Perceived Intelligence and Pedagogy: How Teachers' Perceptions Influence Teaching

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"Great results can be achieved with small forces."

– Sun Tzu

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Abstract

Mathematics has the lowest pass rate in comparison to the other Grade 12 subjects taught in South Africa. Most discussion related to students' failure rates in the subject elicit discourse surrounding teaching approaches adopted by teachers in teaching mathematics. Pedagogical discussions predominantly focus on teaching strategies and resources; however, little is known about the influence that teachers' perceptions of their students' ability have on their efforts or teaching methods. The aim of this study was to determine if teachers' perceptions of their learners' intelligence influenced the teaching style and approach of the teachers in any way. Teachers are accountable for their pass rates, therefore there was a need to discuss the way teachers adapted to the needs of their learners to optimise efficacy in the classroom. A critical component of attaining student pass rates involved teachers' perceptions of their learners' intelligence. This study examined the little-explored link between perceptions of intelligence in learners and pedagogy to offer a new perspective into inclusive education in Grade 12 mathematics classrooms in Durban, South Africa. Seven conveniently sampled teachers located in Durban, KwaZulu-Natal were interviewed in-depth. Matric mathematics teachers interviewed discussed their perceptions of an intelligent learner in their classrooms and the way these perceptions influenced their pedagogical approaches. Participating teachers in this study discussed the applicability of their respective approaches in teaching mathematics to learners in a South African context. Resultingly, key influences behind teachers' pedagogical approaches were a combination of student ability and an administrative pressure to complete the Grade 12 mathematics curriculum. The interdependent nature of these factors is further discussed in the results of this study.

Key words: mathematics, teachers, implicit intelligence, pedagogy, perceptual intelligence

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Abbreviations and Definitions

The following abbreviations and terms are defined for the purpose of this study.

ACE	Advanced Certificate of Education
ANOVA	Analysis of variance
CAPS	Curriculum Assessment Policy Statements
COVID-19	Coronavirus
DBE	Department of Basic Education
IQ	Intelligence Quotient
MST	Multiple-solution tasks
PGCE	Post-Graduate Certificate of Education
USB	Universal Serial Bus
TIMMS	Trends in International Mathematics and Science Study
Learners	Synonymous to students or pupils
Matriculation or matric	Grade 12
Quintile 1-5	School classification scale based on financial resources with Quintile 1 schools being the poorest and Quintile 5 schools being the most well-resourced.
Respondent	Synonymous to research participant
Scores	Synonymous with student marks, results, and grades.

Chapter 1: Introduction to the Study

Mathematical research in post-apartheid South Africa has gradually shifted towards the inclusion of qualitative research, whereby aspects of diversity are focused upon (Adler & Venkat, 2014). In the dynamic context of South African education, issues of diversity, accessibility, and quality of education are increasingly important to an equitable mathematical pedagogy (Adler & Venkat, 2014). With the expansion of research in the field of mathematics, an array of sociological and psychological perspectives underlies research aimed at enhancing students' performance in classrooms through equal opportunity (Adler & Venkat, 2014). Chen et al. (2021) presented a discursive analysis of the meanings that mathematics teachers attached to their pedagogical decisions. Mahleba et al. (2021) utilised narrative analysis in addition to classroom observations to determine factors affecting learners' poor mathematics performance in Mpumalanga. Perceptual data is increasingly important to the context of mathematics teaching as the perceptions of both teachers and learners affect classroom dynamics (Chen et al., 2021; Mahleba et al., 2021). Thus, it is necessary to investigate these perceptions as influential factors in successful teaching and learning, especially with regard to subjects with high failure rates (Gardee, 2019). This research proposes that teachers' perspectives of students' intelligence is an influential factor in their pedagogical approaches to mathematics.

1.1 Background of the Study

The National Senior Certificate is the qualification obtained by students at the end of Grade 12 or matric level. This certificate enables entry into higher education and is regarded as an important achievement for learners in South Africa. The matriculation examination results are published annually by South Africa's Department of Basic Education, wherein a census pertaining to provincial and regional learner pass rates is released to members of the public. These annual statistics disclose the percentage of learners, categorised by region, who passed or failed each subject. The Department of Basic Education's statistical reports have been met with criticism, particularly from

the media. According to the reports therein, mathematics and cognate subjects have had the lowest pass rates when compared to the other subjects that matric learners were enrolled in (DBE, 2019b).

Learners' results in mathematics have been of interest in educational research. There is considerable attention drawn to South Africa's performance in the TIMSS tests in comparison to other countries (Vithal et al., 2005). According to the TIMSS Report released by The Department of Basic Education (2015), 52% of South African learners met the lowest international benchmark in mathematics. While this placement was above most other African countries and several Middle Eastern countries, concerns regarding low mathematics results among South African matric learners has been a recurring theme in both research and the media. The TIMSS Report released in 2019 by The Department of Basic Education (2019) revealed that 37% of South African learners met the lowest international benchmark in mathematics, which indicates a reduction in the pass rates. The challenging circumstances caused by the COVID-19 pandemic between 2020 and 2021 resulted in a further decline of pass rates in mathematics literacy from 57% to 49% respectively (DBE, 2021).

Due to 2019 matriculation results, the chairperson of the Council for Quality Assurance in General and Further Education and Training, John Volmik, stated that learners' performance in mathematics did not appear to be progressing along the same trajectory as other subjects (Pijoos, 2020). Volmik noted a decrease in the number of candidates in mathematics-based subjects, including accounting, over the past years. There was a decrease in learners' performance in mathematics despite improvements in other subject areas such as geography and physical science (DBE, 2019b; Pijoos, 2020). One of the fundamental reasons attributed to learners' poor performance in mathematics has been the pedagogical approaches to teaching mathematics in schools (Pijoos, 2020). The Department of Basic Education (2021) maintains that problem-solving skills need to be developed, and learners need to become confident in their dealings with mathematical problems (Pijoos, 2020). Pijoos (2020) suggested that there are significant

achievement gaps between learners based on: language, socio-economic status, the development of a residential area, and school resources.

Historically, most educational research into mathematics revolved around the: elements of the mathematics syllabus (Gal, 2009) or linguistic barriers affecting learners' performance (Howie, 2003). There has been limited research pertaining to teachers' perception of learners' intelligence in South Africa.

1.2 Statement of the Problem

According to the diagnostic report on content subjects released by the Department of Basic Education (2021), Grade 12 examination candidates were identified as becoming "over reliant on past examination papers" alone (p. 184). The Department of Basic Education (2021) emphasised the importance of learners developing analytical skills beyond memorisation and replication. Previously, educational research into mathematics focused on the mathematics syllabus or linguistic barriers affecting learners' performance (Gal, 2009; Howie, 2003). Mathematical research of this nature focused primarily on enhancing learners' achievements in the context of the South African mathematics syllabus. However, a contemporary approach to mathematics education has emerged on the African continent with an emphasis on the role of pedagogy in constructing equal opportunities for learners in the mathematics classroom (Assan, 2019; Gardee, 2019). The rationale behind this approach is to examine the intersection of pedagogy, social relationships and student achievement in the classroom environment. The influence of these factors upon one another impacts the opportunities students receive to optimise their mathematical understanding and accomplishment (Gardee, 2019). There has been limited research pertaining to teachers' perception of learners' intelligence in South Africa, and the role that these perceptions play in creating equal opportunities in the mathematics classroom. Teachers routinely form evaluative judgments of their students' capabilities and may adjust their teaching approaches accordingly (Assan, 2019; Gardee, 2019;

Parker & Adler, 2014). Hence, it is necessary to further examine this relationship within the South African teaching context to inform mathematical teaching practice in the country for optimal learner equity and achievement.

1.3 Purpose and Objectives

This research is motivated by the suggestion that teachers' implicit ideologies surrounding intelligence can influence the achievement gap between learners (Sternberg & Grigorenko, 2003). While the matric mathematics exams are standardised in South Africa, the pedagogical approaches to teaching mathematics varies between classrooms, which influences the quality of input that learners receive. Generally, teachers adhere to key elements of the syllabus to prepare their learners for the national matric examinations. Despite utilising similar syllabi, learners' performance in mathematics differs comparably. This suggests that pedagogical approaches also differ between teachers, as a relationship between teacher expectations and student achievement has been identified. As a result, higher expectations are placed upon higher achieving students, and lower expectations are placed upon struggling students (Gardee, 2019; Parker & Adler, 2014). Higher achieving students are therefore more likely to be perceived as intelligent compared to their lower-achieving peers, which influences the classroom dynamic (Gardee, 2019; Sternberg, 2020). As per previous studies, the experiential nature of this particular relationship between teachers and learners in the South African mathematics classroom warrants a narrative exploration into teachers' own decision-making (Gardee, 2019; Parker & Adler, 2014).

The aim of this study is to examine mathematics teachers' perceptions of intelligence in their learners. The objectives of this study are:

- To examine how matric mathematics teachers define intellectual ability in their learners.
- To determine if matric mathematics teachers' perceptions of intellectual ability in their learners influences their teaching approaches.

- To establish the teaching approaches (pedagogical or otherwise) favoured by matric mathematics teachers in response to their perceptions and other limitations.

1.4 Research Questions

The research questions addressed in this study revolve around matric mathematics teachers' perceptions of their learners and their definitions of intelligence relating to their learners. Additionally, this study determines if there is a link between these perceptions and favoured pedagogical approaches in the classroom environment. It is necessary to determine the extent to which these pedagogical approaches are used to optimise learners' success in mathematics at a Grade 12 level. The primary research questions are as follows:

- How do mathematics teachers define and perceive intelligence in their learners?
- Do these perceptions of intelligence influence pedagogical adaptations made by the teacher to optimise learner success in mathematics?
- What teaching approaches (pedagogical or otherwise) do these mathematics teachers favour?

1.5 Significance of the Study

The relationship between teachers' perceptions of intelligence in their learners and their pedagogical approaches in the classroom has remained minimally explored in South African schools. Perceptual intelligence or implicit intelligence is informed significantly by the background and experiences of the individual (Sternberg, 2020). The nature of the professional role, teaching, embodied by the individual influences their viewpoints. The mathematics teachers interviewed in this study had their individual views of learners' intelligence informed by their respective backgrounds in education, notably formal teacher training qualifications and their experiences in the classroom. A further link can be established from the application of these teachers' viewpoints to the learners and the classroom environment. While these viewpoints are fathomable, there is limited critical discourse on the effects of these viewpoints on teaching approaches or its effects on the

learning environment. Essentially, the significance of this study lies in extrapolating this lesser-known discourse from the narratives of these educators and connecting it to factors of perceived intelligence and favoured pedagogical approaches. Moreover, this study poses implications for teaching and learning mathematics at the matric level, which may have further implications for learners' success rates in the subject. These are discussed in the literature review.

1.6 Assumptions of the Study

Implicit beliefs and perceptions are transferrable between teachers and learners, influencing learners' attitudes, motivations, and views of success (Gardee, 2019; Gardee 2021; Johnsson et al., 2012; Ogbonnaya et al., 2016). Sternberg and Grigorenko (2003) emphasise that teachers with limited and biased perceptions of intelligence strongly impede on learners' potential. Learners' motivation and cultivation of a learners' potential are critical to success in the academic environment (Sternberg & Grigorenko, 2003). Although learners themselves were not interviewed in the scope of this study, learner motivation is discussed in relation to favoured teaching approaches noted in the interviews conducted for this study. Therefore, this study assumes that the teachers sampled have individualised viewpoints of learner potential and learner motivation, which influence their pedagogical approaches.

1.7 Scope and Delimitations

Qualitative research designs aim to explore the interdependencies of phenomena that are more complex than what can be encapsulated by a few variables (Terre Blanche et al., 2006). This form of research is embarked upon primarily through a holistic inquiry (Terre Blanche et al., 2006). Samples are procured to investigate phenomena through a scientifically informed process of inquiry that lends insight to the research questions. In this particular case, the investigation is based on the interdependencies of perceptual intelligence and pedagogy as embodied by seven matric mathematics teachers in Durban, KwaZulu-Natal. Although the topic of this study is narrow, the

scope of inquiry remains broad enough to investigate nuances in the narratives provided by the research participants. Therefore, this study encompasses an inquiry into: perceived intelligence in learners, preferred methodologies, pedagogical adaptations, and learner motivation. The results of this study are limited to the local context and parameters of the voluntary sample. This includes the location of this study, the type of institutions where the sample was procured, and other contextual realities of the sampled teachers. Hence, this study is localised, which limits the implications of the results to its own context. These factors will be discussed in the methodology section.

1.8 Operational Definitions

Throughout this study, intelligence is defined by the concept of implicit intelligence, or perceived intelligence. An implicit theory of intelligence is a perception of intelligence informed by the contextual experiences of the individual (Maltby et al., 2017). The everyday life and context of the individual influences how they perceive their own and others' intelligence. These perceptions inform the conclusions, judgements, and decisions individuals make in their everyday lives and occupations (Maltby et al., 2017). Correspondingly, this perceptual intelligence is applied to an educational context wherein academic achievement is an allied construct to perceptions of intelligence (Sternberg, 2020). Intelligence broadly encompasses a measure of someone's ability to acquire knowledge. Academic achievement involves measuring how much knowledge someone has gained from educational experience (Sternberg, 2020). Although academic achievement is an application of ability, educational settings often equate academic achievement to a reflection of individual intellectual ability (Sternberg, 2020). With the duality of these concepts in mind, this study aims to examine how much academic achievement informs intelligence within teachers' perspectives. Therefore, the operational definition of intelligence utilised in this study is that of the reciprocating nature of academic achievement and intellectual ability.

In this study, several terms are used interchangeably such as: learner and student, educator and teacher, matric and matriculant. The terms learner and student refer to secondary school pupils. Educator and teacher are considered synonymous in this study. The terms matric and matriculant refer to students who are in Grade 12. Matric is a term commonly used in South Africa to refer to Grade 12 learners because it is the year in which they write the National Senior Certificate examinations to qualify for university entrance, thus becoming a matriculant.

1.9 Dissertation Structure

Chapter 1 outlines the background of the study in addition to the aims, objectives, and significance of the study.

Chapter 2 contains the literature review in which all concepts and the theoretical framework used in this study are discussed in detail.

Chapter 3 discusses the methodology, which encompasses the study design and data collection process.

Chapter 4 is the analysis and detailed discussion of the themes and findings of this study.

Chapter 5 concludes the research by summarizing the key findings of the study and providing recommendations for future research.

1.10 Summary

In summary, the current study examines the application of implicit intelligence on pedagogical decisions made by mathematics educators in the South African schooling context. The objective is to review these narratives for links between perceived intelligence of learners and pedagogical adaptations that may enhance or inhibit learners' success in mathematics at the matric level. Success in mathematics has been under critical review in South African educational literature because the subject produces the lowest pass rates of all the courses examined at matric level. Perceptual

intelligence is used as a psychological insight into educational practices, which lends necessary insight into teaching practice.

Chapter 2: Literature Review

2.1 Introduction

Passing the National Senior Certificate examinations is considered crucial to South African youths, as the results of these examinations determine their career prospects. The importance of these examinations is reflected in the body of mathematics research in the country, the majority of which emphasises secondary mathematics education (Adler et al., 2016; Smith, 2020). Mathematics research conducted locally between the years of 2000 and 2015 utilised qualitative research paradigms to investigate pedagogical solutions to issues in secondary school mathematics education (Adler et al., 2016). Mathematics education research conducted between 2000 and 2015 focused on secondary school learners due to the changing socio-political landscape of post-apartheid South Africa wherein educational reforms were being implemented for educational equality. Hence, secondary school learners' needs were prioritised for the purposes of vocational entry after matriculation in the newly democratic South Africa. For the pursuit of classroom equity, teachers needed to adapt their pedagogies to cater to a diverse range of learners' needs despite having had limited resources (Adler et al., 2016, p. 88; Taylor, 2021). The necessity of these pedagogical adaptations in South Africa's democratic transition can be attributed to two key factors: an increasingly diverse learning landscape, and performance management measures (Vithal et al., 2005; Adler et al., 2016; Taylor, 2021). The former acknowledged learners' needs by giving consideration to how prejudice, poverty, disabilities, and multilingualism adversely affect learners' performance in mathematics (Adler et al., 2016; Taylor, 2021; Vithal et al., 2005). The latter occurred in response to regulatory measures imposed on teachers at governmental and institutional levels whereby teachers were made strictly accountable for students' performance in mathematics (Taylor, 2021). Despite extensive investigation of pedagogical approaches to mathematics, little is known about the implicit psychological factors and social dynamics underpinning these approaches in the mathematics classroom. Adapting pedagogical approaches in the classroom to suit the needs of learners is one of

the numerous judgements teachers make in their profession (Rausch et al., 2016). Besides pedagogy, teachers' professional judgements encompass matters such as student allocation, assignment feedback, behavioural management, and adapted assessment practices (Rausch et al., 2016). Teachers' individual professional judgements rely on their perceptions, which are informed by professional training, professional experience, and other broader social narratives (Rausch et al., 2016). Sternberg (2020) contends that learners' skills and capabilities are identified through evaluative judgements made by teachers, which are subject to the teachers' individual notions of intelligence. These evaluative perceptions are referred to as implicit theories of intelligence (Sternberg, 2020). The interconnected nature of implicit theories of intelligence, evaluative judgement, and pedagogical decisions forms the basis of this study.

2.2 Theoretical Overview of Intelligence

Definitions of intelligence have evolved and adapted over time based on relevance to the social and cultural context in which it occurs (Sternberg, 2020). The Intelligence Quotient, commonly referred to as IQ, is one of the most popular quantifiable representations of intelligence (Maltby et al., 2017). Intelligence testing reflects skills and aptitudes of individuals within a specific age range, and the IQ is the quantifiable result (Maltby et al., 2017; Sternberg, 2020). Theorists Spearman and Gardner gained popularity in the fields of education and psychology for less numerically quantifiable theories of intelligence (Sternberg, 2020). Spearman's theory of general intelligence utilised various tests and factor analyses to numerically express intelligence as a general cognitive ability, whereas Gardner introduced the concept of multiple intelligences that proposed numerical expressions of human intelligence that were not an accurate description of ability (Sternberg, 2020). The theory of multiple intelligences focused on nine different types of intelligence that are based on innate, biological capabilities and the socio-cultural context of the individual (Gouws & Dicker, 2011; Maltby et al., 2017). The nine intelligences identified by Gardner are: logical-mathematical intelligence, verbal-linguistic intelligence, musical intelligence, spatial

intelligence, bodily-kinaesthetic intelligence, intrapersonal intelligence, interpersonal intelligence, naturalistic intelligence, and existential intelligence. Based on Gardner's paradigm, the most applicable intelligence to this research is logical-mathematical intelligence, which encompasses an individuals' capacity to reason and solve problems using numerical methods (Gouws & Dicker, 2011; Maltby et al., 2017).

Following Gardner's approach, Sternberg (1997) expanded upon theories of intelligence that were more broadly encapsulating of skill sets associated with intelligence, as opposed to a numerical representation. Sternberg (1997) discussed commonalities in definitions of intelligence over time, which included factors such as the ability to learn, the ability to adapt to the learning environment, and higher-level abilities as defined by the cultural context of the individual. Sternberg (1997) emphasised that humans do not strictly adapt to their environments, but are involved in its creation and selection, which included various fundamental mental processes involved in the cultivation of intelligence based on cultural and environmental factors. These factors include: the recognition of a problem and its nature, the construction of problem-solving strategies, the representation of the problem mentally or physically, and the monitoring and evaluation of solutions to the problem (Sternberg, 1997; Sternberg, 2020).

Intelligence is a concept that is inherently intertwined with educational contexts and academic achievement. Sternberg (2020) stipulated that there is a "reciprocal relationship between intelligence and achievement" (p. 1051). This reciprocal relationship exists in education because intelligence is viewed as the ability to gain knowledge, while achievement involves the application of knowledge. Application of knowledge involves creativity, critical thinking, problem-solving, and the ability to overcome challenges by incorporating previous knowledge with new knowledge (Sternberg, 2020). Additionally, students tend to learn new concepts if their previous knowledge is

adequately solidified. Thus, academic achievement is inextricable from discussions of intelligence within educational contexts as the two are viewed as interdependent.

Sternberg (2020) stated that educators have a predisposition to teach critical thinking skills and equip learners with problem-solving skills to enhance their academic achievements. Sternberg (2020) theorised that in order to determine what to teach, educators will already have evaluative perceptions or assumptions informing their understanding of a student's ability. This theory suggests that learners are already capable of critical thinking by default, and the educator's presence is to facilitate skills that enable academic achievement. Therefore, educators already have implicit evaluative assumptions of a learner's critical thinking skills which assists in identify the skills most appropriate to the subject matter (Sternberg, 2020). These implicit evaluative assumptions are informed by implicit perceptions of intelligence that permeate both broader society and educational contexts (Maltby et al., 2017; Sternberg, 2020). Due to the interdependent nature of implicit intelligence and academic achievement, both concepts are examined further to understand the intricacies by which they inform one another.

Sternberg and Grigorenko (2003) further established a theory of intelligence directly related to learning capabilities in the triarchic theory of intelligence, which is also known as successful intelligence (Maltby et al., 2017). The three factors involved are analytic intelligence, creative intelligence, and practical intelligence (Sternberg & Grigorenko, 2003). Analytic intelligence refers to an individual's ability to analyse, monitor, and evaluate information during the process of problem-solving (Tigner & Tigner, 2000).

Creative intelligence is valued in novel situations where innovation is applicable. Individuals possessing innovative skills are persistent in their problem-solving despite hindrances, impediments, and obstacles (Tigner & Tigner, 2000). Practical intelligence is more difficult to recognise as it can vary between contexts. Practical intelligence generally comprises a combination of strategic

planning, judgment, and appropriate decision-making capabilities based on the context (Tigner & Tigner, 2000).

The concept of practical intelligence, also known as the triarchic theory of intelligence or the successful theory of intelligence, focuses on applicable knowledge to everyday situations (Maltby et al., 2017; Sternberg, 1997; Sternberg, 2020). Sternberg and Grigorenko (2003) proposed adaptations for teaching practice based on the triarchic theory of intelligence. Sternberg and Grigorenko (2003) view intelligence as multi-dimensional and emphasise that there are multiple ways to be intelligent. Sternberg and Grigorenko's theory of successful intelligence suggest that "students' failures to achieve at a level that matches their potential often result from teaching and assessment that are narrow in conceptualization and rigid in implementation" (Sternberg & Grigorenko, 2003, p. 208). The focus on pedagogical approaches is of essence in the discussion of mathematics delivery in South African classrooms where the teachers' assessments of their learners' competencies is not based on intelligence testing, but rather their perceptions of their learners' intelligence, which is discussed in the section of implicit theories of intelligence.

2.3 Implicit Theories of Intelligence

Implicit theories of intelligence are the everyday ideas formed by people regarding what constitutes intelligence in others (Maltby et al., 2017). Implicit theories of intelligence are important to everyday life as they influence how people perceive both their own and others' intelligence (Maltby et al., 2017). People use these perceptions to draw conclusions and make judgments pertaining to daily life, including occupational choices and decisions regarding personal relationships (Maltby et al., 2017). Implicit theories of intelligence can inform research around psychological and social constructs in order to give insight into cross-cultural views of intelligence, or the development of individual intelligence (Maltby et al., 2017).

Individual views of intelligence are an aspect of implicit intelligence (Sternberg, 2020). The concept of implicit intelligence includes the daily influences, experiences, and occurrences that contribute to an individual's personal notions of intelligence (Sternberg, 2020). These everyday ideas are further informed by the education and professional occupation of the individual (Sternberg, 2020). As a result, these implicit theories of what individuals define as intelligence informs decisions about themselves and others (Maltby et al., 2017).

Implicit beliefs of intelligence can be divided into a binary consisting of two categories consisting of incremental views and entity views (Jones et al., 2012). These views are otherwise known as fixed and malleable views of intelligence respectively (Dweck et al., 1995b). Entity, or fixed, views of intelligence contrast incremental views with beliefs that intelligence is predetermined and static (Jones et al., 2012). The incremental, or malleable, view is rooted in the notion that individuals can actively control their intellectual competency. The malleable view of intelligence encompasses the belief that intelligence can be increased through learning (Jones et al., 2012). Implicit theories of intelligence are of particular importance in educational settings where academic motivation comes into question. Learners' views of intelligence determine their levels of motivation to perform academically (Jones et al., 2012). Learners who believe that intelligence is malleable experience more motivation and perform better academically than peers who perceive intelligence as fixed and unchanging (Dweck et al., 1995b; Jones et al., 2012). Students' attitudes toward intelligence can change with age and experience, as their social, cultural, and educational context in also influences their attitudes; moreover, teachers' attitudes can transfer to their students (Dweck et al., 1995a; Jones et al., 2012; Jonsson et al., 2012; Ogbonnaya et al., 2016).

Despite acting as fundamental assumptions, people's implicit theories of intelligence in cannot be viewed rigidly. They are, instead, better viewed as "alternate ways of constructing reality" (Dweck et al., 1995b, p. 268). Thus, implicit theories are referred to as the systematic way by which individuals

think about intelligence, thereby influencing the approaches they take towards learning goals (Jonsson et al., 2012). Teachers' implicit theories of intelligence directly contribute to their perceptions of learners. Additionally, these perceptions of learner intelligence influence the teaching approaches that teachers take towards their learners (Jonsson et al., 2012). One such influence lies in the overlap between epistemological beliefs of intelligence and implicit beliefs of intelligence where epistemological beliefs, or the nature of "knowing", can vary based on disciplinary areas. This suggests that knowledge can differ between subjects, thus influencing the manner by which intelligence is perceived and defined in each subject (Jonsson et al., 2012). Teachers delivering varying subjects may have different implicit theories of intelligence that are systematically influenced by both the learning environment and epistemological beliefs about their subject area (Jonsson, 2012).

The aforementioned research into the implications of implicit intelligence on teaching and learning sought observable outcomes wherein learner achievement was the primary focus. The overlapping nature of implicit and epistemological beliefs of intelligence are key influences to the pedagogical approaches that teachers favour. Justifications of these approaches can be addressed by acquiring teachers' own narratives of intelligence and pedagogy. This study seeks to address this gap by focusing on teachers' reasoning behind their views of intelligence and pedagogical adaptations.

2.4 Pedagogy and Mathematics

Teaching approaches are at the forefront of discourse surrounding matric mathematics results. Teachers' approaches to teaching mathematics become a focal point in media discourse surrounding mathematics scores. Thus, it is essential to discuss the pedagogical approaches favoured and implemented by mathematics teachers. Pedagogical knowledge refers to an understanding of practices and teaching methodologies that extend beyond the subject matter itself (Carney & Roselmina, 2013). Within pedagogical knowledge is the concept of disciplinary literacy, which

refers to the manner by which teaching and learning changes in response to the subject content (Carney & Roselmina, 2013). In other words, pedagogical knowledge refers to ways of thinking, reading, and knowing in the discipline (Carney & Roselmina, 2013). Therefore, educators' pedagogical knowledge involves their ability to select appropriate modalities of delivery to accommodate the learners' levels of competency in the subject in a multitude of contexts (Carney & Roselmina, 2013; Watkins & Mortimore, 1999). A unanimity of both content knowledge and pedagogical knowledge should be combined to determine the approach most suitable to learners' needs to ensure the effective delivery of course material (Carney & Roselmina, 2013; Sternberg & Grigorenko, 2003; Watkins & Mortimore, 1999).

Mathematical pedagogy is relative to the context in which mathematics teaching occurs (Murray & Allotey, 2022). In secondary mathematics classrooms, mathematical understanding is described as "making connections between ideas, facts, or procedures where the extent of understanding is directly related to the characteristics of the connections" (Goos et al., 2007, p. 37). Cultivating mathematical understanding in learners requires a teacher's evaluative judgement to identify suitable pedagogical techniques that encourage mathematical understanding (Goos et al., 2007). Comparative studies conducted by Murray and Allotey (2022) investigated the common factors integrated into mathematical pedagogy in Singapore, Ghana and the United States. These comparative studies revealed that effective mathematical pedagogy involved an integration of linguistic and contextual factors, particularly with regards to ethnomathematics (Murray & Allotey, 2022). Ethnomathematics is defined as "the mathematics which is practiced among identifiable cultural groups" (Murray & Allotey, 2022, p. 111). The practice of ethnomathematics enhances mathematical understanding through culturally relevant content which creates a point of relation between the learners and the syllabus. One such example is the significance of soccer as a popular sport to mathematics learners in Ghana. The popularity of the sport among learners in Ghana offered an indiscriminate way to grasp the concepts of shape and space where the ball, field, score, and

number of players in the game were used to illustrate different mathematical concepts (Murray & Allotey, 2022). Teachers in Ghana incorporated these influential games as a means of developing mathematical thinking skills while complying with resource constraints and linguistic limitations faced in the country (Murray & Allotey, 2022). The relatively universal understanding of soccer-related vocabulary and numerical values associated with points and scores complimented the mathematical concepts being introduced to learners. Thus, teachers facing limitations in teaching materials or linguistic limitations could utilise common soccer terminology to illustrate mathematical concepts (Murray & Allotey, 2022).

2.5 Pedagogy and Implicit Intelligence

Teachers' implicit theories of intelligence have a strong influence on their pedagogical approaches to both teaching and classroom conduct (Dweck et al., 1995a; Ringle, 2014). These ideologies and judgements can affect all aspects of classroom activity, particularly performance and learning goals (Dweck et al., 1995a). Sternberg and Grigorenko (2003) proposed a theory that "students' failures often result from teaching and assessment that are narrow in conceptualization and rigid in implementation" (Sternberg & Grigorenko, 2003, p. 208). Teachers whose perceptions of intelligence are aligned with specific models and ideologies may have a strong influence on either cultivating or limiting a learner's intelligence and potential by communicating goals that are rigid, narrow, and biased (Dweck et al., 1995a; Ringle, 2014; Sternberg & Grigorenko, 2003). This perception becomes particularly important when confronting learners who become discouraged when encountering difficulties in the learning material. Types of academic input can act as a mediating factor between student self-concept and student motivation (Dweck et al., 1995a). Students' motivation and self-concept is directly related to the learning opportunities they have access to. There appears to be a significance in cultivating learning environments that encourage autonomous and intrinsic motivations for positive academic outcomes (Dweck et al., 1995a). Learners' motivational responses and persistence towards learning goals are directly related to their sense of

self-concept; those who believe their intelligence is malleable are more likely to pursue learning goals for the sake of improving, whereas those who believe their intelligence is fixed are less likely to engage with more difficult tasks (Dweck et al., 1995a). Therefore, the educator's approach to learners plays a mediating role in influencing learners' self-concept, motivations, and ability to achieve learning outcomes.

Gardee (2019) suggests that the social relationships between teachers and learners in the South African context is equally as impactful as pedagogy in the mathematics classroom. In social interactions in the classroom, learners are assigned identities by their teachers based on their behaviour and performance (Gardee, 2019). These are considered identities of affiliation that not only construct mathematical identities for learners, but determine their learning opportunities and resources (Gardee, 2019). Thus, the matter of teachers' evaluations and judgements of learners' abilities plays a critical role in the degree of equity learners are provided with in the mathematics classroom (Gardee, 2019). In the case of Gardee (2019), certain mathematics teachers had higher expectations for high-achieving learners, and lower expectations for low-achieving learners. Mathematics teachers with unequal expectations of learners were more likely to offer different opportunities to learners based on their perceptions of learners' mathematical abilities (Gardee, 2019). Low-achieving learners were encouraged to focus on lower-order questions, thus reducing their opportunities to tackle more complex, higher-order questions (Gardee, 2019). This inequitable environment produced high-achieving learners who consistently scored well on assessments, and low-achieving learners consistently scored poorly. In contrast, teachers who focused on creating an equitable classroom community, in which all learners were regarded as equally capable, produced learners who consistently passed assessments regardless of mathematical ability (Gardee, 2019). Teachers who practiced equity in the classroom were able to cultivate more positive relationships with their learners, resulting in learners becoming confident in their ability to acquire mathematical skills (Gardee, 2019). The results of the study conducted by Gardee (2019) proposed a strong

argument for the idea that teachers' perceptions of student ability directly impact their pedagogical approaches to mathematics teaching. Furthermore, these perceptions or evaluative judgements can inadvertently affect students' learning opportunities in the classroom, their confidence in the subject, and their overall ability to succeed. This study focuses exclusively on one aspect of mathematics teachers' evaluative judgement: their perception of learners' intelligence and mathematical ability. It is through the lens of implicit intelligence or perceptual intelligence that an evaluation of pedagogy is discussed.

2.6 Empirical Studies: Implicit Intelligence and Teaching

Research addressing students and implicit perceptions of intelligence are more common than research addressing teachers' perceptions of intelligence. Nonetheless, some studies addressing teachers' perceptions have been conducted. One Swedish study conducted in 2012 used mixed analysis of variance (ANOVA) to measure 226 teachers' implicit theories of intelligence across various disciplines, including language, social science, mathematics, and practical disciplines (Jonsson et al., 2012). To encourage sample diversity, teachers were selected from private, semi-private, and rural high schools. The results of the study indicated that while teachers in other disciplines favoured incremental views of intelligence, mathematics teachers generally appeared to favour entity views of intelligence where beliefs of success in mathematics depended on their learners' innate intellectual abilities (Jonsson et al., 2012). Teachers played an influential role in cultivating this attitude in their learners (Jonsson et al., 2012). This finding supported the theory that epistemological beliefs regarding a subject were factored into implicit beliefs about learners' intelligence in that subject. Learners who believe intelligence to be a fixed trait do not achieve as well as peers who view intelligence as a malleable trait (Jones et al., 2012; Gardee, 2019). Thus, entity views of intelligence held by teachers are problematic in the learning environment and have serious potential to hinder mathematics education. Another finding within the study was the attempt to correlate the age of teachers and their years of experience to their views on intelligence. Entity

theories of intelligence were favoured by two specific groups: younger teachers with less than 13 years of experience, and older teachers with more than 13 years of experience (Jonsson et al., 2012). In that respect, younger referred to an age group of under 48 years, and older referred to an age group of 48 years and above. An explanation provided for the higher prevalence of entity beliefs in younger, less experienced teachers was an insufficient amount of teacher training, resulting in unrealistic expectations of learners by these younger teachers (Jonsson et al., 2012). A suggestion made for the older and more experienced group of teachers was that their entity views were rooted in personal experience. These teachers' experiences may have cultivated beliefs that learners can only control certain aspects of their learning, while other factors are beyond their control (Jonsson et al., 2012).

Regarding educators' age and experience, another study attempted to examine the implicit perceptions of intelligence among pre-service and in-service teachers comparatively (Jones et al., 2012). A sample of 270 student teachers, most of which were female, were recruited for the study at convenience from two large public universities and one large private university (Jones et al., 2012). Surveys were performed with these learners using the *Theories of Intelligence Scale – Self Form for Adults* as adapted from Dweck (1999). The results of the study revealed that participants' definitions of intelligence frequently included grades achieved in school, procedural skills, personal characteristics, cognitive processes, and motivation (Jones et al., 2012). There were no significant differences in how pre-service teachers defined intelligence compared to their in-service counterparts. These definitions of intelligence aligned with current educational research, which can be attributed to the educational psychology courses taken by these student teachers at university level (Jones et al., 2012). The study concluded that this elucidation may serve as an explanation for the 77.6% of the study's respondents viewed intelligence as a malleable trait. Only 33 of the in-service student teachers surveyed had a year or more of full-time teaching experience. Due to these limitations in teaching experience, the results of Jones et al. (2012) may not be as applicable as

studies utilising more experienced teachers. The study inferred that teacher training contributed to the viewpoints of these student teachers. These limitations in experience may explain why there was no significant difference in viewpoints of the pre-service and in-service teachers surveyed (Jones et al., 2012). Approximately a quarter of the student teachers surveyed in Jones et al. (2012) believed that intelligence is a fixed, unchangeable trait. This result raised questions about the influence of teacher training in cultivating beliefs about intelligence that may be transferred to their learners (Jones et al., 2012).

Jones et al. (2012), Jonsson et al. (2012), and Ogbonnaya (2016) investigated the impact of teachers' opinions on learners' academic performance. The importance of teachers' beliefs of learners' abilities is a motivating factor behind this research into teachers' implicit beliefs of intelligence. This study hypothesises that mathematics teachers' beliefs of intelligence in their learners can affect their pedagogical adaptations to optimise learners' success.

2.7 Empirical Studies: The South African Context

South Africa's learning context is simultaneously diverse and complex. The nation's poor international standing with mathematics scores is well-known and continuously the focus of educational research. Only 52% of South African learners met the lowest international benchmark in mathematics in the year of 2015 (Department of Basic Education, 2015). This number declined to 37% in 2019 (Department of Basic Education, 2019b). Concerns regarding low mathematics results among South African learners is a recurring theme in educational discourse at a national level. After the publication of the 2019 matriculation results, chairperson John Volmik of the Council for Quality Assurance in General and Further Education and Training stated that learners' performance in mathematics is not progressing positively (Pijoos, 2020). Volmik mentioned a decrease in the number of candidates in accounting, a mathematics-based subject, over the past five years. He further noted a sharp decrease in learner performance despite improvements in other subject areas,

such as geography and physical sciences (Pijoos, 2020). South Africa has long been presented with a crisis where there is a scarcity of qualified teachers, and high failure rates are attributed to the weakness in teacher education (Jones et al., 2012; Jonsson et al., 2012; Ogbonnaya, 2016; Mahlaba, 2020). Du Plessis and Mestry (2019) emphasised that rural schools continue to face the difficulties with regarding education based on limited resources and facilities. Factors contributing to this include: a severe lack of funding and resources, overcrowded classrooms, and underqualified teachers. Student indiscipline is known to further complicate the teaching and learning process in both rural and urban areas (Ogobonnaya et al., 2016). While these are pertinent factors that are not to be overlooked, teachers and teaching processes frequently come under scrutiny when addressing learners' success in mathematics. Language barriers and the manner by which these barriers are addressed are focal points of research conducted in mathematics teaching (Du Plessis & Mestry, 2019; Howie & Plomp, 2003; Ogbonnaya et al., 2016). Teacher knowledge, particularly content and pedagogical knowledge, are also crucial to the success of their learners in the classroom (Adler & Davis, 2006; Ogobonnaya et al., 2016).

Learners' negative attitudes towards mathematics was among various factors that contributed to the difficulties they faced in the subject (Ogbonnaya et al., 2016). Ogbonnaya et al. (2016) used self-administered questionnaires with one open-ended question to allow for personal commentary from the 135 participating mathematics teachers. Several influential factors were noted to negatively affect learners' mathematics performance, including issues of income, teacher knowledge, and language barriers. A notable influence on learners' negative attitudes towards mathematics was teachers' views of their learners' (Ogbonnaya et al., 2016). The study revealed that students' achievement in mathematics was negatively impacted due to teachers discouraging their participation in the subject. Several teachers reported that they told learners that mathematics was not suited for them, and they will therefore not pass (Ogbonnaya et al., 2016). This serves as an extreme example of how teachers' beliefs of learners' mathematical intelligence can directly affect their learners' motivations and

learning outcomes. In furtherance, a constantly changing curriculum was identified as a crucial obstacle to the implementation of effective pedagogy and the achievement of learning outcomes (Ogbonnaya et al., 2016). Several participating teachers expressed that the content of the curriculum was too dense to be covered in the short periods of time allocated to the subject by their schools (Ogbonnaya et al., 2016). This issue was further exacerbated in under-resourced schools with overcrowded classrooms, limited resources, and student indiscipline, all of which contributed to the difficulties teachers faced in delivering subject matter (Ogbonnaya et al., 2016). The investigation identified pertinent themes through a quantitative methodology. As a result, no reflections regarding how these teachers adapted their methods to accommodate these difficulties was encompassed within the scope of the study. This study aims to address this gap by utilising an interview-based qualitative methodology to further investigate narratives of teachers' pedagogical adaptations in the mathematics classroom based on these commonly faced difficulties.

Howie and Plomp (2003) is an example of a less recent study that investigated influences on learners' mathematics performance using a quantitative methodology. Data was gathered from over 9000 participants across 225 schools (Howie & Plomp, 2003). The study focused on the effects of language in tandem with other factors influencing mathematics achievement. The acquisition and understanding of the English language by teachers and students was found to be the key contributing factor to students' success. However, the study also concluded that while language played the strongest role in mathematics achievement, there was a significant role played by teachers in their dedication to their learners' achievement (Howie & Plomp, 2003). This dedication encompassed adaptation to learners' needs, particularly with regard to bridging language gaps in order to communicate effectively (Howie & Plomp, 2003). Despite the emphasised importance of this adaptation, there was little discussion of the measures teachers took to bridge these gaps, or narratives included to reflect this component.

According to Adler and Davis (2006), learners' performance in mathematics was based on the quality of mathematics teachers' training. Adler and Davis (2006) emphasised the importance of pedagogical approaches in mathematics to adapt to learners' needs. Adequate teacher training was highlighted as critical to learners' success in mathematics (Adler & Davis, 2006). The study discussed the availability and enrolment of teachers in various teaching programmes including the Post-Graduate Certificate of Education (PGCE) and the Advanced Certificate of Education (ACE) in reference to both the current and historical context of teaching in South Africa (Adler & Davis, 2006). The components of courses offered to teachers and the content knowledge therein was examined on a large scale as part of a project created to bridge the gaps in teacher education for mathematics teachers (Adler & Davis, 2006). During apartheid, the segregated nature of education did not allow for non-white teachers to enrol in PGCE programmes, but rather mandated race and college-specific options (Adler & Davis, 2006). Post-apartheid, one manner of redressing the historical inequalities was the creation of condensed programmes where necessary components of mathematics were taught specifically for classroom delivery (Adler & Davis, 2006). It was previously assumed that the lack of teacher knowledge had the most significant impact on pedagogical shortcomings. However, one major shortcoming reported in the study was that teachers were aware of the mathematical components they needed to deliver but were not trained to understand the reasoning behind them (Adler & Davis, 2006). This posed a significant barrier to teaching mathematics in a classroom setting due to teachers' inability to make the content meaningful to their students, which resulted in students expressing an unwillingness to learn (Adler & Davis, 2006). Furthermore, without a comprehensive understanding of the rationale behind the mathematical concepts being taught, teachers had difficulties effectively communicating mathematical theories and methods to their learners (Adler & Davis, 2006).

2.8 Conceptual Framework: Social Constructivism

Social constructivist frameworks suggest that individuals and their experiences are derived from systems of meaning within a social context (Terre Blanche, Durrheim & Painter, 2006). These frameworks display how understandings of individuals or groups can be elicited from larger discourses (Terre Blanche, Durrheim & Painter, 2006). Social constructivism captures reality through social constructs (Ritchie & Lewis, 2003). Social constructs are comprised of collective, shared meanings and individual, self-identified meanings that work concurrently to shape individual perceptions and world views (Ritchie & Lewis, 2003). The manner by which individuals experience and perceive the world and themselves is influenced by the social constructs in their contexts (Ritchie & Lewis, 2003). A fundamental assumption of constructivism is that knowledge is constructed based on experiences, and cannot be objective or absolute (Yilmaz, 2008). The knowledge derived from social constructivism is socially and culturally influenced, and internally formed through a cycle between internal mechanisms and external influences (Yilmaz, 2008). Politics, power, the economy, religion, cultural belief systems, and status are among the external influences that are socially constructed (Yilmaz, 2008).

Learning refers to changes in the way people think about aspects of the real world (Assan, 2019). The goal of learning is to engage in a process of understanding the critical aspects of phenomena and to develop meaning relevant to the learner (Assan, 2019). Both constructivism and sociocultural perspectives are influential theories of learning in mathematics education (Assan, 2019; Goos et al., 2007). Constructivism is the active construction of knowledge and personal meanings that are related to interactions with the world. In mathematics education, constructivism is defined as "how actions, observations, patterns and informal experiences can be transformed into stronger and more predictive explanatory ideas through encounters with challenging tasks" (Goos et al., 2007, p.29). These educational transformations involve cognitive changes that are triggered by conflict with previous ways of thinking and knowing. Students can communicate these changes of thinking

and reflect on their adequacy of mathematical understanding through classroom participation (Goos et al., 2007). Effective participation in a constructivist classroom involves a negotiation of classroom norms to regulate patterns of interaction and discourse. Some classroom norms, such as behavioural expectations and school attire, are socially and culturally influenced. Other norms are specific to the teacher and the discipline, including expectations surrounding classroom communication and what constitutes an acceptable mathematical solution to a problem (Goos et al., 2007). Effective teaching and learning requires that educators acknowledge how learners make sense of the world around them and integrate everyday knowledge into the classroom for practical application (Assan, 2019). Teachers are responsible for involving students in a culture of mathematical enquiry at a disciplinary level while maintaining a classroom that is inclusive and conducive to cognitive change (Assan, 2019; Goos et al., 2007).

To reiterate, implicit theories of intelligence are largely formed through individual perception and socio-cultural influences (Maltby et al., 2017). Moreover, implicit views of intelligence held by everyday people are informed by traits that are regarded as intelligent within their respective social, cultural, and religious contexts (Maltby et al., 2017; Sternberg, 1997). Views of intelligence can vary between nations, cultures, religions, and ethnic groups. A social constructivist approach allows for discourses surrounding each teacher's narrative, and an insight into the influences behind their implicit perceptions of intelligence (Terre Blanche et al., 2006). Social constructivist approaches offer insights into how teachers have constructed their perceptions of intelligence, and the influence these perceptions have on their teaching methodologies (Jones et al., 2012). The triarchic theory of intelligence, otherwise known as successful intelligence, is based on implicit intelligence, which is a socially constructed concept (Sternberg, 2020). As the model is rooted in socially constructed and negotiated concepts, the focus of the theory is adaptation according to learners' needs (Maltby et al., 2017). In brief, the model of successful intelligence suggests that success is derived from a variation of approaches that cater to the needs of learners in their contexts. While the triarchic theory of

intelligence does not stand alone in informing teaching methodologies, the notion of adapting pedagogical approaches to the needs of learners is prevalent in research addressing learners' achievement (Jones et al., 2012; Jonsson et al., 2012).

Another argument in favour of constructivism in education emanates from the emerging body of knowledge informing constructivist approaches to pedagogy. Constructivist approaches to learning integrate pre-existing ideas of the world with subject matter in order to create a deeper understanding of the content (Yilmaz, 2008). A key reason to advocate for such a position is to reduce potential conflict between existing worldviews and new insights derived from the subject matter (Yilmaz, 2008). Thus, constructivism can be used as a tool to diversify learning in ways that are relevant to learners. Constructivist approaches to learning may already be in practice by teachers without a conscious intention as they adapt subject matter to the socio-cultural context in which the learning is conducted (Yilmaz, 2008). The qualitative methodology informed by a social constructivist framework is appropriate for this study based on the pre-existing underpinnings of socially constructed influences on perceptions of intelligence. Social constructs play a crucial role in the classroom thereby making this framework appropriate for the research questions centred around teachers' perceptions (Ogbonnaya, 2016).

2.9 Summary

The discussion of the above-mentioned studies highlighted the various factors that contributed to the difficulties of teaching mathematics in South Africa's diverse and complex context. Two repeated themes that emanated from previous research on mathematics teaching were the transference of teachers' beliefs on their learners, and how these beliefs were influenced by their professional context. However, none of the aforementioned studies critically discussed the narratives of teachers comprehensively to identify and address the socio-cultural and political aspects that led to these classroom practices. Most research on implicit intelligence in relation to teachers and

pedagogical practices adopted a quantitative, survey-based approach to identify pertinent themes and shortcomings within education systems. Although these quantitative survey-based approaches are useful in identifying broad, generalised issues in education systems, it is necessary to examine how teachers' implicit ideologies are formed, and how these ideologies transfer into classroom practice. A qualitative methodology allows for opportunities to discuss the socio-cultural influences that cultivate the implicit notions of intelligence possessed by teachers and gain a personal perspective of how teachers navigate their methodologies in accordance with students' needs. This study discusses how teachers' implicit beliefs of intelligence affect their pedagogical approaches, which identifies useful techniques from their training.

Chapter 3: Methodology

3.1 Introduction

The primary aim of this study was to determine the influence that perceived intelligence had over matric teachers' pedagogical approaches to teaching the mathematics syllabus. Sternberg and Grigorenko's (2003) proposed teaching model for successful intelligence was initially presented as a guide to review how teachers perceive intelligence in their learners, and the degree to which they amend their methodologies to adapt to variable intelligences. Data necessary to address the research questions was procured through semi-structured research interviews with qualifying mathematics teachers in Durban, KwaZulu-Natal. The data was then categorised thematically and analysed according to the methods outlined by Braun and Clarke (2006) to create a relevant, contextual understanding of the participants' narratives.

3.2 Research Questions

The methodology of this study revolves around three key research questions:

- How do mathematics teachers define and perceive intelligence in their learners?
- Do these perceptions of intelligence influence pedagogical adaptations made by the teacher to optimise learner success in mathematics?
- What teaching approaches (pedagogical or otherwise) do these mathematics teachers favour?

3.3 Research Objectives

The objectives of this research in relation to the research questions are:

- Objective 1:

  To examine how matric mathematics teachers define intellectual ability in their learners.
- Objective 2:

  To determine if matric mathematics teachers' perceptions of intellectual ability in their learners influences their teaching approaches.

- Objective 3:

  To establish the teaching approaches (pedagogical or otherwise) favoured by matric mathematics teachers in response to their perceptions and other limitations.

3.4 Paradigm and Design

A paradigm can be described as "a broad way of conceiving understanding in a particular area of research" (Howitt, 2016, p. 533). This qualitative study utilises a naturalistic social constructivist paradigm to analyse common themes in interview data. A qualitative research design was adopted to critically explore central themes arising from interdependent variables in this study. Qualitative inquiry explores complex interdependencies that cannot be meaningfully derived from a few variables (Terre Blanche et al., 2006). Terre Blanche et al. (2006) suggest that holistic qualitative inquiry involves studying a phenomenon as a complete system comprising of more than the sum of its parts. No single definition can fully encapsulate that which qualitative research aims to address, however certain ideologies make qualitative research identifiable. Qualitative research emphasises rich, detailed, descriptive data that captures individual perspectives (Howitt, 2016).

Constructivist theory asserts that individual perceptions of reality derive meaning from experiences constructed through human activity within social contexts (Bikner-Ahsbahs et al., 2015). In contrast to its positivist counterpart, social constructivism argues that there is no objective truth that captures reality (Howitt, 2016). All meanings are constructed within and informed by the context in which the individual presides. Constructivist methodologies are concerned with the meaning and rationale ascribed to individual experiences as a result of broader social contexts (Bikner-Ahsbahs et al., 2015). The research interview, whether semi-structured or in-depth, is an important method in social constructivist approaches. Unlike quantitative research in which data is "collected" through questionnaires, qualitative research data is "generated", and meaning is "co-constructed between the researcher and the informant" (Bikner-Ahsbahs et al., 2015, p. 18). In the course of research

interviews, contextually relevant meaning is negotiated between the researcher and the participant (Bikner-Ahsbahs, 2015). Thus, the nature of the relationship between the researcher and their participant(s) influences how data is generated and perceived in the research context. To limit bias, researchers are encouraged to maintain a self-reflexive stance throughout the research process to accurately capture the socially constructed perceptions relevant to the study (Bikner-Ahsbahs, 2015; Howitt, 2016).

Mathematics education research has steered away from strictly epistemological perspectives (Schoenfeld, 2016). A spectrum of research methodologies broadened the scope of mathematics research to include aspects of learners' cognate abilities and experiences of learning (Schoenfeld, 2016). Schoenfeld (2016) stated that constructivist approaches to mathematics were quintessential to "investigations of student thinking in general", with special attention to how mathematical learning is impacted by "the knowledge base, problem-solving strategies, metacognition, and belief systems" (Schoenfeld, 2016, p. 509). This development in mathematics education recognises shortcomings in the discipline and reframes mathematical learning as involving interdisciplinary skills (Schoenfeld, 2016).

The methodological design of this study is similar to that of Chen et al. (2021) and Mabena et al. (2021). The study conducted by Chen et al. (2021) was situated in an urban area of the United States, while the study conducted by Mabena et al. (2021) was situated in the South African province of Mpumalanga. Chen et al. (2021) utilised qualitative research interviews to analyse the manner by which mathematics teachers make sense of their pedagogical responsibilities. The study adopted a narrative approach to identify mathematics teachers' pedagogical reasoning through storytelling and implied claims (Chen et al., 2021). The individualised narratives of these teachers offered insights into the value they placed in their profession, and the amount of care taken in selecting pedagogies suitable for their learners (Chen et al., 2021). The study gathered data through semi-structured

research interviews lasting approximately 30 minutes. The data was then coded and analysed for insights into pedagogical sensemaking and pedagogical responsibility among these mathematics teachers (Chen et al., 2021). Mabena et al. (2021) also utilised a qualitative approach to analyse mathematics teachers' narratives of poor learner performance in mathematics within the Mpumalanga province. This qualitative case study utilised observation and semi-structured interviews to identify factors that influenced learners' negative performance in mathematics (Mabena et al., 2021). The narratives of teachers and other staff members were gathered through semi-structured interviews and triangulated with classroom observation data (Mabena et al., 2021). The data was analysed and divided into factors relating to student performance and factors relating to teacher performance. Teachers' narratives of pedagogical difficulties factored into the poor performance of mathematics learners in the study (Mabena et al., 2021). Both Chen et al. (2021) and Mabena et al. (2021) employed methods of qualitative inquiry to their investigations of mathematical pedagogy. These studies aimed to provide a socially contextualised understanding of teachers' pedagogical reasoning as it pertained to their learners' performance in mathematics. This study relied on social constructivist methods due to the nature of the research questions. The research questions in this study addressed implicit theories of intelligence as they translate into pedagogical approaches in the classroom. Implicit theories of intelligence are individualised, contextual, and are rooted in socio-cultural influences (Maltby et al., 2017). Thus, it was appropriate to use a qualitative social constructivist approach in the process of collecting and analysing data to address the research questions.

3.5 Population and Sample

Purposive sampling enables the researcher to choose cases or narratives based on the features of the participants (Silverman, 2013). While purposive sampling is guided by theoretical underpinnings, the method was not used to select populations in order to test a preconceived hypothesis or theory (Silverman, 2013). Silverman (2013) discusses purposive sampling as involving critical thought

about the parameters, features, and accessibility of the population being studied. Time, resources, and the phenomenon being studied are the guiding factors behind purposive sampling (Silverman, 2013). Rather, non-probability purposive sampling is used to select participants that reflect specific features of a group or population in qualitative research (Ritchie et al., 2013; Silverman, 2013). Samples are chosen on the basis of their features for the purposes of illustrating or informing the phenomenon being studied (Silverman, 2013). The deliberate choice of participants based on these features is to enable an investigation of main themes contained within the data as it relates to the research questions (Alkassim et al., 2016). Non-probability purposive convenience sampling was used for the selection of participants in this study.

In this study, the targeted population was Grade 12 mathematics teachers accessible in Durban, KwaZulu-Natal. The sample of mathematics teachers comprised of Grade 12 mathematics and mathematics literacy teachers. In order to create narratives of pedagogical adaptation, preference was given to teachers with at least two years of experience teaching mathematics or mathematics literacy with two or more groups of Grade 12 learners. Various high schools in the Durban area were approached based on accessibility and their Grade 12 mathematics teachers' willingness to participate in this study. Participants were also selected based on their internet access for remote interviews in order to comply with the government's COVID-19 measures in 2021 (Department of Health, 2021). As a result of this approach to convenience sampling, two educational institutions volunteered their teachers for the purpose of this research. Seven participants were interviewed for the purpose of this study to allow for a diversity of narratives.

The Quintile ranking of schools in South Africa is based on geographical and financial advantages (Ogbonnaya & Awuah, 2019). Quintile 1 schools are considered the most disadvantaged, and Quintile 5 schools are considered well-resourced and advantaged (Ogbonnaya & Awuah, 2019; van Dyk & White, 2019). Resultingly, schools within the ranks of Quintile 1-3 receive more

government support than Quintile 4 and 5 schools, as schools in the lower Quintiles do not charge school fees. Quintile 4 and 5 schools receive less government support due to being privatised and charging admission fees (Ogbonnaya & Awuah, 2019; van Dyk & White, 2021). Five participants in this study were from a Quintile 5 school. Two participants were from an institution for disadvantaged learners. This sample size was two more than intended, as the initial five participants all taught at one well-resourced institution. Therefore, two additional participants were selected from an institution for disadvantaged learners to allow for a diversity of narratives. Due to the COVID-19 pandemic, social distancing regulations mandated that no physical contact was to be made with the participants of this study in the interest of mitigating public health risks. Hence, participants could not be interviewed face-to-face. Samples for interviews were difficult to procure as the interviews for this study had to be conducted telephonically (Department of Health, 2021). Efforts were made to ensure a diversity of perspectives in the sample. The additional two teachers were procured through a charitable institution that supplements the education of low-income learners from public schools in Durban. These teachers met the requirements of this study and offered a diverse range of perspectives that contrasted those of the Quintile 5 school.

To avoid potential miscommunication between the researcher and participants, the teachers selected were both English-speaking and delivered their lessons in the English language. Rural and under-funded schools were among the most affected by the COVID-19 pandemic and were lacking in the internet facilities necessary for digital teaching and learning (Landa et al., 2021). Therefore, rural and under-funded schools were not approached because contacting teachers in these areas for participation was not feasible. Furthermore, teachers in rural and under-funded schools are faced with the challenges of teaching multiple grade levels simultaneously, poor learner attendance, a lack of resources, and threats to their safety (Du Plessis & Mestry, 2019). As a result, rural and under-resourced schools frequently resort to employing underqualified teachers who lack formal training (Du Plessis & Mestry, 2019). By excluding the possibilities of a lack of training, limited resources,

and risks to safety, this study could focus the teachers' pedagogical choices directly in reference to the needs of their learners.

3.6 Interviews as a Research Instrument

3.6.1 Social Constructivism and Interviews

Social constructivist approaches to qualitative research are inherently concerned with language. Social constructivism is concerned with the manner by which broader social phenomena are encoded in language (Terre Blanche et al., 2006). In qualitative research, interviews are utilised as a form of data collection that enable detailed explanations of socially constructed themes (Cohen et al., 2007). In addition, Silverman (2013) suggests that interviews are frequently used to draw on a participant's perceptions of a phenomenon or experience, and interviews provide an avenue to access the participant's narrative. For the purposes of this study, the socially informed concept of intelligence was discussed by the participants of this study, as it translated into their teaching profession. According to the social constructivist approach, the discourses produced within these narratives were parallel to established relational patterns and discourses of the associated context. Although individual narratives do not reflect on entire populations, there is merit in analysing common themes in these narratives as they derive from and apply to a broader social discourse (Howitt, 2016). In other words, the value of information obtained through interviews may reflect commonly shared meanings in the context being studied (Terre Blanche et al., 2006). Within the scope of this study, interviews allowed for the discussion of two primary aspects of teaching: the first being how teachers perceived intelligence in their learners, and the second being how the teachers' perceptions translated into the classroom setting. As discussed in the literature review, teachers' perceptions of intelligence were assumed to be informed by broader social discourse surrounding intelligence. This study's research objectives were informed by interviews and a thematic analysis of the participating teachers' discourse.

Three different interview styles can be identified in face-to-face interviews, namely: the structured interview, the semi-structured interview, and the in-depth interview (Fontana & Frey, 2000). Within the structured interview, the interviewer asks a series of pre-established questions, and adheres to a rigid structure through the interview process and no flexibility is permitted to avoid leading questions or response bias (Fontana & Frey, 2000). In contrast to the structured interview style, in-depth and unstructured interviews are akin to "a conversation with a purpose" (Ritchie et al., 2013, p. 138). The manner of questioning in unstructured interviews include wording and follow-up questions, which can be adjusted to any extent between interviews as required by the participant or the researcher without compromising the goals of the research question (Cohen et al., 2007). Furthermore, unstructured interviews allow for an in-depth exploration of broader social phenomena without the intention to draw conclusive results (Fontana & Frey, 2000). Semi-structured interviews combine aspects of structured and in-depth interview styles. In semi-structured interviews, a degree of rigidity and consistency is maintained between interviews across the sample, where key questions are delivered in a similar manner to structured interviews, and probing questions are confined to the most relevant aspects of the research question (Ritchie et al., 2013). Semi-structured interviews are flexible enough to enable data collection on less quantifiable components of research, such as beliefs, values, perspectives, and perceived problems while still maintaining a structured consistency (Cohen et al., 2007). Semi-structured interviews allow the researcher to address research questions and pursue variables of interest in a respondent's dialogue while still maintaining enough structure and consistency to directly address the objective of a study. Semi-structured interviews also allow for cross-questioning in order to ensure a mutual understanding between the interviewer and interviewee, which was utilised in the interview process for this study (Fontana & Frey, 2000).

3.6.2 The Interview Schedule

Interviews require the production of a schedule comprised of key interview questions that address the aims of the research (Silverman, 2013). This study adopted a semi-structured interview

method. In addressing the objectives of this study, all interview questions were posed in a similar manner to each participant with some rephrasing to address potential misinterpretations. The length of the interview depended on the participant's available time and the detail to which they responded to the interview questions. Each interview lasted between 30 minutes and 75 minutes. All interviews were recorded and transcribed for the purpose of analysis. A simplified variation of the Jeffersonian transcription system (Howitt, 2016) was adopted to note prominent features in the interaction between the researcher and participant including, but not limited to: overlapping speech, pauses, and manners of delivery. However, this form of transcription is more suitable to discourse analysis in which specific features of individual discourse are analysed to create meaning (Howitt, 2016). For the purposes of this study, these features of speech will not be included in the final analysis as thematic analysis is concerned with common patterns and themes emanating from the data rather than the individual discourse (Braun & Clarke, 2006).

The interview schedule used for this study, provided in Appendix D, was divided into three sections: background information of the participant, how the participant views intelligence, and classroom methodologies. The background information of the participant outlined basic demographic information, such as their name, age, and gender. The educational background of each participant was also included in the interview schedule to ensure that the participating teachers were adequately qualified for the purpose of this study. By reviewing the qualifications of participating teachers in this study, the researcher could eliminate the limitation of poor teacher education as a variable in this study (Jones et al., 2012; Jonsson et al., 2012; Ogbonnaya, 2016; Mahlaba, 2020). Participating teachers were asked about the amount of professional experience they have in order to eliminate inexperience as an influential variable on the results (Jones et al., 2012; Jonsson et al., 2012). The second and third sections of the interview contained open-ended questions about the participating teachers' perceptions of intelligence and classroom methodologies. Open-ended questions are commonly used in social constructivist research interviews as these questions allow participants to

communicate their individual narratives to the researcher (Howitt, 2016; Terre-Blanche et al., 2006). The interview questions used in this study were descriptive in their inquiry. These open-ended questions were designed to elicit descriptive responses that would reflect the participants' perceptions of the research objectives. For example, the participants were asked how they would describe an intelligent student, or how they would adapt to the pace of their students.

3.6.3 The Accessibility of WhatsApp

Interviews were conducted telephonically through an internet-based platform called WhatsApp. As of July 2021, an estimate of 95.4 percent of internet users in South Africa used WhatsApp (Ceci, 2022). Vermeulen (2021) stated that the majority of internet users in South Africa access the internet through mobile devices. Furthermore, the COVID-19 pandemic resulted in social distancing protocols that increased social media use (Vermeulen, 2021). The growth of social media use in South Africa correlates with the increasing number of users with major cellular networks in South Africa (Vermeulen, 2021). Additionally, major cellular networks in South Africa provide customers with data packages exclusively for WhatsApp use (Ceci, 2022, Vermeulen, 2021). WhatsApp has situated itself in South Africa as an alternative to text messaging and phone calls. This application was accessible, cost-efficient, and data-efficient to all participants in this study. Provisions were made to provide data or airtime to participants remotely, however, no participant required this provision. Most participants in this study accessed WhatsApp through the unlimited internet connection provided at their schools. Conducting these interviews via this application came at no cost to the participants of this study.

3.7 Thematic Analysis

Braun and Clarke describe thematic analysis as "a method for identifying, analysing, and reporting patterns within data" (Braun & Clarke, 2006, p. 79). It can be argued that "through its theoretical freedom, thematic analysis provides a flexible and useful research tool, which can

potentially provide a rich and detailed, yet complex, account of data" (Braun & Clarke, 2006, p. 78). As a methodology, thematic analysis uses constructivism to acknowledge how individuals draw meaning from and are impacted by their experiences in a social context (Braun & Clarke, 2006). Thematic analysis is a method that can be adopted to reflect realities as they are experienced, and provides an approach to discuss those experiences in academic terms. As a tool, thematic analysis is accessible and flexible enough to be used on its own or in conjunction with another form of analysis, such as discourse analysis (Braun & Clarke, 2006). For the purposes of this study, thematic analysis was used to analyse the discourse surrounding teachers' perceptions of intelligence and its relevance to their pedagogical approaches in the classroom. As implicit theories of intelligence are often derived from socio-cultural contexts, and are specific to these contexts, thematic analysis was used as a method to analyse and reflect upon common themes in the data that are broadly applicable to the context being examined. It is for this reason that thematic analysis was chosen over discourse analysis. This study sought to identify common themes in teachers' perceptions of learners' intelligence as they exist in the South African context, and then identify possible links that these perceptions may have to their pedagogical approaches. The scope for broader applicability was a key factor behind the use of thematic analysis. Thematic analysis allowed for an in-depth exploration into these mathematics teachers' views of intelligence while also allowing for further exploration into their pedagogical approaches, particularly in relation to limitations they faced. Despite each interview's discourse being individuated, thematic analysis allowed for a focus on broader themes regarding the experiences of limitations in the learning environment, which contributed to the other findings in this study.

Thematic analysis enables the researcher to identify patterns and themes in the data that directly address the research objectives (Braun & Clarke, 2006). Braun and Clarke (2006) outline the steps to thematic analysis: it begins with familiarisation of the data, followed by the coding of the data, then identifying themes in the data, and finally developing and refining these themes before

presenting the results. Qualitative research that relies on interviews as a primary data source requires that the interview transcriptions get coded and analysed according to the aforementioned sequence. Within this study, the teachers' interviews were recorded, transcribed, then analysed for semantic and latent themes in the data. An inductive approach was adopted for the purposes of this study; all themes reported from the data were derived from the data itself. During the analysis process, it was essential to critically reflect on the themes derived from each respective section of the interview questions. The interview schedule for the purposes of this study contained a range of questions pertaining to perceptions of intelligence, pedagogy, and other facets of teaching. The areas covered included the educational background of the teacher, how the teacher perceived intelligence in a learner, and the teacher's classroom management. The participants were further questioned on their difficulties pertaining to teaching mathematics at a matric level. The extensive nature of the interview generated an abundance of data provided by the participants. This rich data had to be refined to address the research objectives. The themes chosen were ultimately intended to reflect upon the research questions, while the broader perspectives rationalised the themes uncovered. The themes derived from the data were linked to previous literature in addition to being applied to the context of teaching mathematics at matric level.

Open coding refers to the process of conceptualising data into codified phenomena (Bikner-Ahsbahs et al., 2015). A coding paradigm is then implemented in order to apply relevant theoretical perspectives to the codes in the data (Bikner-Ahsbahs et al., 2015). This study employed open coding in the initial conceptualisation of general themes pertaining to the research questions. For example, quotes that broadly encapsulated definitions of intelligence were categorised under the theme of intelligence. Examples of these quotes are provided below:

> *Teacher C: My story of intelligence is anyone who can solve the problem no matter how easy or difficult the problem is. Cause when you say easy or difficult it all depends under whose – who's formulated that question? How is it difficult or not difficult?*

> *Teacher E: Well uhm I'm not sure whether it's only me but I don't see that getting and A means you're intelligent because with our education system in South Africa, if you [are] assessing with the maths and uh – with the other subjects obviously but with the maths you have to practice a lot, you can get an A even if you're not that bright.*
>
> *Teacher F: Uh usually in the maths classroom you'd pick up from their homework and from their tests and stuff who's intelligent and capable. Usually my class is the ones who's asking for extra work after school.*

In the excerpts above, Teachers C, E and F discussed identifying intelligence in learners. However, their definitions make reference to different aspects of learning. The theme of intelligence was used as a broad code to identify quotes pertaining to intelligence. These quotes were then categorised into sub-themes based on the content within them. For example, the quote provided by Teacher C was categorised into a sub-theme of ability whereby intelligence is defined by learners' ability to tackle all levels of questioning. The quote provided by Teacher E was categorised under the sub-theme of practice. The sub-theme of practice includes quotes from teachers who believed that learners' performance in mathematics was dependent on the extent to which they practiced their skills rather than their innate mathematical abilities. The quote provided by Teacher F was categorised under the sub-theme of ability and the sub-theme of grades. This quote discussed learners' abilities as observable through assessments, and as recognisable through extra practice.

After broadly categorising quotes under themes and sub-themes, connections between sub-themes were sought out. Connections between sub-themes were sought out within individual narratives to discern broader complexities in the participants' perspectives. One such example is contained in the following quote provided by Teacher E:

> *Teacher E: They have to be motivated. You get your top learner in school who'll find the subject easy [and] who'll continue doing all the work and gets everything right. And [then] you get the learners who are slightly battling with the subject and so on but they have to be motivated and persevere. If you can get the motivation then it's definitely going to work otherwise they [are] gonna give up altogether on the subject and just let it go.*

Teacher E explicated the role of learner motivation in mathematics, thereby categorising this quote under the sub-theme of motivation. In this example, motivation was linked to learners' willingness to

practice their mathematical skills. Teacher E highlighted that weaker learners need to remain motivated to do their work in order to succeed in the subject. This example highlighted a connection between the sub-theme of practice and the sub-theme of motivation. The recurrence of these sub-themes and connections were presented in the final analysis of the data.

3.8 Credibility and Transferability

In qualitative research, credibility refers to the trustworthiness of the research and its findings (Tracy, 2010; Silverman, 2013). The credibility of a qualitative study can be achieved through thick, detailed description, triangulation, and partiality (Tracy, 2010). Thick, detailed descriptions pertain to an in-depth explanation of each finding within the socially situated context (Tracy, 2010). Interpretative qualitative data can take on different meanings when divorced from the context in which it occurs. Thus, it is necessary that the researcher provides thick and extensive descriptions to "account for the complex specificity and circumstantiality" of the data (Tracy, 2010, p. 843). Researchers are advised to demonstrate meaning by producing data that is justified with abundant literature (Tracy, 2010).

Triangulation of data is among the most effective methods of ensuring the validity and reliability of qualitative research (Golafshani, 2003; Howitt, 2016;). Triangulation refers to a process where two or more data collection methods are used to gather data that addresses the research question (Howitt, 2016). Golafshani (2003) and Howitt (2016) suggest using supporting interview data with observational data to ensure congruence and reliability of research findings. Unfortunately, triangulation of data could not be employed for this study due to the COVID-19 pandemic and lockdown regulations. No in-person observations of classroom conduct could be made between the years of 2020 and 2021 in order to maintain social distancing in compliance with COVID-19 lockdown regulations. Instead, dependability was enhanced through the consistency of measures taken throughout this study. While no objective tool or measure can be implemented to interpret the

findings of a qualitative study, the dependability of the data was maintained through the consistency of measures taken during the analysis process (Howitt, 2016). The same transcription method and transcriber were used for all interviews. All digital interviews were conducted through the same communication platform. No connections were established between the researcher and any participant prior to the time of the digital interviews. These measures aided in maintaining consistency between interviews and ensuring that the interviews were not biased due to personal relationships or interactions. Respondent validation was also adopted throughout the course of the research interviews. Howitt (2016) discusses the role of respondent validation as ensuring that researchers and participants maintain a mutual understanding of what is being said during the interview process. To put this into effect, a researcher may rephrase a participant's response to convey their understanding. Participants are then given an opportunity to comment on the researcher's understanding and correct them if necessary (Howitt, 2016). During the interview process in this study, participants' contributions were reiterated to them frequently to give them an opportunity to clear up any misunderstandings. Follow-up questions were used throughout the interviews to ensure clear communication between the participant and researcher.

In the context of qualitative research, validity is referred to as confirmability. This may entail a process of verifying research findings with previous research done in the area (Silverman, 2013). Howitt refers to confirmability in qualitative research as ecological validity. Ecological validity refers to the extent to which the research outcomes reflect the realities of the research context (Howitt, 2016). The retention of ecological validity in the interpretation of qualitative data is the primary means by which confirmability was addressed in this research. This study compared its findings with previous research to maintain confirmability and establish a concrete sociological context for data interpretation. Qualitative research relies on the study of phenomena within their natural context (Howitt, 2016; Terre Blanche et al., 2006). Conversations, discussions, and interviews are forms of discourse that are derived from a sociological, political, and ecological

context (Terre Blanche et al., 2006). Qualitative validity is largely interpretative because the analysis of qualitative data is interpreted to suit the context from which the data was retrieved (Howitt, 2016). Congruence with previous research data adds to the transferability of the study by offering additional, informed perspectives on the discussion of the study outcomes (Golafshani, 2003). The extent to which this study maintains transferability was established through the use of similar established research in mathematics education throughout the literature review and the data analysis.

Dependability was further enhanced through reflexivity. Within the discussion of findings, reflexivity is maintained by discussing the assumptions made prior to data collection compared to the findings of this study. To further enhance reflexivity and reduce confirmation bias, two deviant cases were presented in the data analysis to illustrate findings that were not consistent with other participants in the study. This transparency offers a clarity of perspective from which the research is being viewed, thus opening the interpretations of finding to further critique for future research.

3.9 Ethical Considerations

Ethical approval for this topic and the design of this study was achieved through the University of KwaZulu-Natal's School of Applied Human Sciences under the reference number of HSSREC/00001678/2020. The approval letter from the University of KwaZulu-Natal is provided in Appendix D. Permission to approach schools in Durban and interview mathematics teachers was granted through the Department of Education under the reference number of 2/4/8/4195. The letter of approval from the Department of Education is provided in Appendix C.

Confidentiality draws its value from autonomy, respect for persons, and trust (Dhai & McQuoid-Mason, 2010). Individuals have a right to privacy, and this right to privacy protects their autonomy. Under the South African Constitution, all individuals have a right to free choice and informed consent (Dhai & McQuoid-Mason, 2010). To ensure individual autonomy, individuals must be well-informed of the research being conducted. Informed consent requires that the

researcher gives a thorough overview about potential participants' involvement in the research process (Silverman, 2013). This includes all details of the participants' involvement, compensation, and how the information participants provide will be used (Silverman, 2013). Informed consent required that the participants were clearly informed about the nature of this study. Additionally, participants were informed of the intended use of the information obtained through the interview, and the right to withdraw consent at any time during the research process (Cohen et al., 2007). In addition to obtaining informed consent from participants, the original consent forms were physically stored securely in the office of the researcher to ensure confidentiality.

Quotes used for the purpose of this study were used with consideration towards sensitive information, and anonymity was pursued as far as possible without compromising the integrity of the data. For example, the quotes used for the analysis and report did not contain identifying information. Identifiable information contained in the quotes, such as learners' names or names of staff members, were omitted. Additionally, participants were referred to with letters instead of names or pseudonyms. Further precautions were taken by ensuring the participants' pronouns were not described in the research. Only information specifically pertaining to teaching and learning was included in this study.

The interviews were handled with confidentiality. All participants consented verbally to the recording of the interviews. The interviews were recorded on a mobile device and the recording files were extracted and moved to a password-protected USB flash drive that is in the custody of the researcher. Copies of the recordings were made exclusively available to the researcher and research supervisor. In compliance with government mandated COVID-19 pandemic regulations, the original recordings and letters of consent could not be physically handed to the research supervisor until the lockdown was lifted. As of the completion of this research in December 2021, the national lockdown remained at Level 1.

3.10 Summary

Qualitative interviewing requires that the researcher take the stance of an active listener who is aware of the comments made by the participant while directing the discourse toward the research question (Howitt, 2016). In order to guide the interviews to address the research questions, the interview schedule was carefully planned to ensure that concepts related to this study were adequately covered. The sampling method focused on both accessibility and qualifications, thus ensuring that thorough and relevant interviews were conducted. Where thematic analysis was used, interpretive bias was reduced by linking findings to previous research.

Chapter 4: Analysis and Discussion

4.1 Introduction

Thematic analysis was utilised to identify recurring themes in this sample of mathematics teachers' narratives. The research questions contained two critical components: how mathematics teachers perceived intelligence in their learners, and their pedagogical approaches in the classroom based on their perceptions. Within the content of pedagogical adaptations were favoured pedagogical approaches and adapted pedagogical approaches. The intention was to differentiate between teachers' preferred methods and methods chosen based on their perceptions. Key themes relating to these components were extracted from the data. This analysis will utilise representative quotations from participants to highlight the themes found within the data and express shared sentiments throughout the sample of participants for the sake of brevity. These themes are categorised in the manner by which they address the research questions outlined in the research methodology. Two deviant cases are also provided for further discussion on mathematical practices related to the research objectives.

4.1.1 The Sample

Seven respondents participated in the research interviews for the purpose of this study, which is two more than the initial sample size. The justification for over-sampling was the need for a diversity of perspectives as five participants were private school teachers. Due to the difficulties in accessing participants during the COVID-19 pandemic, convenience sampling required that willing participants had internet connection or mobile data for the research interview via WhatsApp. As a result, five willing participants were able to participate in the research interviews using the internet connection provided at their school premises. Restrictions or lack of availability of internet access in public schools around Durban made it difficult to obtain more perspectives from teachers in those schools. However, two willing participants were procured through a non-governmental organisation in which teachers taught under-privileged learners for free.

As a result, the sample size was increased to seven for a diversity of perspectives, and to reduce bias toward any specific type of school in this study. Each of the participants were qualified with a nationally recognised teaching qualification. A minimum of two years of teaching experience was a requirement to participate in this research study. Within the sample procured, the teacher with the least experience taught for more than two years. More teaching experience was considered advantageous. One participant mentioned teaching for longer than a two-year period but did not state the exact number of years they had been teaching in the interview. The range of teaching experience in the sample made the data rich in content related to the research questions being addressed. Table 1 contains qualifying descriptions of the teachers that participated in this study.

Table 1

Description of Participating Teachers

Participant	Relevant Qualifications	Years of Teaching Experience	Type of School(s) Taught
Teacher A	Bachelor of Education (Honours) in Maths and Science	10 years	Private
Teacher B	Post-Graduate Certificate of Education in Mathematics Education (intermediate and senior phase)	Undisclosed	Public, Charity
Teacher C	Higher Diploma in Education Post-Graduate Certificate of Education	34 years	Private
Teacher D	Bachelor of Science in Maths and Chemistry Higher Diploma in Education	35+ years	Public, Private, Charity
Teacher E	National Diploma in Teaching Mathematics and Physical Science Bachelor of Social Science in Mathematics and Statistics	21 years	Private
Teacher F	Bachelor of Education	7 years	Private
Teacher G	Bachelor of Science in Maths and Chemistry Higher Diploma of Education	20 years	Private

4.2 Objective 1: Defining Intelligence in Learners

4.2.1 Theme 1: Intelligence is Unique

A recurring theme among participants' narratives was the understanding of intelligence as unique to each learner. Each participant provided a definition of intelligence that differed from a traditional, IQ-based view. Participants offered perspectives of intelligence that combined learners' ability in the subject with other achievements or character traits. Teachers provided unique combinations of achievements and character traits in their definitions of an intelligent learner in the mathematics classroom. One participant had a perspective of intelligence as constituting a "unique" combination of academic performance and "selflessness":

> *Teacher A: I would think an intelligent student is someone who can think outside the box because everyone can think, and everyone can think outside the box. Look at things differently, apply themselves differently. Be the unique person…we've had some good students over the years…you get a student that is brilliant where they are all-rounders in terms of not academic only, but they end up with academic performance…in school as well as on the playgrounds as well. They are sport inclined. They are ever ready to give themselves up to do work at school, assist learners, assist teachers so they go above and beyond the marks. So that, for me, is brilliant - where you can offer yourself before anything else. Being selfless.*

This excerpt illustrates a view of intelligence that encompasses excelling in multiple areas while maintaining a character that is widely received as positive. This view closely aligns with the theory of multi-dimensional intelligence suggesting that there are multiple ways to be intelligent (Sternberg & Grigorenko, 2003). Teacher A essentially described a learner that can be considered as intelligent in more than one way. That is, the learner possesses exceptional ability in academics in addition to other areas such as sports and emotional intelligence. No further comment was made by Teacher A in relation to these different intelligences being accommodated in a classroom environment. Teacher A's description concurs closely with the study by Jones et al. (2012) in which participants' definitions of intelligence included grades achieved in school as well as procedural skills, personal

characteristics, and motivation. Another participant, Teacher G, held a similar sentiment in which intelligence was defined by academic performance as well as personal motivation:

> *Teacher G: I think intelligence it would be multi-faceted. You can't just say one thing makes a student intelligent. First, it would have to be natural ability combined with the level of uhm work they're prepared to put in, especially in maths. Yeah so it's intelligence combined with the drive and the grit in order to get the result that they want.*

The definition of intelligence provided by Teacher G alludes to a "natural ability" possessed by the learner in combination with personal motivation to work for the result that they wish to achieve. The notion of natural or innate ability aligns with findings in Jonsson et al. (2012) where the majority of mathematics teachers sampled perceived success in mathematics to be linked to a learner's innate skill in the subject. Unlike the findings in Jonsson et al. (2012), Teacher G discussed the merit of hard work and continuous practice in learner success. Jones et al. (2012) referred to motivational factors when discussing traits of an intelligent student in the South African context. A combination of grades, procedural skills, personal characteristics, and motivational factors were common characteristics in definitions of learner intelligence provided by South African teachers (Jones et al., 2012). This bears a semblance to sentiments expressed by Teacher A where intelligence encompassed more than one area in which a learner has abilities. In the definition provided by Teacher A, the areas accompanying academic achievement were extracurricular activities and personal characteristics. The definition provided by Teacher G emphasised personal motivation in order to achieve academic accomplishments alongside the "natural ability" of the learner. Further to this perception, Teacher B also referred to multiple intelligences but emphasised the individual strengths of learners. Teacher B stated:

> *Teacher B: I think we do see learners that are very competent in mathematics or certain concepts in mathematics and they do have mathematical intelligence um but you know I also understand the different types of intelligence that learners have, you know? Some may have emotional intelligence, some may have language intelligence where they {are} able to communicate very well. And I find that the learners with other types of intelligence, maybe not mathematical intelligence, but like maybe like language intelligence, … they {are} able to*

> *present their answers very well. They are able to communicate very well and I then try to encourage those learners to develop those talents further. You know, they may not be able to solve the problem in one go as a as a student with mathematical intelligence, but they may be able to present that solution to that problem in a brilliant you know very eloquent manner….I think as teachers…we need to understand the different types of intelligences and also appreciate it and bring out the best in them the learners.*

The view of the participant, Teacher B, is closely aligned with a multi-dimensional theory of intelligence. In contrast to the response of the previous participant, Teacher B discussed integrating the abilities of a learner into the context of the mathematics classroom. This viewpoint aligns with Sternberg (1997) and Sternberg and Grigorenko (2003) who state that there are multiple skill-sets associated with intelligence, which can represent a learner's ability in the subject. Sternberg (1997) discussed the various mental factors that contribute to intelligence and academic ability. Two of the factors mentioned by Teacher B, which are aligned to Sternberg (1997), are: (1) the construction of problem-solving strategies and; (2) representing the problem mentally or physically. By strategizing according to learners' needs, Teacher B demonstrated a pedagogical perspective that encapsulated a multi-dimensional view of intelligence. Teacher B not only viewed intelligence as being unique to the learner in question but discussed how a different type of intelligence can play a vital role in understanding mathematics (Sternberg & Grigorenko, 2003).

While all participants referred to a multi-dimensional model of intelligence in their own descriptions of intelligence, the applications of this ideology indicated variations in perception. The first participant, Teacher A, defined an intelligent student as one who possesses combination of multiple intelligences, and excels in numerous skill sets outside the academic realm. The second participant, Teacher B, focused on the ability of a student to excel at one of the multiple intelligences and the manner by which their unique intellectual capacity can aid in their academic performance.

4.2.2 Theme 2: Grades as a Frame of Reference

Despite an awareness of the multiple types of intelligences, grades were a determinant of a student's capabilities in mathematics among the participants. Assessment strategies such as tests,

homework, and past performance were central to identifying intelligent and capable students in the classroom. In the following excerpt, Teacher A identifies an intelligent student in their mathematics classroom through their academic performance despite previously defining an intelligent student by non-academic characteristics:

> *Teacher A: Ok well the first thing that we get to see is obviously the academic performance. So before a learner comes into our classroom, we look at the last year's performance and we judge. We look at it from there as to how a learner is coping from the previous grade. And that will enable you to understand how they will possibly take off in the new grade. So that's your first outline in terms of how the student performs. Then in the classroom you get to see the interactions. Whether a learner is positive or whether they are soft-spoken when they are commenting or giving answers. That automatically tells you they have a lack of uh…confidence. Or sometimes they quite shy, you know? You gotta try and break that from them.*

Teacher A acknowledged individual traits of the learners in addition to their academic performance. According to Teacher A, a matric learner's academic performance is inextricable from the educational environment as the performance of a learner determines their opportunities to participate in higher level mathematics. Teacher A discussed the use of learners' academic performance from previous years to determine their likelihood of success in the ensuing year. Additionally, Teacher A referred to learners' character traits potentially inhibiting their success. Although Teacher A did not discuss optimising the success of a learner in the classroom, but Teacher A's statement reflected a desire to encourage further participation of a learner by boosting their confidence to enhance their success. The statement made by Teacher A reflected the approach taken by Teacher A to narrow potential gaps in learning and remedy learners' weaknesses. This approach is not tailored to the individual strengths of each learner. Instead, Teacher A focused on motivating learners through attempts to boost their confidence. The establishment of positive relationships between teachers and learners can increase learners' success in mathematics, as these positive relationships result in increased opportunities for learners to seek support (Gardee, 2019; Gardee, 2021). While grades

were still used as a frame of reference for intelligence, Teacher A sought to encourage learners to obtain passing grades.

In the following excerpt, Teacher F discusses the use of grades to identify intelligent and capable learners:

> *Teacher F: Uh usually in the maths classroom you'd pick up from their homework and from their tests and stuff who's intelligent and capable. Usually, my class is the ones who's asking for extra work after school. Sometimes it could be the quiet one but…I will judge after like my first assessment and stuff to see…so you can pick up the capabilities of the students like that… also with their homework…we can see them showing an effort and asking for work and things like that.*

Teacher F incorporated performance from numerous types of assessments to identify learners as intelligent and monitored their progress. While all seven participants integrated grades and academic performance in their perceptions if intelligence, Teacher F was the only participant to define mathematical intelligence exclusively by assessments and academic performance.

The participants of this study indicated that learners' marks and records from previous years provided an indication of mathematical ability, which the educator used to form expectations of their learners. As the academic year progressed, the participating teachers tailored their methods to the needs of their learners. Learners' grades are inescapable in the academic environment and are inevitably referred to when monitoring the progress of a learner in mathematics. This idea concurs with a previous study conducted by Jones et al. (2012) where teachers reported grades achieved in school as a characteristic of learner intelligence. Although the themes of these narratives are common and definitions of intelligence overlap, each participant placed a different emphasis on the various types of intelligence encompassed by the theory of multiple intelligences. Teacher A highlighted personal characteristics, such as motivation and demonstrations of effort, as indications of intelligence while Teacher B highlighted different academic skill-sets. Teacher F highlighted

academic accomplishments through assessments and grades, while Teacher G emphasised the role of motivation on academic achievement.

4.2.3 Theme 3: Motivation and Initiative

Jones et al. (2012) discussed motivation as a core factor in the definitions of learners' intelligence provided by South African teachers. Teachers providing definitions of learners' intelligence that include motivational factors also view intelligence as a malleable trait (Jones et al., 2012). Jonsson et al. (2012) highlighted that teachers' perspectives are transferable to their learners, including perspectives on learners' ability. Referring to recent Sub-Saharan African research by Arthur et al. (2021), motivation, perceived ability, and attitudes towards mathematics were determinants of academic performance in mathematics.

In this study, aspects of personal motivation and an inclination to work for a mark resonated throughout the narratives provided by the participants, as mathematics was referred to as a subject requiring a great deal of practice. Only one of the seven participants in this study perceived "natural ability" to be a component in a learner's intelligence. The majority of the participants placed a greater emphasis upon the motivation of the learner and the amount of hard work the learner puts into understanding the subject. One such example of the sentiment of hard work was provided by Teacher D in a statement that emphasised focus and understanding in their definition of intelligence:

> *Teacher D: Alright so to me intelligence would actually mean firstly being able to understand an educator who's trying to educate that learner. To understand and be on the same wavelength as that educator so when the educator says something you then with that educator uhm completely and know exactly what the person is talking about and you are able to grab that baton and run with it…. So your listening, your focusing is so important. So if that learner's is got that those factors in him or her that is focused – be focused, be contemplating, listening carefully and then take the baton and run with it. So that's the first part. Second part is obviously the amount of work that that learner does after the education in the classroom. So if he or she goes home, how much of work you do then, the volume of work that you do post-teaching is also very important to become who I would refer to as "intelligent" and producing the results that you see flashing in the papers.*

Teacher D provided a definition of intelligence that focused on the efforts made by the learner to comprehend the teacher or educator. The first notable difference between the response provided by Teacher D in comparison to the other participants is the specificity of the types of initiatives a learner engages in to be classified as intelligent. In the perspective articulated by Teacher D, the attentiveness of a learner during class time is at the forefront of their ability to succeed in the subject. According to Teacher D, attentiveness refers to the listening skills and focus of the learner in order to understand the content delivered by the educator. Teacher D implied that the success of the learner is dependent upon close adherence to the instructions and content delivered by the educator. The second dimension of this definition of intelligence was the amount of work that the learner dedicates to the subject, outside of school hours. The role of working and practicing for success in mathematics was explicitly mentioned by five of the seven participants in their definitions of intelligence, making it a recurring theme throughout the data. The sentiment of working for a higher grade was mentioned by Teacher G in their definition of an intelligent student. Teacher F included requests for "extra work" in their definition of intelligence which also focused on assessment strategies and grades. In the abovementioned excerpt, Teacher D emphasised the quantity of work that a learner performs outside of teaching hours as important in defining intelligence in a student. This perception of learners' intelligence in the mathematics classroom veers away from the notion of a natural ability. A perception of intelligence defined by personal motivation and initiative is conceptually a form of intelligence (Carr & Dweck, 2011). Carr and Dweck (2011) outline motivation as critical in the pursuit of intellectual goals. Under the presumption of intelligence being malleable or changeable, motivation acts as a non-intellectual drive towards intellectual progress (Carr & Dweck, 2011). Carr and Dweck (2011) declare that motivation "initiates goals related to the acquisition and display of intellectual skills" (p. 1061). The teachers interviewed for the purpose of this study provided perspectives indicating that motivation to practice mathematics influences learners' achievement in the subject. Therefore, learners do not have to be "bright" in order to be considered intelligent and

equipped with mathematical ability. Most of the participating teachers emphasised motivating their learners, therefore suggesting that they are cultivating beliefs of malleable intelligence in their learners to optimise learners' success in mathematics (Arthur et al., 2021). Learners who believe intelligence is malleable experience more motivation and success in the classroom than those who believe intelligence is fixed (Dweck et al., 1995b; Jones et al., 2012). According to Teacher E and other participants in this research, the implementation of personal initiative in learners' study habits manifested in higher marks and better overall achievement in mathematics as a subject:

> *Teacher E: I'm not sure whether it's only me but I don't see that getting an "A" means you're intelligent because with our education system in South Africa, if you assessing with the maths and uh – with the other subjects obviously but with the maths, you have to practice a lot. You can get an "A" even if you're not that bright. So uh you do come across learners who are naturally gifted but it's very few. I only experienced a few in my lifetime.*

Teacher E did not provide a conclusive definition of what constitutes an intelligent student in their perspective but offered a perspective whereby intelligence did not correlate with success in mathematics. Teacher E stated that a learner does not need to be "bright", meaning intelligent, to succeed in mathematics because practice is of greater importance in their perspective. "Gifted" learners are "few" in their experience, alluding to the idea that a high score in mathematics does not depend on a natural ability in the subject. The perspective of Teacher E is similar to that of Teacher D. Both teachers expressed that learners who understand the teacher and practice mathematics achieve high grades. The participating teachers in this study consistently emphasised the importance of learners' initiative and motivation to practice their mathematics as a determinant of their success. In the excerpt below, Teacher C provides a narrative of two students that embodied these values:

> *Teacher C: I've sponsored 2 girls from Iraq. They were trying to find a place at uh schools in our area, and they couldn't get in. Because nobody gave them a chance. And when I spoke to this one uh to the mother and uh she pleaded "please help" so I had to make - cause I'm senior, we made a presentation to give these girls a chance. And we gave them a chance and with the results, the big girl, the one that reached matric, she was accepted at 4 different universities because her mark was so good. And she had for the MBTs which is a very – to me I think that's the top of the range exam if you want anyone to know how good you are. And*

> *this girl had 98% because she was able to think out of the box and able to solve problems and uh with the result the universities grabbed her. And now she's at Cape Town University.*
>
> *Interviewer: That is phenomenal. So what made you believe that those 2 girls had the ability, had the competence?*
>
> *Teacher C: Because uh when I looked at their mark that they have brought in from Iraq, it was absolutely astonishing. When you gave them a few sums to do, they knew what was happening, but they had a problem explaining because of the language barrier. When I had them in school for 2 years they were able - they knew they knew that's what they wanted so therefore they work hard. And they displayed all the marks… I must have tutored them every second day. I used to go to their house for free in the afternoon to help them because I made it my duty. One of the rules that how I brought them to school is that I will monitor their progress. And uh I went out of my way to make sure that these girls receive extra help in all the subjects….That's why I always use them as that example and my motto in the class is "if they can do it, so can you."*

This excerpt highlights two notable features: (1) Teacher C's perspective of what constitutes intelligence and;(2) the additional support that Teacher C was willing to provide learners that embodied this perspective of intelligence. The assessment of these two learners and their competence in mathematics was based on a combination of themes discussed thus far, markedly: grades as an indication of academic competence, and personal motivation to succeed. The perception provided by Teacher C included factors of academic performance and personal motivation to define these learners as intelligent and capable. The first indicator was the record of academic performance from a foreign country, which prompted Teacher C to sponsor the aforementioned learners from Iraq. The second indicator was the enthusiasm that the learners demonstrated and the adaptations they were willing to make to overcome language barriers. The combination of these two factors encouraged Teacher C to perceive these learners as intelligent, competent, and able. This is illustrated in the manner by which Teacher C used this story to motivate other learners: if these learners were capable of putting in the effort despite language barriers and immigration status, then the implication is that all learners should be capable of the same success. Although the validity of these claims can be questioned, Teacher C's final statement served as a testament to the emphasis that this teacher placed on motivation and practice when encouraging learner success in mathematics.

The efforts made by Teacher C to accommodate these learners brings into question the length an educator is willing to adapt their teaching methods to accommodate such learners. While this is a unique example, it provides a catalyst for further discussion on pedagogical adaptations to suit learners of different levels of capability in the mathematics classroom. In this circumstance, Teacher C has offered a positive mathematical identity to the two learners from Iraq based on their past performance in mathematics (Gardee, 2021). This categorisation of learners' into the category of intelligent resulted in the learners being awarded extra support and resources outside the classroom to ensure their success in the subject (Gardee, 2021). As discussed by Sternberg and Grigorenko (2003), the successful intelligence of a learner can manifest through teaching methods that target a learner's unique abilities in the subject. In the excerpt provided by Teacher C, the two learners from Iraq were able to cultivate their abilities through teaching methodologies tailored to their abilities by Teacher C (Gardee, 2021; Sternberg, 2003; Sternberg, 2020). Thus far, the teachers participating in this study have indicated their willingness to adapt to learners' needs through a variety of teaching approaches. Notably, the additional support provided by Teacher C occurred outside of the allocated class time assigned to mathematics. Pedagogical flexibility was reported to be inaccessible to participating teachers in this study. The lack of pedagogical flexibility was attributed to limited class time among other factors. The accessibility of pedagogical approaches is further discussed in the ensuing sections.

4.3 Objective 2: Favoured Approaches

4.3.1 Theme 4: Peer Learning

Peer-to-peer learning, also referred to as peer learning, is a common practice in education due to its accessibility and efficacy in the classroom environment (Alegre et al., 2019). Peer learning is an approach by which learners can assist one another in the classroom under the supervision of the teacher. Learners impart knowledge to one another through their use of simplified and direct speech, sharing of cultural references, and more recent knowledge of content that can assist their peers

(Alegre et al., 2019; Arthur et al., 2021). Peer learning was commonly used by the teachers in this study to facilitate learners' understanding of content in the mathematics classroom. In the excerpt below, Teacher B discusses peer learning as a method that encourages learners:

> *Interviewer: And in terms of developing the weaker areas of the students - because you mentioned that solving a problem is one component and then presenting or communicating your answers is another component, um how do you facilitate encouraging them in their weaker areas?*
>
> *Teacher B: In the weaker areas, you know we design more worksheets… we also get peers to help one another - students that may be stronger in certain areas can assist other learners. They can help them learn. Also, sometimes we use the technique of memos where we provide a problem and then we provide the solution in form of a memo so that the learner can follow the memo. Then when he has a problem that does not have a solution, he is able to work easier with that problem. But I think peer learning is good. It helps a lot and students are more comfortable learning from their peers. They feel less intimidated learning from their peers so a lot of peer interaction is encouraged.*

When asked how weak learners are motivated in the mathematics classroom, Teacher B listed resources, such as worksheets and memoranda, but accentuated the role of peer learning. Teacher B reported peer learning to be a less intimidating experience for the learners as they feel more at ease learning from their peers than from the teacher. The encouragement of peer interaction is a common theme throughout the interviews:

> *Teacher E: I actually encourage learners to ask learners next to them so if they have a problem, I don't know how other teachers work but I allow it to happen.*
>
> *Interviewer: Ok are you quite fond of peer-to-peer learning?*
>
> *Teacher E: I am quite fond of peer-to-peer learning and that is why I go with having interactive classrooms. We do not remain quiet, so I do get learners to assist other learners. Yeah. That is the case in my classroom. I am fond of it.*

Upon the mention of peer-to-peer learning, Teacher E expressed a fondness for the practice. Teacher E specifically outlined that they encouraged their learners to seek assistance from their peers prior to the teacher. The efficacy of peer-to-peer learning is well-known and a longstanding practice in the field of education with its underpinnings in social interdependence theory (Cockerill et al., 2018). This theory suggests that motivation increases when a learner has shared goals with their peers, encouraging cooperation in their attainment of shared goals. This results in a greater sense of

responsibility among all learners to achieve goals and promote one another's success (Cockerill et al., 2018). Peer learning has also been identified as a mediating factor in student interest in mathematics within an African context (Arthur et al., 2020). Teacher A expressed an affinity towards the use of peer learning to mediate in circumstances where there was a language barrier:

> *Teacher A: I think we had a few cases whereby they weren't as fluent in English and it became a bit of a problem in that sense. We have a lot of African learners who speak Zulu. So let's think… I think I used to use sometimes to get across to them that I used to find a mediator…When I used to talk – I mean she'll understand what I'm saying but who better to go and explain it to them than a learner themselves? So I communicate, speak what I have to in class and then get a learner from the class to probably say it in Zulu so that those who don't understand will understand it better. And I used to see a brilliantly eyed reaction from them because they used to be happy that they could understand it in their native language.*

Language barriers are a common difficulty navigated by teachers in South African mathematics classrooms (Adler & Davis 2006; Howie & Plomp, 2003; Ogabannaya et al., 2016). Peer learning enables direct speech and the sharing of cultural references that are relevant between peers (Alegre et al., 2019). Cockerill et al. (2018) adds that peer learning decreases intimidation that can come with the unilateral direction of teacher to student learning. The participants in this study favoured peer learning due to its array of benefits in bridging socio-cultural divides, including those posed by linguistic differences. Teacher A expressed that they use a mediating student to translate content for other learners to understand. Similarly, Teacher F expressed the use of peer learning to overcome language barriers as well as to get feedback on their own teaching style and delivery:

> *Teacher F: Ok with maths literacy this mostly comes up as well. Sometimes it helps when I know that I have to explain certain things, then another learner would translate it for me sometimes or tell me "this what they are not understanding" and say it in a different way. I've experienced that 'cause a learner would say "you know what maybe you're giving them too much information" or "explain it like this" or "this is what they're not understanding". You get learners that would translate for you and then over the years you learn to figure out how to explain to learners with different language barriers and stuff like that.*

The response provided by Teacher F discussed the use of mediators to bridge language barriers as well as provide feedback to the teacher on content that was not understood. This may further affirm claims made by other teachers in this study that learners are less intimidated by their peers and can

express their difficulties more easily. In the case of Teacher F, peer learning was also used as a form of feedback by which learners would ascertain the difficulties faced by their peers and communicate these difficulties to the teacher. Teacher F expressed using this feedback to better navigate teaching across language barriers.

4.3.2 Theme 5: Visualising Problems

Visualisation is the mental process of interpreting and understanding information regarding figures, shapes, objects, maps, graphs or functions (Goos et al., 2007). Additionally, visualisation embodies "the creation of images from abstract ideas" in a student's mind, on paper, or through technological media (Goos et al., 2007). Approaching problem-solving with the aid of visualisation is widely acknowledged as a useful strategy in cultivating spatial reasoning by examining the properties of figures in two-dimensional and three-dimensional planes (Bikner-Ahsbahs, 2015; Goos et al., 2007). Furthermore, visualisation provides a medium for the acquisition of mathematical language as visual representations can transcend language barriers and enhance learners' understanding of mathematical concepts (Goos et al., 2007).

Four participants in this study utilised visual representations in their teaching methodologies to assist learners in understanding mathematical concepts. In addition to worksheets and questionnaires, Teacher B discusses using visual representations outside the classroom context to assist learners that have difficulties grasping spatial concepts:

> *Teacher B: We design worksheets and questionnaires and so on to cater for learners that are at different levels in the assessment. Also to support these different levels we also have a lot of practical activities because such students are good at learning through visual intake. You know through visual means by seeing. So for example we would take them outside and we would look at a building and I would ask them to try and identify geometric shapes in the building and some would say 'you know the door is rectangular shaped' and 'the roof is a prism' and someone would say 'the water fountain is a circle' and this helps them in their spatial visualisation. It helps…learners that may be a little slower in some mathematical processes.*

In the excerpt above, Teacher B discussed taking learners outside the classroom to discover geometry in the physical world in order to assist those who have difficulties with mathematical processes. Visualisation is commonly regarded as an elementary technique, as primary school learners are often given visual aids when first being taught basic shapes (Bikner-Ahsbahs, 2015; Goos et al., 2007). However, the application of elementary techniques in advanced mathematics can be effective in the presence of learners with different learning abilities or language barriers inhibiting their acquisition of new terms (Bikner-Ahsbahs, 2015; Goos et al., 2007). When asked about methods that assist learners of varying levels of ability, Teacher G confirmed that their learners respond well to visual representations.

> *Teacher G: I think for algebra they wanted to see each [step] separate and by the teacher on the board. So writing the lines out and explaining as you go along, that works very well. With geometry I use the data projector and the textbook is on there. Sometimes I might show a video because they prefer the visual diagram or even animation of the picture so you can highlight the angle or what happens if this moves or that moves. So definitely the tech for the geometry. But even when I'm using the technology, it's still [at] their speed - like 'let's talk through this together', 'now you do this one'.*

Teacher G stated that learners preferred visual diagrams as it enabled them to see what happened to the shape or object when a mathematical concept was applied to it. While visualisation commonly refers to illustrations of geometric figures, Teacher G discussed visualisation as presenting individual steps of an algebraic equation to learners for their understanding. Despite the absence of shapes and figures in algebraic equations, Teacher G illustrated problem-solving methods in a visual manner for the ease of learners' understanding. Moreover, Teacher G acknowledged pacing the content according to the learners' needs in addition to using visual aids. Learners were encouraged to participate in problem-solving alongside Teacher G, suggesting a co-operative classroom environment wherein learners were encouraged to participate.

4.3.3 Deviant Case 1: Chalk and Talk

Peer-to-peer learning and visualisation are essential methodologies in facilitating mathematics education (Alegre et al., 2019; Bikner-Ahsbahs, 2015). These two methodologies allow mathematics teachers to address learners with different levels of ability despite resource limitations (Alegre et al., 2019; Bikner-Ahsbahs, 2015). However, one participating teacher in this study expressed that they favoured a traditional method to teaching mathematics:

> *Teacher C: I come from the chalk and talk way of teaching. I still feel like it's irreplaceable, it's the most effective, I believe that very strongly. And what's most important in teaching – you can get lots of these philosophies in education, theories in education saying "use this method and that method and that method"… So when it comes to audio-visual aids as well, what is more audio-visual than a teacher standing in front with a chalk in his or her hand and a board there and explaining something? That's also audio-visual. So most important I think is to stand out there to deliver that lesson in the most understandable way that you possibly can and being audible by using effective but simple language that the child will understand, that the learner will understand, and explaining [it] properly.*

In the excerpt above, Teacher C expressed what could be interpreted as frustration with theories, philosophies, and methodologies in education. Although Teacher C was aware of new, evolving teaching methodologies, they retained a traditional "chalk and talk" method of teaching for its efficacy in their teaching experience. Teacher C suggested that a teacher alone can be equally as effective as audio-visual methodologies by being physically present in the classroom and delivering the lesson using simple language. The traditional "chalk and talk" method emphasised by Teacher C is a dialogue-based methodology that benefits learners who are sociable and cooperative (Goos et al., 2007). This traditional approach to teaching mathematics is rich in dialogue, therefore requiring a level of linguistic competency among learners in order to participate in the classroom. The implementation of a language-sensitive approach improves delivery of mathematical content when using a dialogue-based approach to teaching (Goos et al., 2007). Bikner-Ahsbahs et al. (2015) suggest that teachers who adhere to traditional methods engage in a process of comparative reflection to become aware of the choices they have made in constructing their educational process. While

traditional methods may be effective in achieving learning outcomes, it does not cultivate meaningful learning experiences for mathematics learners (Bikner-Ahsbahs et al., 2015). Although Teacher C used traditional, dialogue-based teaching in their classroom, they emphasised adapting to the linguistic abilities of the learners to optimise learners' understanding. This excerpt from Teacher C provides an example of adapting a favoured pedagogical approach to the abilities of learners in their mathematics classroom.

The frustrations with different teaching methodologies expressed by Teacher C can be contextualised by the following excerpt:

> *Teacher C: Who started this IQ? Who said this is the best way of doing things? I believe this [is] from colonial. This is from so-called British. They came with this stupid idea of using this test. We [are] a different country, we need to use our own. Why must we use somebody else's yard stick? Who said this is the best? We always think that other people are the best like we want to steal other people's ideas and put it here with a result…For South Africa we need a South African way of checking how a pupils operate and work.*

In the excerpt above, Teacher C referenced the turbulent history of intelligence testing in South Africa. The policies of segregation during apartheid ensured that only white South Africans received social, economic, and political privileges (Laher & Cockcroft, 2013). Non-white race groups were granted limited access to resources, with indigenous black South Africans being denied basic resources altogether. During apartheid, psychological tests were brought to South Africa by Britain and adapted to the abilities of white South Africans (Laher & Cockcroft, 2013). Psychological tests, including intelligence tests, were misused to justify the unequal distribution of resources and opportunities imposed by apartheid. White South Africans had greater access to education, sanitation, and healthcare than black South Africans, which resulted in higher scores on intelligence tests. However, these tests were used to create narratives of inferior intellect among indigenous black South Africans whose low scores were affected by illiteracy and illnesses as a result of poor access to resources (Laher & Cockcroft, 2013). From a social constructivist perspective, the sentiments expressed by Teacher C towards the concept of intelligence were informed by the historical misuse

of intelligence tests as a measure of mental aptitude. As a result, the teaching methodology favoured by Teacher C was purposefully disconnected from the practices informed by intelligence research.

4.4 Objective 3: Pedagogical Adaptations

4.4.1 Theme 6: Limited Time

When discussing favoured pedagogical approaches for learners with different abilities, the most commonly held sentiment among the participants was a lack of time to cater to individual learners' needs. All the participating teachers expressed having limited time to deliver a rigorous mathematics syllabus in preparation for the matriculation examinations. Moreover, the participating teachers taught multiple classes throughout the day in addition to developing assessments, grading tests, and engaging in other professional responsibilities. Consequently, a commonly expressed sentiment among this sample of educators was that there was insufficient time in the school schedule to tailor their methods to the individual needs of every learner in the classroom. The teachers participating in this study did not possess the time to optimise every individual learner to their full potential irrespective of the ability of the learner. In the following excerpt, Teacher E discusses the rigorous mathematics syllabus and limited time as factors affecting individuated learner support:

> *Teacher E: Ok so uhm I'll be honest with you. Our syllabus in South Africa, we basically are trying to complete as much as we can. We don't have time to provide for our highflyer learners as such. But we do have – I mean we don't have time to cater for them but we do provide extra work for them. Like we do give them uhm extra questions to answer and different types of questions but that's about it. We don't actually have time due to the way the syllabus is made and we'll have to find the time basically to finish the syllabus. So for those that are gifted we just give them extra questions and….then the thing about our South African syllabus is that we looking to make people pass…you know? It's not an easy syllabus to teach the way we want to.*

These teaching circumstances faced by the participating teachers may be an underlying factor to their perceptions of learner intelligence. The time constraints faced by these teachers make individualised feedback for learners difficult, so the personal initiative of the learners to improve their grades may be perceived as strategic in the mathematics classroom. Teacher E expressed that the pass rate for

mathematics was a priority, thus restricting the teacher's ability to deliver the syllabus in "the way they want to" during teaching hours. Therefore, a learner's success depends on the learner's personal willingness to improve their grades. As a result of these circumstances, learners of different levels cannot immediately be catered to beyond simply being provided with extra work. Time becomes a critical thematic issue when discussing teaching methodologies because it is inextricable from these educators' narratives due to its impact on their ability to adapt. This is not to suggest that the participating teachers did not adapt to their learners' needs. Rather, there are limitations on how the educator could cater to these learners. Teacher F was questioned on their management of students with different levels of ability in their allotted class time. Teacher F responded with the following:

> *Teacher F: Uhm ok during that [class] time, if you see that they are shy then try to have them see you during break…or you make that appointment when you'd like to see me. And also, you have like intelligent students and stuff…I do the pairing or I try and give them extra work on their own….you know like maybe extra questions and say "you can work on this after school" so it also improves them as well. So don't disadvantage them as well because in class you can't do all types of questions. So [I] try to cover the basics, level 1 and level 2. Anything above that is their time and then you just judge by which students you know are capable and try to improve them as well. So they don't get bored in your class as well.*
>
> *Interviewer: Oh ok. So would you say that you tend to adapt what you deliver in class based on your students?*
>
> *Teacher F: Yes I do. It depends on the class you see. Like I said, after you teach normally and after the first assessment…you figure out what the capabilities of your students are and then you'll adjust. Maybe you need to spend more time explaining the basics and give a little extra work to practice on at home. And if it's on the other [end of the] spectrum then maybe you can go move a bit faster to cover the work.*

The response provided by Teacher F highlights the need to use time outside of the classroom to develop learners in ways that address their shortcomings. While Teacher F adapted to the pace of the learners in the classroom, the pace was ultimately determined by the overall majority. Teacher F looked to ensure that the overall class was able to complete the first two levels of questioning and prescribed higher levels of questioning to individual learners who appeared more capable in order to keep high-achieving learners preoccupied in the classroom. This concurs with the narrative provided

by Teacher E in which "highflyer" learners cannot be catered to in the classroom beyond being provided with extra work. Both narratives reflected a desire to ensure the overall class understood the lesson and were capable of handling the first two levels of questioning in order to pass the subject. In effect, adaptations were made to ensure learners' success in mathematics as a subject, but more individuated attention to optimise individual learner success could only be offered outside of teaching hours due to limited class time. This sentiment is captured as a theme due to how common it is throughout the different participants' narratives. One participant, Teacher G, aptly summarises her strategy below:

> *Teacher G: You teach I would say….for the…middle and then I do give extension work for the ones that are moving at a slightly faster pace. And the ones that are not, like below the middle, you have to make sure they cover the level 1 and 2 questions and get it right so they are able to pass. But they are unable to answer the level 4 questions, so you have to tell them "don't focus on the level 4 until you get level 1 and 2 right". Otherwise, they only focus on the problem-solving and forget about the basics and they get the problem-solving wrong.*
>
> *Interviewer: So you try to build them up from the most necessary areas?*
>
> *Teacher G: Ya from the foundation. Ya some children have to focus on the foundation to move on while others get it quickly so you can give them more problem-solving questions.*

Within this sample, key adaptations made to teaching approaches in the participants' classroom did not revolve around any specific group of learners. The average pace and ability of the majority of learners was of primary importance in order to get the necessary pass rate, which involves ensuring that the lessons adequately cover the first two levels of questioning. If an educator catered to learners of different ability, particularly those that are "intelligent" or "gifted", they needed to work outside of allocated lesson times as to not disadvantage other learners. Thus, the approaches chosen by the participating teachers in this study did not take into account learners' different levels of ability. Instead, the approaches focused on the pace of the overall class in order to cover content as quickly and effectively as possible.

4.4.2 Theme 7: Lack of Prior Knowledge

Another critical barrier to providing individuated support for different learners and their abilities was a lack of prior knowledge among learners. Without the relevant prior mathematical knowledge, such as basic arithmetic skills, learners could not understand new subject matter. This theme echoes throughout the sample, and parallels literature suggesting that shortcomings in the acquisition of mathematics in previous schooling years carries over into the new academic year (Paras, 2001). With a lack of previous knowledge, educators in this sample found it difficult to remedy this disadvantage within the limited class time allocated to the subject by the school, and the rigour of the mathematics syllabus. This, in turn, inhibited pedagogical flexibility. The following excerpt from Teacher D discusses their experiences with this lack of prior knowledge:

> *Teacher D: There are learners in a class who have a major problem with basic, basic, basic mathematics, Shreya. I mean absolutely basic mathematics. I mean simple operations of basic addition, subtraction, multiplication and division with numbers – with just plain numbers, positive and negative numbers, they have issues with that. And they are in grade 10 this. And they are supposed to have known this from grade 7. And so it's something to do with prior learning. Prior learning problem that they have, that they have missed out for whatever reason. So that's the other issue that is problematic. And then there…is obviously the child's nature. There are children who are very playful in nature. They will go home and do everything except do the homework. So they come without anything done. With a blank book. They're not having done or put any thought into the lesson that was done in the day and then when they will go home, they don't even look at the books then come back the next day. So the misunderstanding they got or the misunderstanding they had during yesterday's lesson is still there. They didn't go home and think about what teacher taught today, let me try and put some thought and try to understand what was taught. They don't do that and that that that's their lifestyle now...And that's when they get lots of gaps in their knowledge thereafter because they don't fill those gaps in. And as a teacher, it's very difficult to be able to fill all the gaps for a learner, you know? A lot will depend – I always tell the learner 20% is done by the teacher, you've got to do the 80% on your own.*

Teacher D expressed frustrations with learners who have gaps in their mathematical knowledge, and therefore could not progress with the content to taught at their grade level. Gaps in prior learning critically impact the ability of the educator to move forward with the mathematics syllabus in the limited allocated time. Should the educator need to revise past content to fill in those gaps, the

syllabus for the year may not be covered in its entirety, which will then disadvantage learners during their examinations. Interestingly, Teacher D attributed these gaps in knowledge to the initiative individual learners take to revise past content and fill knowledge gaps. While a lack of prior knowledge negatively impacts the pedagogical prospects of the educator in the classroom, the theme of learner motivation and initiative re-emerges as a suggested remedy to this issue. Despite the majority of participating teachers expressing similar sentiments regarding teaching and learning, they defined the nature of the circumstances differently from one another. In the excerpt below, Teacher G refers to a lack of prior mathematical knowledge as being attributed to weak former schooling:

> *Teacher G: When they come with a weak foundation it's very difficult to fix. It takes too long because we have to go through the syllabus at the given pace. We can't change that. So if the child is not coming from a school that has covered the basics and they did not have a strong foundation from the primary school and grades 5, 6, and 7 for maths then it's going to take twice as long for them to learn.*

In contrast to Teacher D, Teacher G does not place the initiative of remedying knowledge gaps on the learner. Instead, Teacher G holds prior schooling responsible for producing weak foundational mathematical knowledge in learners. This issue broadly encompasses socio-economic problems that would impact upon the ability of the learner to grasp new mathematical content and progress towards the next grade level or a high matriculation exam result. Learners' performance in higher grade levels is determined by how prepared they were at lower grade levels (Ogbonnaya et al., 2016). When basic mathematical concepts are not grasped at lower levels, learners struggle to retain concepts at higher grade levels due to mathematical knowledge gaps (Mabena et al., 2021; Ogbonnaya et al., 2016). Resultingly, the theme of limited allocated time to lessons was further emphasised in relation to the rigour of the syllabus combined with knowledge gaps. Teacher G stated that there is not enough class time to remediate the lack of prior knowledge, which inhibits pedagogical flexibility and learner success in mathematics.

4.4.3 Deviant Case 2: Practical Visualisation

Due to limited class time, the participating teachers expressed being unable to remedy individual learners' lack of prior learning. As a result of these limitations, the teachers chose their methodologies to address the needs of the majority of learners based on the learners' performance in assessments. Peer-to-peer learning and visualisation were commonly used methodologies to serve the needs of the majority of learners. In lieu of pedagogical adaptations, these two methodologies were used to enhance learners' understanding of the rigid mathematics syllabus during the limited allocated class time. However, Teacher B was able to provide a narrative of pedagogical adaptation. Notably, Teacher B taught underprivileged learners who required pedagogical intervention. Thus, Teacher B discussed the need to make content relevant to learners through practical application:

> *Teacher B: My learning in my institution taught me to try and understand the students' prior learning and to try to make the work relevant to the students' day to day life. To look at a concept and then relate the concept to something in the real world…For example if we [are] trying to find the side of a triangle, you rather take the learners out into the open, into the schoolyard and maybe look at a light pole and say 'we [are] standing at a certain distance from the light pole and we want to construct something here and we want to find out the height of the light pole…' It's some practical work, life relevant way so that [it] makes mathematics more relevant to their real lives. Makes it more practical, more exciting and makes it something that they can look forward to.*

By creating a practical application to visualisation, Teacher B demonstrated an attempt at connected learning. Connected learning is established when mathematical teaching and learning are negotiated with learners, built on prior knowledge, and applied in a socially, culturally, politically, or professionally empowering way (Goos et al., 2007). As secondary learners are still in the process of developing their logical reasoning skills, they will not immediately grasp the logical reasoning associated with new concepts (Bikner-Ahsbahs et al., 2015). Connected learning allows learners ample opportunity to engage with and apply their logical reasoning skills to problems that are familiar or tangible in nature (Bikner-Ahsbahs et al., 2015). Additionally, practical investigations are more likely to contain tasks with multiple solutions that apply learners' prior knowledge (Mahlaba, 2020). Tasks with multiple solutions can be investigated individually or collaboratively with

learners' existing prior knowledge, thus engaging learners with different levels of ability (Mahlaba, 2020). The pedagogical adaptation demonstrated by Teacher B was not representative of the adaptations made by the rest of the participating teachers in this study. However, this adaptation is notable as it neither favours nor disadvantages learners based on perceived intelligence. Rather, connected learning and multiple solution tasks allow learners with different intelligences to collaborate in a mathematical investigation equally (Mahlaba, 2020).

4.5 Summary of Findings

Overall, the participating teachers in this study perceived intelligence as being unique to each learner. The participating teachers in this study collectively viewed learners' motivation and hard work as indicators of intelligence. While grades were used as a frame of reference to determine learners' mathematical ability, low-achieving learners were not perceived as incapable of mathematical success. The participating teachers highlighted the role of learners' motivation as a key component in encouraging learners to practice mathematical skills in order to obtain higher grades.

Peer learning and visualisation were the most commonly favoured approaches among the participating teachers. These were accessible and efficient methods to enhance learners' understanding of mathematical concepts. Furthermore, peer learning offered a remedy to the issue of language barriers. Learners were able to assist their peers by translating and explaining the mathematical language used in their classwork. Visualisation also offered a medium by which language barriers could be transcended, as illustrations could communicate concepts without the need for linguistic intervention. Utilising two broadly accessible and efficient approaches to methodologies proved to be a practical solution for teachers who were restricted by class time. Only one participating teacher expressed an affinity towards traditional teaching methodologies with little desire to adapt their methods.

The majority of participating teachers in this study expressed an inability to adapt their pedagogy to the needs of different learners. Limited class time allocated to mathematics required that the participating teachers present as much of the mathematics syllabus as possible. Thus, there was little ample time to focus on individual learners or remedy a lack of prior learning. Only one participant discussed a pedagogical adaptation to cater to weak learners.

Chapter 5: Conclusion and Recommendations

5.1 Overview

In order to determine a link between perceived intelligence in learners and teachers' preferred methodologies, this study sought to examine teachers' own narratives of adapting to the potential of their learners. The significance of this study was based on a link between the factors of perceived intelligence and pedagogical adaptations in the South African context. Pedagogical knowledge encompassed teachers' ability to adapt their methodologies to the needs of their learners (Carney & Roselmina, 2013). Based on previous literature, this study assumed that mathematics teachers would view high-achieving learners as more intelligent than their peers and employ the skills of these high-achieving learners in assisting their struggling peers (Alegre et al., 2019; Carney & Roselmina, 2013). This assumption was only partially true. The majority of participating teachers in this study chose teaching methodologies that addressed the average learners' capabilities, which was the first two levels of questioning in the units being taught. Further assistance was provided outside of class time for learners who struggled with the content as well as learners who were ahead of their peers. The limitations on allocated time to lessons in the school day was the determining factor behind their limited pedagogical choices. The parameters by which their methodologies were restricted seemed to have no connection to their perceptions of intelligence in their learners. Thus, the primary assumption underlying this study was disproven, but gave way to a discussion of other critical and influential elements of perceived intelligence and pedagogical preference in the South African schooling context.

5.2 Review of Findings

This study examined an unexplored facet of school education in South Africa, which was teachers' perceptions of learner intelligence and the influence of these perceptions on their pedagogical approaches. Although the data was rich with information that extended into other facets of education, only themes pertinent to addressing the research questions of this study were reviewed.

The perceptions of intelligence held by matric mathematics teachers were the focal point of this study. The participating teachers all perceived intelligence as multi-dimensional; intelligence in a learner was not identified on a strictly academic basis. All participants were aware of multiple intelligences and the implications of having learners with different abilities in their classroom. However, the teachers interviewed expressed an inability to adapt to the needs of mathematics learners with different types of intelligence to make learning more relevant to them.

The teachers interviewed for this study expressed having insufficient time during school hours to adapt their methods to the individual strengths and weaknesses of their learners. Some teachers expressed their preoccupations with remedying a lack of prior knowledge in their learners. A lack of fundamental mathematical knowledge was the result of learners having not grasped pertinent concepts in previous grades, including: addition, subtraction, multiplication, and division. As a result, learners were reported to have found themselves struggling to understand concepts within the scope of their examinations at matric level. Such circumstances resulted in teachers using class time to remedy learners' lack of prior learning. Alternatively, the participating teachers in this study encouraged their learners to seek additional help outside teaching hours in order pass mathematics and achieve their National Senior Certificate. The initiative taken by learners to remedy these circumstances factored into the majority of definitions of intelligence provided by the participating teachers.

Peer learning was the most favoured teaching approach in this study for multiple reasons. Firstly, peer-to-peer learning was used by the participants to overcome language barriers in the classroom. By choosing a mediator to assist in translating mathematical problems for their peers, the mathematics teachers were able to fill any knowledge gaps posed by linguistic barriers. Secondly, peer learning was highlighted as being less intimidating for learners. The teachers in this study highlighted that their learners were more at ease discussing their difficulties in mathematics with

their peers than with the teacher directly. In one case, learners had reported the difficulties faced by their peers in mathematics to the teacher in order to improve lesson delivery for the whole class. Peer learning proved to be an affordable and accessible means of addressing some of the teaching difficulties faced by the participating mathematics teachers in this study.

Although the implicit theories of intelligence served the purposes of this research, the role of intelligence may need to be relooked. Multicultural views of intelligence are an additional factor contributing to implicit theories of intelligence (Sternberg, 2020). Social and cultural influences shape individuals' perceptions, including their perceptions of intelligence. Cultural influences on intelligence theories in the South African context were not integrated into this research. Thus, the implicit theories of intelligence used in this study could be further expanded to include multicultural perspectives of intelligence. The addition of a multicultural perspective could assist in contextualising mathematics teachers' perspectives within a uniquely South African teaching context (Mahlaba, 2021; Sternberg, 2020).

5.3 Implications of the Study

A qualitative study of this nature cannot be representative of the wider state of teaching in South Africa. However, this study contains themes that contribute to a body of known research regarding mathematics teaching in the country. In the South African context, teachers are encouraged to utilise more inclusive methodologies in order to avoid disadvantaging any learners. Inclusive education is frequently discussed in relation to the disability status and cognitive impairments of learners, but has yet to be examined in relation to teachers' concepts of learners' intelligence (Dalton et al., 2012). The Department of Education (2001) released a white paper addressing special needs and inclusive education under the premise that all individuals have the ability to learn given that their individual needs are addressed. The white paper states that a system's inability to recognise a diverse range of individual learning needs results in a breakdown of learning as a whole (Department of

Education, 2001). Attempts to offer equal quality education to all individuals resulted in the development of special schools in which learners with specific disabilities could enrol. Despite such efforts, implementation of inclusive education is partial as specialised education for learners with special needs remains limited due to various socio-economic circumstances throughout the country (Dalton et al., 2012; Mahlaba, 2020). Moreover, learners who struggle to grasp educational content due to special needs or otherwise still attend school within the general education environment and are expected to achieve in similar ways to their peers (Dalton et al., 2012). The general education environment present in South African public schools is plagued with issues of language barriers, insufficient prior knowledge, safety concerns, and inadequately qualified teachers (Adler & Davis, 2006; Howie & Plomp, 2003). Addressing the needs of learners who struggle with mathematics or learners who are far ahead of their peers is not as urgent a matter as remedying the aforementioned list of pertinent issues inhibiting learner pass rates in the subject.

The findings of this study align closely with the realities of teaching mathematics in the South African context. Linguistic barriers and resource shortages are common hurdles that South African learners struggle to overcome (Adler & Davis, 2006; Mabena et al., 2021; Ogbonnaya et al., 2016). The participating teachers in this study highlighted that linguistic barriers and learners' resource shortages had a significant impact on learners' performance in mathematics. Although five of the seven participants in this study were employed in a Quintile 5 private school, the issues of insufficient class time, language barriers, and the socio-economic status of learners still affected the teachers' abilities to adapt to learners' individual needs. The results of this study therefore imply that even when teachers are fully qualified and adequately resourced, the broader socio-cultural and economic implications of teaching in the South African context still create barriers to success for learners in the mathematics classroom.

5.4 Recommendations for Practice

Recommendations for more inclusive teaching practices that function within the constraints of the South African context are aplenty. Dalton et al. (2012) discussed the applicability of a neurologically supported Universal Design for Learning that can cater to learners of all abilities, including those with learning disabilities. The Universal Design for Learning essentially simplifies common learning tasks into subcategories and offers corresponding alternatives to commonly used approaches. The proposed alternatives offer flexibility that cater to a broad spectrum of learning needs without depending on curriculum changes or special needs resources (Dalton et al., 2012). This Universal Design for Learning presents a diversity of means by which a concept can be delivered, engaged with, and expressed based on learners' abilities (Dalton et al., 2012). Use of this design for learning is not widespread throughout South Africa at present but holds potential for implementation in South African schools. With necessary training, teachers may implement such methods without many additional resources or any amendments to a curriculum.

In relation to mathematical content, Mahlaba (2020) suggests the implementation of multiple-solution tasks (MSTs) to cater to the different problem-solving capabilities of learners in a diverse learning environment. Tasks that require multiple solutions encourage active learning, critical thinking, and creative problem-solving which are encompassed by the current Curriculum and Assessment Policy Statement (CAPS) that is used by teachers nationwide. The practice of producing multiple solutions to a complex and multi-faceted problem helps learners practice and develop a broad range of mathematical skills (Mahlaba, 2020). It also allows for the practical application and merging of these problem-solving skills within the capabilities of a diverse group of learners. Learners who are considered more capable, intelligent, or gifted would benefit by producing more solutions to a problem, while learners who have difficulties in mathematics can use a multiple-solution task (MST) to practice necessary problem-solving skills alongside their peers (Mahlaba, 2020).

5.5 Limitations

While this study may maintain internal validity, the extent to which it retains transferability may be limited. In qualitative research, transferability refers to the generalizability of findings as they are applicable to the broader context outside the sample of the study (Shenton, 2004; Terre Blanche et al., 2006). The issue of transferability in qualitative research is rooted in a lack of consistent measurements by which reliability can be measured. Both credibility and transferability can be increased by: maintaining consistency in questioning; organised record-keeping; clear interview transcripts and; cross-referencing information throughout the research process (Shenton, 2004). This includes cross-referencing with respondents through the interview process and checking interpretations with supervisors or other qualified researchers. The dependability of the study increases with the insurance of these factors, thus allowing for this research to be repeated in the future (Shenton, 2004).

Qualitative designs with semi-structured interviews pose the limitation of a small sample size that is immediately accessible to the researcher at that time. The demographic factors of the participants of this study were not entirely representative of the broader population of South Africa. The results obtained from this sample were based on the input of teachers in Durban. Therefore, these results may not be transferable to other regions of the country. The methodologies used may not be transferable to other populations, such as those in rural areas or teachers who do not deliver their lessons in the English language. The choice of interviewing English-speaking teachers brings into question the confirmability of the study, which refers to the predispositions of the researcher themselves (Shenton, 2004). In this study, the primary means of communication with participants was through the English language. This may have impacted upon the transferability of this study as the outcomes of this study will not necessarily apply to non-English-speaking and rural areas of South Africa. The results of this study may not apply to teachers of other grade levels because of the exclusive focus on matric mathematics teachers. Despite the sampling criteria adhering specifically

to English-speaking respondents, interpretations between an interviewer and their respondent may vary in discourse. Cross-referencing was used to reduce ambiguity. Interview questions were purposefully phrased in neutral language to avoid ambiguity (Ritchie et al., 2013). The repetition of items and phrasing were also essential to the interviewing process (Ritchie et al., 2013).

5.6 Recommendations for Further Research

This study ascertained a relationship between teachers' perceptions of intellectual ability in mathematics learners, and their pedagogical adaptations in response to their perceptions. The intention was to determine the extent to which the participating mathematics teachers were able to cultivate successful intelligence among their learners. The intention of this study was to integrate a psychological perspective into the expanding body of mathematics education research in South Africa (Adler et al., 2016). While some findings were unique, the majority of issues raised by the participating teachers paralleled previous research into effective mathematics education (Adler et al., 2016). The mathematics teachers interviewed for this study were aware of a multi-faceted view of intelligence. While grades were still used as a benchmark in determining learners' success in the subject, there was an acknowledgement of the individual learner's ability and inclination to cultivate their abilities. Despite this awareness, the participating teachers were limited in their pedagogical approaches and were unable to cultivate individual learners' abilities due to exterior factors, namely time constraints and a lack of prior knowledge in learners.

Although the effects of factors such as resources, limited training, and cultural viewpoints were taken into consideration, the nature of the Grade 12 mathematics syllabus itself was not examined. Thus, the connection between teachers' implicit intelligence and contents of the mathematics syllabus remains unestablished. The CAPS Grade 12 mathematics syllabus issued by the Department of Basic Education was expressed to be inflexible in nature by the participants of this study. It is necessary for the content of the mathematics syllabus to be covered in its entirety by learners

obtaining their National Senior Certificate. The rigidity of the syllabus combined with the pressure to deliver content and ensure pass rates limits teachers' pedagogical adaptations aimed at optimising individual learners' success. Rather, collective academic success was emphasised to ensure that no individual learner was disadvantaged. Future research into the impact of perceived intelligence on pedagogy should consider the variables beyond the teachers' control. The role of a rigid syllabus imposes a requirement that educators must work around to get through to learners with individual needs. A proposal for the future may be to question how teachers work around the rigid syllabus before commencing further questioning on their perceptions of learner ability.

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APPENDIX A

Participant Consent Form

Dear participant,

My name is Shreya Singh, and I am a Master's student conducting research in the psychology department of the University of KwaZulu-Natal (Pietermaritzburg campus).

I invite you to participate in research involving matric mathematics teachers. The aim of this research is to critically discuss how matric mathematics teachers view intelligence and success in their students, as well as how their classroom methodologies are influenced by the level they view their students to be at in the subject. This study involves an interview of approximately 30-45 minutes with questions related to their students, classroom conduct, preferred teaching methodologies, and other pedagogical information related to teaching mathematics.

Your participation in this study is completely voluntary, and can be withdrawn at any time during the research process. There are no financial compensations for your participation in this study as it is purely for research purposes. No personal or identifying information regarding your identity or the content of the interview will be revealed. Your anonymity will be ensured by changing your name in the final write-up, and omitting personal details (such as spouse names, name of the school, etc). Your name may only be revealed to the research supervisor (Dr. Buthelezi) if necessary, or to contact legal authorities should you reveal your participation in illegal activities.

This study has been ethically reviewed by the Department of Basic Education and approved by the psychology department of UKZN College of Humanities.

Should there be any concerns or questions, you may contact me or my supervisor using the contact details provided below.

Researcher: Shreya Singh
Tel: 071 222 8907
Email: shreyacsingh@gmail.com

Supervisor: Dr. Nontobeko Buthelezi
Tel:
Email: buthelezin@ukzn.ac.za

UKZN Human Social Science Research Ethics (HSSREC): College of Humanities

Tel: 031 260 4557/4609

Email: HssrecHumanities@ukzn.ac.za / Hssrec@ukzn.ac.za

Consent to participation in research

- I, _____, volunteer to participate in this research study.
- I have the right to withdraw consent at any point during the research process.
- I have the right to refuse to answer any questions without consequence.
- The purpose and nature of the study were explained to me, and I have had the opportunity to ask questions about the study.
- I understand that the information I provide for this study will be treated with confidentiality (i.e. names changed, location and employment undisclosed).
- I understand what compensations are available to me should I participate in this study.
- I understand that the researcher is legally obligated to report to relevant authorities should I reveal my participation in illegal activities.
- I understand that if I have any questions about the study or require clarification, I may contact the researcher and their relevant supervisor using the details provided.

I hereby consent to:	(Please tick)
Being interviewed.	YES / NO
Audio recording of my interview.	YES / NO
The use of my interview recording and transcript for research purposes.	YES / NO

Signature of Participant: …….. Date:……

Signature of Researcher: …….. Date:……

Signature of Witness: …….. Date:……

Signature of Supervisor: …….. Date:……

APPENDIX B

Interview Schedule

Background and Demographic information

- Name, age, race
- Languages spoken (primary, second language, etc.)
- Where are you from (region, home country, etc)?
- Occupational background
    - Educational background
    - How many years have you been teaching?
    - How long have you been teaching matric students?
    - What subjects have you taught in your career?

Perceptions of Intelligence

- What does intelligence mean to you?
- How would you describe an intelligent student?
- How have you identified intelligent students in the past? Through what means? What were the signs?
- How do you describe or demonstrate intelligence to your students? How do you convey intelligence in the classroom?

Classroom Methodologies

- Describe your approach/style to teaching mathematics.
- How do you measure or gage a student's progress throughout the lesson? Throughout the week? Throughout the school year?
- How do you typically deliver your lessons? What materials, assessment practices, and activities do you use, and why?
    - Language: how do you facilitate the understanding of mathematical language in the classroom?
    - Does your delivery change depending on your learner's understanding of the language?
    - How do you question your students? Do you question certain students more than others?
- How do your assessment practices change based on your students' pace?
- What measures are in place for students who are ahead? Students who are behind?

APPENDIX C

Department of Education Research Approval

KWAZULU-NATAL PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

OFFICE OF THE HEAD OF DEPARTMENT

Private Bag X9137, PIETERMARITZBURG, 3200
Anton Lembede Building, 247 Burger Street, Pietermaritzburg, 3201
Tel: 033 3921082 / 033-3921051

Email: Phindile.duma@kzndoe.gov.za
Buyi.ntuli@kzndoe.gov.za

Enquiries: Phindile Duma/Buyi Ntuli **Ref.**:2/4/8/4195

Ms Shreya Singh
Unit I The Ridge
228 Mazisi Kunene/ South Ridge Road
Berea
DURBAN
4001

Dear Mr Simelane

PERMISSION TO CONDUCT RESEARCH IN THE KZN DoE INSTITUTIONS

Your application to conduct research entitled: **"TEACHING MATHEMATICS BASED ON PERCEIVED INTELLIGENCE OR PERCEIVED INTELLIGENCE AND PEDAGOGY: HOW TEACHERS' PERCEPTIONS INFLUENCE TEACHING:**, in the KwaZulu-Natal Department of Education Institutions has been approved. The conditions of the approval are as follows:

1. The researcher will make all the arrangements concerning the research and interviews.
2. The researcher must ensure that Educator and learning programmes are not interrupted.
3. Interviews are not conducted during the time of writing examinations in schools.
4. Learners, Educators, Schools and Institutions are not identifiable in any way from the results of the research.
5. A copy of this letter is submitted to District Managers, Principals and Heads of Institutions where the Intended research and interviews are to be conducted.
6. The period of investigation is limited to the period from 25 August 2020 to 10 January 2022.
7. Your research and interviews will be limited to the schools you have proposed and approved by the Head of Department. Please note that Principals, Educators, Departmental Officials and Learners are under no obligation to participate or assist you in your investigation.
8. Should you wish to extend the period of your survey at the school(s), please contact Miss Phindile Duma/Mrs Buyi Ntuli at the contact numbers above.
9. Upon completion of the research, a brief summary of the findings, recommendations or a full report/dissertation/thesis must be submitted to the research office of the Department. Please address it to The Office of the HOD, Private Bag X9137, Pietermaritzburg, 3200.
10. Please note that your research and interviews will be limited to schools and institutions in KwaZulu-Natal Department of Education.

[redacted]

Dr. EV Nzama
Head of Department: Education
Date: 25 August 2020

APPENDIX D

University Ethical Approval Letter

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

22 September 2020

Ms Shreya Singh (218059008)
School Of Applied Human Sc
Howard College

Dear Ms Singh,

Protocol reference number: HSSREC/00001678/2020
Project title: Perceived Intelligence and Pedagogy: How Teachers Perceptions Influence Teaching
Degree: Masters

Approval Notification – Expedited Application

This letter serves to notify you that your application received on 17 June 2020 in connection with the above, was reviewed by the Humanities and Social Sciences Research Ethics Committee (HSSREC) and the protocol has been granted **FULL APPROVAL**

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment/modification prior to its implementation. In case you have further queries, please quote the above reference number. PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

This approval is valid until 22 September 2021.
To ensure uninterrupted approval of this study beyond the approval expiry date, a progress report must be submitted to the Research Office on the appropriate form 2 - 3 months before the expiry date. A close-out report to be submitted when study is finished.

All research conducted during the COVID-19 period must adhere to the national and UKZN guidelines.

HSSREC is registered with the South African National Research Ethics Council (REC-040414-040).

Yours sincerely,

[redacted]

Professor Dipane Hlalele (Chair)

/dd

APPENDIX E

Adapted Interview Transcription Key

This transcription key was adapted for readability in the formal of this thesis.

Symbol	Meaning
-	Sudden cut off in a statement.
…	Lapses in speech. Places in sentences where there appears to be a pause but it is evident that the individual is searching for the words to express what they have to say. Also used to condense long excerpts of text.
(.)	Notable pause, gap, or hesitation.
[word]	Words, concepts, and ideas that the participant was making reference to but did not express verbally.

APPENDIX F

Original Interview Transcription Key

This is the original Jeffersonian transcription key used in transcribing the interview data.

Key:

P	Participant
I:	Interviewer
[ ]	Interruptions when speaking
{ }	Words that are difficult to make out but are the best guess of the researcher
-	Sudden cut off
…	Lapses in speech. Places in sentences where there appears to be a pause but it is evident that the individual is searching for the words to express what they have to say
(.)	Noticeable hesitation, gap, or pause
underlined	Indicates areas where there is emphasis
:	Placed after sounds that were elongated
((sniff, laugh, cough))	Description of sounds that are not spoken or in words
(8:20)	Time stamps (for personal and reader reference)

APPENDIX G

Editing Certificate

70 Steve Biko Road, Berea
DURBAN 4001
Tel: 031 373 2660
Email: gayathrees@dut.ac.za

22/09/2022

To whom it may concern:

This letter serves to confirm that I have edited the language and grammar of the thesis titled "Perceived Intelligence and Pedagogy: How Teachers' Perceptions Influence Teaching" by Shreya Singh (UKZN student number: 218059008).

Yours faithfully,

Gayathree Singh

MAppLing (USQ); MSc (GISc)(MMU, UK); PgD (GISc)(MMU, UK); GradCert (TSL)(USQ); CELTA (CAMBRIDGE, UK); NHD (Survey)(MLST, SA); Cert ((I&O Pysch)(UNISA)