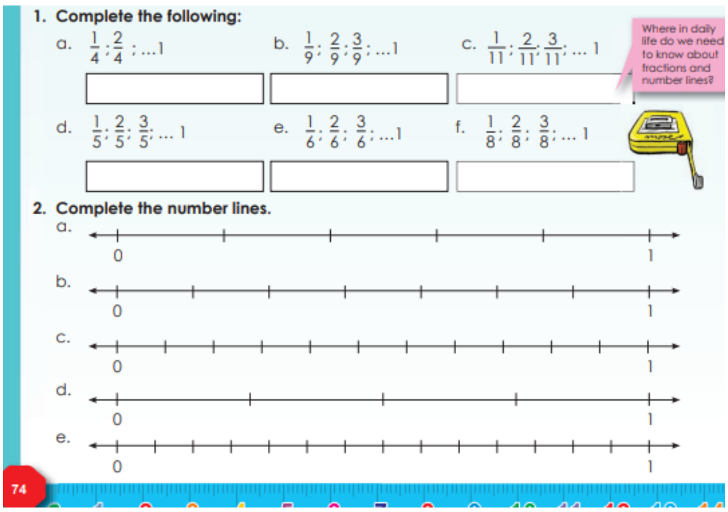
"… assessment task is that it has to include all the cognitive levels, ranging from level one up to five" (**Teacher C)**

"… the task must also accommodate all the cognitive levels…." (**Teacher E)**

However, however, the observations of lessons on fractions indicate that teachers gave learners tasks that are pitched at low-order cognitive levels.



(Teacher A homework)



5. Say whether it is a proper or improper fraction, or a mixed number:

a. $\frac{2}{4}$ ☐ b. $\frac{6}{2}$ ☐ c. $1\frac{1}{2}$ ☐

d. $\frac{8}{5}$ ☐ e. $\frac{1}{5}$ ☐ f. $\frac{7}{4}$ ☐

6. Write down:

a. Five proper fractions.

b. Five improper fractions.

c. Five mixed numbers.

(Teacher C classwork)

2. Write in the simplest form.

Example: $\frac{12}{16}$

$= \frac{12}{16} \div \frac{4}{4}$ HCF:

Factors of 12: {1, 2, 3, (4), 5, 6, 12}

$= \frac{3}{4}$ Factors of 16: {1, 2, (4), 8, 16}

a. $\frac{6}{18}$ b. $\frac{15}{25}$

c. $\frac{3}{9}$ d. $\frac{7}{21}$

e. $\frac{4}{36}$ f. $\frac{18}{36}$

3. Fill in the missing words.

(common factor, numerator, denominator)

a. Fractions can be simplified when the ______ and ______ have a ______ in them.

b. Give five examples of fractions that can be simplified.

(**Teacher E classwork)**

Teachers) indicate that they are aware that assessment tasks must include all the cognitive levels. However, the classwork and homework that they gave to learners, taken from the textbooks, did not include all the cognitive levels particularly problem-solving. Teacher A gave learners homework on equivalent fractions; the task is pitched at routine procedure (Level 2). The question necessitates learners to use the common denominator in order to make the denominators equal. Teacher C asked learners to do a task for classwork on page 74 of the DBE[1] book, number 1 which required the learners to complete a number line of fractions with a common denominator. The task

[1] Mathematics Department of Basic Education workbook

is also at routine procedures (Level 2). Learners are expected to work out an unknown variable by applying a certain procedure. The task requires low-order thinking. Teacher C asked learners to do numbers 5 and 6 from the DBE book, both tasks were pitched at knowledge (Level 1). The tasks required learners to use mathematical facts of fractions and apply knowledge that they have about proper fractions, improper fractions and mixed fractions. Teacher E gave learners a classwork task from a DBE book number 2 (a-c). Learners had to write the fractions in the simplest form, which is at routine procedure (Level 2). This task, as shown in the example, requires learners to apply a rule of simplifying a fraction, which is to find the Highest Common Factor (HCF). Using their knowledge of timetables, learners need to simplify the fraction. He further requested learners to do number 3 (a &b). These two tasks are Level 1 (knowledge) and they require learners to use their knowledge of fractions. The tasks require them to recall what they know about fractions in order to get an answer.

The above discussion indicates that the assessment tasks given by teachers o nly included knowledge (Level 1) and routine procedure (Level 2) cognitive levels which were low-order thinking fractions assessment tasks. As teachers relied on the textbooks, they could not endure that the problem-solving cognitive level was included in their assessment tasks. This aspect is confirmed by Ni et al. (2018) who revealed that teachers were unable to involve learners in problem-solving cognitive level assessment tasks. This is against the model of task progression (Henningsen & Stein, 1997) which posits that teachers need to include problem-solving cognitive level in their assessment tasks in order to maintain logical task that inspires learners to increase knowledge and skills of mathematics. The model further adds that in order for all the learners' ability to understand mathematical concepts can be achieved high-order thinking and lower order thinking assessment tasks need to be balanced. Appropriate knowledge of cognitive level demands balance, awareness of the need to balance tasks and the knowledge and skill to design and create context specific assessment tasks can empower teachers to actively involve learners' thinking developments and eventually learners will develop an improved comprehension of mathematical ideas and concepts.

4.5 CONCLUSION

This chapter presented the findings emerging from the analysis of data collected through interviews and observations. The aim of the study was to explore how teachers balance their assessment tasks to accommodate problem-solving. The findings were presented with descriptions of teachers' skills and knowledge about balancing mathematics assessment tasks for learners in Grade 7. The chapter further outlined the assessment strategies the teachers use to assess problem solving in Grade 7. Lastly, the chapter explored how the Grade 7 mathematics teachers use their knowledge and skills of assessment to balance the assessment tasks by including problem-solving. This was done to indicate how the teachers could use their knowledge and skills of assessment to formulate the Grade 7 balanced mathematics tasks. The findings presented in this chapter were discussed in relation to literature to uncover parallels and inconsistencies with the findings of this study.

The next chapter addresses the research questions. The researcher considers and draws conclusions from the research study. The study limitations and the recommendations for further research are also discussed.

CHAPTER 5

FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

This chapter presents the findings in an effort to answer the research question: *How do teachers balance mathematics assessment tasks to accommodate problem-solving in Grade 7?* The sections in the chapter are aligned with the aims of this study. Thereafter, the researcher presents the answers to the research questions. Finally, the chapter concludes by offering recommendations for practice and future research while recognising a limitation to the study.

5.2 OVERVIEW OF THE STUDY

As a paradigm, social constructivism drove this study. The researcher seeks to improve general comprehension of the matter or state by collecting the experiences and perspective of variety entities in a small number of case studies chosen for particular reasons to assess the challenges of 'whole states' (Easterby-Smith, Thorpe, & Jackson, 2012). Furthermore, through social constructivism the researcher was given a chance to observe grade 7 mathematics teachers lessons. Furthermore, the researcher used a conceptual framework based on the construct of a mathematical assessment task (see Henningsen and Stein, 1997). This framework allowed the researcher to be analytical and to search for profound meaning from all angles of the problem. The nature of this study was qualitative. Five primary schools were the source of data, four in township schools with learners from poor backgrounds, and one school in an urban area with learners from privileged backgrounds.

5.3 SUMMARY OF RESEARCH FINDINGS

According to CAPS (2018), learners need to be given opportunities in studying mathematics to acquire skills such as systematic thinking, generalisation, making conjectures, and attempting to defend and verify their conjectures. Justification and generalisation are important skills in mathematical reasoning. According to the literature, high-level cognitive demanding assessment tasks like mathematics problem-solving, that are effectively executed help learners' mathematical thinking (Tekkumru-Kisa et al., 2020). The study aimed to explore how teachers balance mathematics assessment tasks to accommodate problem-solving in Grade 7. The cognitive demands and the nature of assessment tasks that were used during assessment and teaching were analysed and critiqued use the lens of the model of task progressions (Henningsen & Stein, 1997). Furthermore, the teaching approaches and teaching tactics of teachers that plays a significant role in the choice and implementation of mathematical activities were studied. The study's three subsidiary research questions are now explored and utilised to respond to the major research question.

5.3.1 RQ1: What knowledge and skills do Grade 7 mathematics teachers have in terms of balancing mathematics assessment tasks?

According to Stephan (2020), teachers face challenges in balancing assessment tasks because they lack the relevant pedagogical content knowledge. Furthermore, the literature indicated that teachers rely solely on textbooks as their source of assessment tasks (Jäder et al., 2020). The empirical findings concur with the literature, as teachers were found to be using textbooks and DBE Mathematics Department of Basic Education workbook as their source of assessment tasks. The study also revealed that teachers do not create their own assessment tasks which should be context specific and relevant to the learners. As a result, the assessment tasks in the textbook do not accurately represent how learning occurred. According to Jäder et al. (2020), if teachers rely on textbooks for assessment tasks, it indicates a lack of knowledge and skills in balancing assessment tasks. Taking this into account, it is apparent that teachers must be enabled to balance their own assessment tasks.

The literature and empirical data reveal that many teachers have inadequate knowledge of problem-solving or Pedagogical Problem-Solving Knowledge (PPK), as it is referred to, which negatively impacts their teaching. According to Usmonov (2021), inadequate PPK makes it difficult to teach and to pose problem-solving tasks to learners, which hinders the development of learner’s problem-solving proficiency (Usmonov, 2021). The empirical findings on this study indicate that teachers do not clearly understand what problem-solving and were unable to give an example of a problem-solving task. The empirical findings in this study are supported by that indicates that teachers’ inadequate knowledge of problem-solving poses a negative impact on learners learning and development. Cai and Lester (2010) avow that teacher’s knowledge of problem-solving and learners’ understanding of problem-solving go hand-in-hand, which means that the ability of teachers to solve problem-solving tasks can potentially increase learners’ ability to solve problem-solving assessment tasks effectively. It is therefore, imperative that teachers be capacitated in solving and teaching problem-solving effectively.

The significance of including problem-solving in assessment tasks in a mathematics classroom has been explored by many authors (Mdladla 2017; Parrish & Bryd, 2021; Zohar 2004). They found that problem-solving greatly assists learners in becoming critical thinkers. Even though the authors above advocate for the inclusion of problem-solving assessment tasks in mathematics, the empirical data findings indicate that teachers generally do not include problem-solving in their assessment tasks as they seem to be reliant on the tasks outlined in the textbooks. Teachers indicated that the inclusion of problem-solving tasks is dependent on the topic being taught. It seems that some teachers feel that problem-solving tasks cannot be used with certain mathematics topics. According to Taley (2022), when problem-solving is not included in the assessment tasks, it results in low-level thinking and reasoning. Based on this, it is clear that teachers should attempt to include a problem-solving component in their assessment tasks as this would promote the development of high-order thinking in learners.

According to Li, Song, Hwang and Cai (2020), teachers’ beliefs about problem-solving matter because they influence both the teaching and the assessment techniques. The literature findings (see Section 2.3.4) and findings from the data from empirical findings of this study (see Section 4.2.4) show that many teachers still consider problem-solving tasks difficult for learners to solve. Consequently, teachers resort to giving learners easy tasks and avoiding problem-solving tasks, so that learners achieve good marks. In other words, teachers are only concerned with learners' achievement by administering easy-to-score tasks, rather than engaging learners in meaningful learning and developing those vital mathematical skills. Furthermore, as a result of teachers’ beliefs about and attitudes towards problem-solving, problem-solving tasks are not included in assessment tasks. Consequently, learners are disadvantaged by not being given an opportunity to engage in high-order learning. In conclusion, it is evident that teachers' beliefs about and attitudes towards problem-solving need to change in order for effective teaching to take place in the mathematics classroom.

5.3.2 RQ2: Which assessment strategies do teachers use to assess mathematics problem-solving in Grade 7

According to Karma, Darma and Santiana (2019) the ability to use effective teaching strategies is key to guaranteeing that effective teaching and learning occurs in a mathematics classroom as it contributes to promoting mathematics problem-solving skills in learners. Although effective teaching strategies are important in helping the learners to learn mathematics effectively, the literature (see Section 2.4.1) and empirical findings of this study (see Section 4.3.1) show that most teachers fail to incorporate problem-solving in assessments. In this study specifically, teachers were only found to be using teacher-centred approaches rather than learner-centred approaches. Consequently, the teaching strategies prevent learners from thinking critically, reasoning logically and developing problem-solving skills. Based on this, Henningsen and Stein (1997) emphasises the necessity for teachers to employ effective teaching strategies that include problem-solving as in doing so, they assist learners in becoming competent in problem-solving. It can be concluded that teachers must devise successful teaching strategies in order to afford learners the opportunity of high-level engagement.

The literature findings (see Section 2.4.2) and the findings from empirical data of this study (see Section 4.3.2) reveal that several teachers use teacher-learner dialogue as an assessment strategy which does not have a positive effect on learners' learning. Teacher-learner dialogue assessment strategy results in learners' disengagement during assessment tasks and deprives learners of the opportunity to discuss, engage and work cooperatively with other learners to solve the assessment task. Furthermore, the empirical findings indicate limited time was given to learners to work on the assessment task. Henningsen and Stein (1997) avow that giving learners limited or insufficient time to work on the mathematics assessment task is not effective. Additionally, teacher-learner dialogue during assessment is not effective and that it prevents learners from engaging in learning that could cultivate their intellectual and critical thinking. Taking this into account, it is apparent that it is of necessity that teacher be trained or capacitated in the use of effective assessment strategies.

According to Mdladla (2017), high-order questions can support mathematics practices, promote mathematical conversations in the mathematics classroom and encourage learners to engage in meaningful assessment tasks, thus constructing their own mathematical meaning. Although high-order thinking skills are viewed as significant, literature (see Section 2.4.3) and the empirical findings of this study (see Section 4.3.3) reveal that teachers during their lesson asked low-order questions. The questions, based on guiding the learners through a process, required rapid replies from learners. This study's findings also revealed that teachers appeared to be more concerned in explaining the process of performing a specific task than engaging learners and utilising questions to seek learners' opinions and views. Consequently, this type of questioning prevents learners from engaging in high-order thinking like problem-solving. According to Henningsen and Stein (1997), it is important that teachers ask learners questions that allow them to reflect and reason individually and on others' thinking. From this, teachers should ensure that they promote class discussions and ask high-order questions in order to develop learner's critical thinking.

5.3.3 RQ3: How do mathematics teachers use their knowledge of assessment to include problem solving in their assessment tasks?

The curriculum, CAPS (2011), recommends the use of a variety of assessment tasks. This is important as it helps learners understand the mathematical concepts as they continuously engage in different assessment tasks. The literature (see Section 2.5.1) and empirical findings of this study (see Section 4.4.1) reveal that teachers selected assessment tasks from the textbooks. The study further revealed that teachers are cognisant about the importance of utilising a variety of assessment tasks as they administered mental maths, classwork and homework daily but did not seem to consider all that the curriculum recommends. Consequently, learners are not really afforded an opportunity to engage in assessment tasks that can possibly develop their mathematics skills and their critical thinking.

According to Viseu and Oliveira (2017), the nature of an assessment task influences and shapes how learners think either widening or constraining learners' perceptions of the subject matter with which they interact during and after teaching. Although balancing the nature of tasks is considered important, the literature (see Section 2.5.2) and empirical findings of this study (see Section 4.4.2) reveal that teachers only selected tasks that were numerical instead of problem-solving and contextual in their assessment tasks. Consequently, by selecting only numerical tasks, teachers are not encouraging effective learner development of mathematics competency. According to Henningsen and Stein (1997), teachers should accommodate all the nature of tasks in their assessment tasks in order to balance learners' competency in mathematics. It is, therefore, important that teachers are developed in balancing the nature of tasks to accommodate problem-solving.

The research literature (see Section 2.5.3) and empirical data from this study (see Section 4.4.3) show that teachers chose and implemented activities, all of which were classified as lower-level tasks. As a result, learners were denied the opportunity to generalise, form conjectures, and attempt to defend and verify their conjectures. According to Henningsen and Stein (1997), it is of utmost importance that teachers use both cognitive demands (low order and high order) to balance their mathematics assessment tasks. In doing so, teachers are giving learners the opportunity to develop skills like problem-solving, critical thinking and reasoning skills which are needed to develop mathematics proficiency. To balance all cognitive demands, teachers must be trained in how to include these demand levels in their assessment tasks. In conclusion, further training is needed for teachers to learn how to apply higher-order thinking practical real-world applications and high levels of engagement.

5.3.4 Main research question: How do teachers balance mathematics assessment tasks to accommodate problem-solving in Grade 7?

Based on the findings presented in the three subsidiary research questions, it can be concluded that teachers find great difficulty in balancing assessment tasks, taking into account the cognitive levels required in the Curriculum and Policy Statement for Mathematics Senior Phase (DBE, 2011). In addition, teachers are challenged in understanding the use of problem-solving and including these in the assessment tasks. It seems that teachers are reliant on textbooks and do not design, create and develop their own context-specific assessment tasks which are more appropriate to the learners they teach.

5.4 RECOMMENDATIONS

Drawing on the findings emerging from this research, recommendations for practice and recommendations for further research are offered.

5.4.1 Recommendations for Practice

The research literature (see Chapter 2) and empirical data findings (see Chapter 4) of this study show that mathematics teachers require additional training that must be tailored to handle the complexity that occurs in mathematics education. They also need to undergo training that will improve their assessment techniques and enhance their pedagogical content knowledge. Further training is required for teachers on how to include problem-solving in their assessment tasks to improve learners' thinking and high-level engagement. Teachers must also collaborate with other mathematics teachers from different schools within the same district to set tasks and to discuss and address the challenges that they each face in implementing balanced assessment tasks. The Department could also intervene by holding regular workshops on the teaching and assessment of problem-solving in mathematics.

5.4.2 Recommendations for Future Research

Other aspects related to assessment in classrooms need to be explored in order for many strategies to be formulated. These include, amongst others, exploring the effect of including higher-order cognitive demands in assessment tasks with learners' mathematical understanding. Furthermore, research could explore teachers' knowledge and attitudes towards assessments specifically in primary schools. Comparative studies are also recommended to show how knowledge of the teachers in diverse contexts impacts the balancing of the mathematics assessment tasks. Participatory action research studies should also be conducted in order to show how issues pertaining to balancing of the mathematical assessment tasks can be addressed through collaborative endeavours. These forms of studies can also provide frameworks in terms of how issues can be addressed in different phases.

5.5 LIMITATIONS TO THE STUDY

Due to the small number of teachers that participated, the sample size was limited. Furthermore, participants were largely female of African descent, with only one male teacher teaching in public schools. If alternative racial origins or male teachers had been included, the findings may have been different. As a result, generalisations that the data reflect all Grade 7 mathematics teachers in all Gauteng schools are not possible. The second limitation of the study is that, even though the study was intended to demonstrate how to balance the assessment tasks, the study seems to be more about the challenges pertaining to balancing the assessment tasks.

5.6 A FINAL WORD

The Curriculum and Policy Statement requires learners to be given the opportunity to acquire the ability to be systematic, generalise, solve problems, and think critically. These goals necessitate the use of assessment tasks that encourage learners' engagement in the development of mathematical thinking and reasoning. This means that teachers must exercise caution while designing assessment tasks and developing assessment strategies. Teachers must also be aware of the cognitive demands and nature of tasks and should include all in their assessment tasks.

The challenges that emerged from the study had implications for assessment and thus required the assessment of mathematics in Grade 7 to be approached differently to enable learners to engage more in meaningful in balanced assessment tasks. Further training for teachers is needed in order to address the complexities that exist within the balancing of mathematics assessment tasks to include problem-solving.

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APPENDICES

Appendix A: Ethical Clearance Approval Letter

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA
UFS UV

GENERAL/HUMAN RESEARCH ETHICS COMMITTEE (GHREC)

09-Feb-2023

Dear Miss Nomthandazo Bhekiswayo

Application Approved

Research Project Title:
Balancing mathematics assessment tasks to accommodate problem solving in grade 7 classes

Ethical Clearance number:
UFS-HSD2022/1740/23

We are pleased to inform you that your application for ethical clearance has been approved. Your ethical clearance is valid for twelve (12) months from the date of issue. We request that any changes that may take place during the course of your study/research project be submitted to the ethics office to ensure ethical transparency. furthermore, you are requested to submit the final report of your study/research project to the ethics office. Should you require more time to complete this research, please apply for an extension. Thank you for submitting your proposal for ethical clearance; we wish you the best of luck and success with your research.

Yours sincerely

Dr Adri Du Plessis
Chairperson: General/Human Research Ethics Committee

Adri Du Plessis
Digitally signed by Adri Du Plessis
Date: 2023.02.09 14:49:59 +02'00'

205 Nelson Mandela Drive
Park West
Bloemfontein 9301
South Africa

P.O. Box 339
Bloemfontein 9300
Tel: +27 (0)51 401 9337
duplessisA@ufs.ac.za
www.ufs.ac.za

Appendix B: Letter of Request to the Department of Education

THE HEAD OF THE DEPARTMENT
GAUTENG DEPARTMENT OF EDUCATION
PO Box 7710
Johannesburg
2000

Dear Sir /Madam

REQUEST TO CONDUCT AN EDUCATIONAL RESEARCH

I, Nomthandazo Maureen Bhekiswayo, student number 2021791401, hereby request permission to do research at five provincial public schools. My plan is to get a Master's degree in Mathematics Education at the University of the Free State.

Semi-structured interviews, observations (including 5 Mathematics classes), and document analysis will be used to collect data. This study will maintain confidentiality and anonymity.

The study's findings will be made available as soon as conveniently possible.

Your consideration will be highly appreciated

Yours faithfully

NM Bhekiswayo

Appendix C: Letter of Approval from the Department of Education

GAUTENG PROVINCE
Department: Education
REPUBLIC OF SOUTH AFRICA

8/4/4/1/2

GDE RESEARCH APPROVAL LETTER

Date:	**21 October 2022**
Validity of Research Approval:	**08 February 2023– 30 September 2023** **2022/492**
Name of Researcher:	**Bhekiswayo NM**
Address of Researcher:	**1 Zandvliet Estate 2**
	Castleview
	Germiston
Telephone Number:	**078 681 0270**
Email address:	**Nomthandazomaureen.bhekiswayo@gmail.com**
Research Topic:	**Balancing mathematics assessment tasks to accommodate problem-solving in grade 7 classes**
Type of qualification	**Masters**
Number and type of schools:	**6 Primary Schools**
District/s/HO	**Gauteng North**

Re: Approval in Respect of Request to Conduct Research

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

21\10\2022

The following conditions apply to GDE research. The researcher may proceed with the above study subject to the conditions listed below are met. Approval may be withdrawn should any of the conditions listed below be flouted:

Making education a societal priority

Office of the Director: Education Research and Knowledge Management
7th Floor, 17 Simmonds Street, Johannesburg, 2001
Tel: (011) 355 0488
Email: Faith.Tshabalala@gauteng.gov.za
Website: www.education.gpg.gov.za

Appendix D: Letter to Principal

14 February 2023

To the school principal

Dear Principal

REQUEST TO CONDUCT AN EDUCATIONAL RESEARCH

I am Nomthandazo Maureen Bhekiswayo, student number 2021791401, and I am writing to request permission to do research at your institution. This study is based on my Master of Mathematics Education studies at the University of the Free State.

Interviews, observations, and document analysis will be used to collect data. It is critical to stress that confidentiality and anonymity will be maintained during this investigation.

The study will not be conducted just at your institution. As previously stated, only the researcher and your Grade 7 maths teacher will be aware of your details or involvement. The study's findings will be made public as soon as feasible.

Your consideration will be highly appreciated

Yours faithfully

____

NM Bhekiswayo

Appendix E: Information Letter and Consent Form

Dear Teacher

Request to participate in a research project

Research project title: "**Balancing mathematics assessment tasks to accommodate problem-solving"**

Please read thoroughly the section below before participating in this study

Purpose of the study

The study aims to explore how teachers design assessment tasks in Grade 7 mathematics and whether the tasks accommodate problem-solving cognitive levels. The knowledge and skills of the teachers will be investigated.

What you will be asked to do in the study:

You will be asked to answer interview questions, being observed while teaching mathematics in grade 7 and the classwork administered in class will be analysed.

Time required:

30 minutes will be enough for answering the interview questions. 40 to 60 minutes of lesson observation and 20 minutes of document analysis.

Risks and benefits:

There is no danger. However, the anxiety associated with evaluating a teacher's work should be expected. This project intends to improve teachers' assessment task design, and the findings will benefit everyone participating in the research as well as the education community as a whole.

Benefits:

Participating in the study will indicate the knowledge and skills regarding balancing mathematics assessment tasks to accommodate problem-solving.

The study's findings may be made accessible to the provincial Department of Education, and intervention initiatives based on them may be offered or recommended. The teachers' recognised competences, if any, will be shared with others in the circuit to which they belong as well as other circuits.

Confidentiality:

Because the researcher will follow the ethical standards necessary for research projects at the University of the Free State, your participation in this study will be kept anonymous. When referring to participants, the researcher will utilise code names or pseudonyms to ensure that the individuals' real names are not revealed.

Voluntary participation:

This study's participation is totally voluntary. You have the ability to withdraw at any moment without penalty.

CONSENT FORM

I, ____________________________________, (teacher's name and surname) hereby give my consent to participate in the study. I am assured of anonymity and know I can withdraw if I do not want to participate.

Signature:____________________Date: __________________________________

NM Bhekiswayo

Appendix F: Letter of Agreement for Learners

14 February 2023

Dear Grade 7 learner

LETTER OF AGREEMENT FOR LEARNERS

I am pursuing a Master's degree at the University of the Free State, and my research study is to explore how teachers balance mathematics assessment tasks in grade 7 classes to accommodate problem-solving. I'll be sitting in on your math teacher's class, taking notes and recording audio. I'll be recording the teacher, not you. I will also make copies of any mathematical tasks provided to you by the teacher in your workbooks, such as homework and classwork.

That is the only way you will be participating in the research, and you will not be required to do anything other than what your teacher asks of you. Please feel free to communicate any concerns that you might have regarding this study.

Yours sincerely

NM Bhekiswayo

Appendix G: Interview Schedule

Date : ___________________________Venue:_______________________________

Teacher:______________________________

1. Briefly explain what you understand about a balanced mathematics assessment task.
2. How do you balance your assessment tasks and what is the source of your assessment tasks?
3. What do you think mathematics problem solving is?
4. Can you give me an example of mathematics problem-solving? Think of a problem you used recently in your classroom
5. How do you accommodate problem-solving into your mathematics assessment tasks?
6. Why do you think paying attention to problem-solving when preparing the mathematics assessment tasks is important?
7. How often do you include problem-solving in your classwork and homework
8. What could be challenges/constraints that may inhibit you from including problem-solving in your assessment tasks?
9. In your own opinion, what makes mathematics problem-solving different from other cognitive levels?

Appendix H: Observation Schedule

LESSON SCHEDULE

Teachers' name___________________________

Number of learners:______________________

Topic:________________________________

	Aspect to observe	**Researchers' Comment**
Teaching strategies used by teachers	Direct teaching/ group work/ whole classroom interacting	
Teaching approaches used by teachers	Teacher-centered/ Learner-centered	
Teacher questioning	Low order questions/ high order questioning	
Time learners spent on working on assessment	Enough time/insuffient time	

Appendix I: Document Analysis

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
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Document analysis

Assessment in class	Aspect to analyse	Researchers comment
Mental maths	Was it administered	
Classwork	Nature of tasks accommodate and cognitive demands accommodate	
Homework	Nature of tasks accommodated and cognitive demands accommodated	
Examples written on a board	Nature of tasks accommodated and cognitive demands accommodated	

Appendix J: Proof of Editing

Cilla Dowse Editing

Dr Cilla Dowse
cilla.dowse@gmail.com
Cell: +27 84 900 7837
(on WhatsApp)

For editing of Master's Dissertations
and
Doctoral Theses

This letter serves to confirm that editing and proofreading was done for:

NOMTHANDAZO MOUREEN BHEKISWAYO

Magister Educationis: Mathematics Education

Faculty of Education

University of the Free State

BALANCING MATHEMATICS ASSESSMENT TASKS TO ACCOMMODATE PROBLEM-SOLVING IN GRADE 7 CLASSES

Cilla Dowse
05 August 2023

Cilla Dowse PhD in Assessment and Quality Assurance in Education and Training: University of Pretoria 2014 Basic Editing and Proofreading: McGillivray Linnegar Associates 2008 Programme on Editing Principles and Practices: University of Pretoria 2009 Editing and Proofreading for Academic Purposes: McGillivray Linnegar Associates 2021 Professional Editors' Guild Associate Member, DOW003	Rosedale Farm P.O. Box 48 Van Reenen Free State cilla.dowse@gmail.com Cell: 084 900 7837

TRANSCRIPTS

QUESTION 1: Briefly explain what you understand about a balanced mathematics assessment task.

TEACHER A

“Okay. Good, good. Good, good day mam. By balance assessment task in mathematics, it means the task includes all the cognitive levels, whereby it shows it allows the child to answer high order questions or low order questions, which means it will accommodate all the learners. If the learner is has low in such intellectual capacity, the learners can be able to answer the low order questions. And even those learners which are good, the high fliers, they can get their high order questions, which means the paper will be balanced to every learner. Thank you.”

TEACHER B

“Okay. Good afternoon, ma'am. What I understand about the balance Mathematic assessment task is that it has to include all the cognitive levels, ranging from level one up to five”

TEACHER C

“Thank you, ma'am. And good morning to It's my pleasure. A Balanced Mathematics, mathematics assessment task is a task that include the low order to accommodate learners with challenges, the middle order is meant for both low order and high order type of leaners, the high order is meant for high achievers to stimulate their efforts”.

TEACHER D

Okay. Your balance mathematics assessment task for grade sevens, we follow Bloom's taxonomy. So, it's levels that are coordinated, as low, middle and high. When we compile an assessment task, there is a certain percentage that we equate to low order questions, middle order questions and higher order questions. The preference is that low order questions have the most percentage, and then your middle order questions and then your high order questions is roughly between 10 and 15%. below what are questions or questions that we formulate in an assessment task, as recall knowledge, anything that learners should know that can actively be they are actively able to answer your middle order questions or questions where we normally do calculations. So, it's calculation that they must do a procedure that they must follow to get to an answer, that also formulate part of complex procedures. So, we also have a complex procedure that learners do so it's quite a method that they must follow. And then your higher order questions is basically where the problem solving comes in. So, we tend to give problem solving questions as high order questions in our assessment tasks.

TEACHER E

“What I understand about the balanced mathematic task is that the assessment or the task must also accommodate the cognitive level, it must also accommodate the slow learning learners must accommodate those who are flying color they do those who are flying colours learners, so accommodate all the level of learners within the classroom.”

QUESTION 2: How do you balance your assessment tasks and what is the source of your assessment tasks?

TEACHER A

“When balancing the assessment tasks, I include questions like first simple questions and multiple choice low order questions which have one mark and then thereafter, I move to the middle order questions where I can ask questions which need some steps from the learner. And I will also put the problem solving questions which high order questions and with high marks so my paper will be inclusive. And where I get my assessment task. I use various sources such as when I can go check my study guides, or my textbooks, or I can go check on Google. And then, but with common with final examination or June examination, we get our task from the Department of District Department of Education at the district office. Thank you”.

TEACHER B

Okay, I balance my assessment task. Whenever I'm setting a task, I make sure that I include all the levels to accommodate all the learners, you know that those learners that are struggling, especially with the language barrier, so at least if there's a level one and level two questions, I'm able to accommodate everyone.

TEACHER C

“I'm guided by the assessment policy framework, 50%, low order the 35%, middle order and 15% high order”

TEACHER D

“So, as I said, we balance our assessment tasks according to the Bloom's Taxonomy and according to the percentages that we are supposed to evaluate. We try and balance as I said, low order, middle order and high order. The sources of my assessment tasks, I mostly pinpoint examples from resources such as our DBE books, textbooks that I use Spot on premier mathematics, Today mathematics, as well as different online platforms such as Twinkle, each classroom, live worksheets, various places that I gather different types of questions to formulate an assist to develop my assessment tasks.”

TEACHER E

“The source of my assessment task is the textbook that I use of which is platinum It's spot on as well as DBE book from the Department of Education. And then, to balance my assessment task, I use the Bloom's Taxonomy just to make the cognitive levels differ from one another so that it accommodates every learner in the classroom”

QUESTION 3: What do you think mathematics problem solving is?

TEACHER A

“Problem solving is the questions which are much deeper, they in they went they initiate a child to think a much deeper will also show that his or her comprehension, and they develop thinking skills in a learner. So, all the question papers must have problem solving question”.

TEACHER B

“Okay, what I think it's mathematical problem solving, I think mathematical problem solving has to do with real life situations that are relatable to mathematics”.

TEACHER C

“Mathematics problem solving its where learners are given sums where they solve problems on their own”

TEACHER D

Your mathematics problem solving? I think is basically a question that we as educators use to assess what the thinking capacity of learners is that are able to solve different problems in different real-life scenarios or if they're able to actually apply how they solve questions, if we give them a real life situation. Your problem solving is very complex, it means more thinking. learners need to be able to understand certain concepts to actually apply it into solving a specific problem that is given that is what I think is mathematics problem solving.

TEACHER E

I think mathematics problem solving, it's whereby learners they need to understand the the questions that is written in words, it can be a scenario, it can be a summary of something so they need to read, and then they understand the question before they answer it. So that's why they said it's a problem solving.

QUESTION 4: Can you give me an example of mathematics problem-solving? Think of a problem you used recently in your classroom

TEACHER A

"Yes, there as I was teaching exponent, and then I use word sums, with sums, which whereby the child will calculate. The question is, I have 54 to the power of one, and 79 to the power of one. What will the total be if I add these two numbers? That's my example of a problem".

TEACHER B

"So okay, example of mathematical problem solving I would like to do an example about let me say Okay, and problem-solving questions that I can think of let me say, I'm teaching fractions and then I asks the learners, maybe common fraction, and then I give them a piece of him of a of a pisza that is divided into six equal pieces. And then I ask the question have to say, if I if I take two pieces and give it to two learners, how many pieces will they be left all together? So, the learners will say, four over six, because only all the pieces are six, but because I took two out of the six, they'll be left with four over six"

TEACHER C

“Thank you, ma'am, as we are dealing with the exponents, here is an example a palindrome is a number or word that reads the same backwards and forwards. Example 101. Now, the question that are asked learners is, learners use the digits 123, and four, to find a three-digit square number, that is a palindrome? Use the very same digits 123 and four, to use a three-digit cubic number that is a palindrome. Thank you”

TEACHER D

So, mathematics problem solving example I'll give is, for example, I introduced exponents to my class and I used the example of why we call them square numbers, where I said, your mom comes to you in your bedroom and she tells you Thando we are going to put a carpet in your room, we need to calculate the area of the carpet. But where your bed is, we are not going to put a carpet we are going to put tiles. So what will the area be of the carpet? And what will the area B of the tiles is a type of problem solving questions that a grade seven learner should be able to, to apply. And with that, we understand that different shapes are used. In a sense if it's a square, there's a certain formula to calculate area if it's a rectangle, there's a certain formula that must be used and to find the area then they subtract the difference of the two for example, that is an example of mathematics problem solving that I've used recently.

TEACHER E

“One of the examples that I will use because you are recently dealing with the exponents, as well as the cube root is that I'll give you the learners maybe the textbook or something or write something on the board to say, can you add the first cube root number that is smaller than 100 with the largest cubic number that is also less than 100. So they need to think of the cubic numbers as well as to think which one is below 100 And which one is greater than one but below then 100, then they add the two for an example one cubed plus six cube. So they need to add those two”

QUESTION 5: How do you accommodate problem-solving into your mathematics assessment tasks?

TEACHER A

“Sometimes I have some questions which are word problems in my assessment task. And then those questions are the questions which will make the child to think about what's the implication or how to solve it and those that it enables learner to check the key words in the questions such as like you can learn I can use addition to boys added to two girls, what is the answer you know? So, I can use word problem questions. Thank you”

TEACHER B

“Okay, I include problem solving that are most relatable to the everyday life situation, problem solving that learners can easily understand yes”

TEACHER C

“it is, it is accommodated in the higher order section”

TEACHER D

“We accommodate problem solving to the mathematics assessment task based on our Bloom's Taxonomy. As I said high order questions must be given about 10 to 15% preference, of which most of the time we have to provide a problem solving question in the assessment task. So a certain topic that is relevant that I need to assess 10 to 15% of that calculated total that the assessment task is out of will be a problem solving question.

TEACHER E

“As we all know, that according to the policy, the problem solving it must contribute up to 10% of the question paper. So I make sure that the 10% of the question paper is covered by the problems are solved for an example if the question pays out of the 100. So that means 10 marks it must be the problem solving or if the question is out of 25. So three marks of those questions they must be from the problem solving”

QUESTION 6: Why do you think paying attention to problem-solving when preparing the mathematics assessment tasks is important?

TEACHER A

“It is important because it shows the thinking skill development of the learner It indicates how far the learner has developed and it is so interesting for those learners who are who have high intellectual capabilities. So, it is good for us to have a problem solving question"

TEACHER B

"it is very important because learners need to understand that mathematics is everywhere. Mathematics, is everything that we do most of the things that we do they involve mathematics. So learners need to understand that. Yes, that is why it is very important for me to pay attention in terms of problem solving when setting tasks"

TEACHER C

"It is important because it helps learners to think critically and it also stimulate their thoughts."

TEACHER D

"Because I believe that problem solving is not just something that learners experience in mathematics, I feel problem solving is also a life skill. It's something learners should be able to master and implement not only in mathematics, but in any other situation that they do face. So it does take preference because learners need to have the ability to be able to solve problems"

TEACHER E

"It is important because it requires logical thinking as well as deeply thinking from the learners because they can attempt the question without understanding so requires them to understand the question first, before they try to answer it."

QUESTION 7: How often do you include problem-solving in your classwork and homework

TEACHER A

"Yeah, at the end of each topic, I give them classwork or class tests which have problem solving. I give them homework always when I give them the homework, I put problem solving and when I give them the test, information test, I also put a problem-solving question. So always I give them problem solving in all the activities. Thank you."

TEACHER B

“Okay, I try always to include in all of the topics, so each and every topics they have like a problem solving questions at the back. By the end of the topic, I always make sure that I do a problem solving involving that certain topic”.

TEACHER C

“Mostly is twice in a class work and twice in homework in each topic”.

TEACHER D

“I try and include at least a minimum at the end of my topics, where we've covered most of the basics, learners are comfortable with the topic, and then we've got a problem-solving question that I apply to the topic, so that learners understand that all topics we can have problem solving questions, and they should have the ability to be able to solve those problems. So, for me most of the time, my classwork and homework, I include problem solving towards the end of topics, where we have quite a bit of time thereafter to explain how to solve the problems and also to give them the ability to master how they are supposed to solve problems”

TEACHER E

“As we all know that according to Gauteng Department of Education, so they want learners to have a class work as well as a homework. So it can be one once a day or once after two days, so we do accommodate it in once or twice per day”

QUESTION 8: What could be challenges/constraints that may inhibit you from including problem-solving in your assessment tasks?

TEACHER A

“As we know that we have those learners with a learning barrier, those learners have a problem of thinking they may be those learners are good in doing a skill such as hand working and maybe singing. So, when I put the problem solving, it will be difficult because they are not gifted in thinking skills. So that will be a very serious a serious contextual factor. Thank you.”

TEACHER B

“Language barrier, you know, when when coming to problem solving many learners are struggling with the language. So, you find that they don't understand it's not like they don't know that maybe the language, they don't understand what is exactly that is required of them. So, I think that is the challenge when coming to setting a problem-solving assessment"

TEACHER C

"Most learners do not attempt to answer such questions because they are lazy to think they just leave the question just as it is, and as such, mostly they get it wrong".

TEACHER D

"Constraints from including problem solving? To be honest, they are no constraints, unless I've got a topic that is quite difficult to formulate a problem-solving question for me to be able to assist the learners, but most of the time, I have to make sure that I have a problem-solving question in my assessment task. So, the constraint will be as for example, a certain topic that I cannot formulate a proper problem-solving question, that might be my challenge"

TEACHER E

"One of the challenges language barrier from the learners, some of the learners they fail to understand the level of language that is used especially in the grid. So that makes them to require more time to solve the problem. So that one of the things that is a challenge when it comes to problem solving"

QUESTION 9: In your own opinion, what makes mathematics problem-solving different from other cognitive levels?

TEACHER A

"Problem solving question is much challenging to the learners. Because it shows the comprehension level of the learners is not that much simple. So it's it's not the same and it's much deeper, deeper than other questions. So problem solving questions are different because they are mostly they use the terminology which learners can't understand. Thank you".

TEACHER B

"It is, it is very different because now we are when we're setting a test for mathematics. Most of the questions we don't necessarily, they're not lengthy. They're just to the point. Maybe they will say to you solve this equation, but when coming to problem solving learners need to really, really, really understand and be able to, what can I say? That they need to understand and be able to, to make sense before they can even answer the question of what is exactly that is required from them".

TEACHER C

"Because it is difficult for the learner as it needs their own understanding and reasoning. Thank you"

TEACHER D

"As I said, problem solving I feel is a skill that learners need to develop not only in mathematics, but as a lifelong ability to problem solve any situation. I also feel the other cognitive levels, it just gives a learner more confidence in the subject. If you are able to problem solve, it's the highest level. It provides learners with confidence. It also provides learners with a better view of thinking and applying the knowledge to the work that we are busy with or in mathematics"

TEACHER E

"I can say it requires more time; it requires understanding. It requires logical thinking. So that's one of the things that makes it to be different to other questions, unlike saying one plus one so the learners will know that the answer is to or they know the routine to follow. But with problem solving, they firstly need to understand the question before they attempt to answer that question".