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DATA-DRIVEN MATHEMATICS INSTRUCTION: A CASE STUDY OF SENIOR PHASE TEACHERS IN GAUTENG, SOUTH AFRICA

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ABSTRACT

Data-driven instructional practice in mathematics classrooms has gained considerable influence in education in South Africa and internationally; however, there is limited knowledge of how teachers use data to inform their instructional practices. This qualitative case study examined data use practices among five senior-phase mathematics teachers in the Gauteng Province, South Africa, through semi-structured interviews and classroom observations. Guided by the Theory of Action, the study reveals that while teachers recognise the importance of data and claim to use a variety of sources, including formal assessments, classroom observations, and learner background information, classroom observations showed significant challenges in translating data into instructional changes. Notably, all teachers used unmodified lesson plans provided by the district despite learner data indicating different needs, suggesting limited professional autonomy in data-driven planning. Findings reveal limited implementation of adaptive instruction, minimal evidence of purposeful teaching aligned with learner data, and variable quality in feedback practices. Barriers include inadequate data literacy, limited professional development, a lack of collaborative data discussion, insufficient guidance in CAPS documentation, and standardised lesson plans that constrain teacher agency. The study recommends comprehensive teacher training in data literacy, revising CAPS documents to include explicit guidance on data use, enhancing the preparation of pre-service teachers, and fostering collaborative environments that support data-driven instructional practices. Critically, it also recommends greater teacher autonomy in instructional planning to enable authentic data-driven practice.

KEYWORDS: CAPS curriculum, data-driven instruction, data literacy, mathematics education, South Africa.

1. INTRODUCTION

Mathematics teachers in South Africa, like teachers worldwide, are expected to utilise data to enhance instruction and support learner success (DBE, 2019; Spaull & Taylor, 2022). This expectation is reflected in the educational policy, theoretical frameworks, and professional standards, such as the South African Department of Basic Education's assessment guidelines, as well as Shulman (1986) construct of pedagogical content knowledge, if descriptions do not explicitly use the term' data,' they at least include knowledge and the use of assessments to improve learners' learning (Kanjee & Moloi, 2014; Schildkamp & Lai, 2013). The South African policy context emphasises this assumption. The Curriculum and Assessment Policy Statement (CAPS) emphasises the importance of assessment in teaching and learning, requiring teachers to utilize both formative and summative assessments to monitor and support teaching and learning, as well as to identify learners who require assistance (DBE, 2019). Data-driven instructional practices, therefore, refer to teaching methods that teachers implement specifically based on data they gather from their learners and their knowledge of teaching, to effectively educate them (Wayman et al., 2017). As part of their profession, teachers should collect data and make informed decisions based on that data.

However, the assumption that teachers will automatically participate in data-driven teaching is problematic, especially in South Africa. The country's education system remains surrounded by substantial imbalances resulting from apartheid-era practices. Despite nearly three decades of democratic government, there are still major disparities in educational resources, teacher training, learner results, and school operations between historically segregated communities. South African pupils generally score poorly on international assessments, such as the Trends in International Mathematics and Science Study (TIMSS). According to the 2019 data, South African Grade 9 pupils ranked the lowest in mathematics of the participating middle-income countries (Reddy et al., 2020). These challenges raise fundamental questions about teachers' ability to use data for instructional practices. One question that can be asked is whether South African teachers possess the necessary training to interpret data. Furthermore, one could also wonder if the classroom sizes, limited resources, high-stakes accountability, and prescribed curricula enable or constrain data use in South African schools.

Mathematics teachers, specifically, are expected to help learners collect, analyse, and draw conclusions from data. Consequently, one might think they have an advantage over teachers in other disciplines. Included in the Mathematics Curriculum Assessment Policy (CAPS) document for Grades 7-9, South African mathematics teachers are expected to teach learners Data Handling, where learners collect, organise, analyse, and interpret data, and draw conclusions from the data (DBE, 2011). Since mathematics teachers guide learners in data analysis processes, they are expected to apply data analytical thinking to their own instructional practices. However, this assumption deserves scrutiny. Teaching learners how to compute mean, median, and mode from a dataset differs significantly from utilising assessment data to diagnose misunderstandings, identify gaps, or differentiate learning experiences. The former refers to content knowledge, whereas the latter involves pedagogical reasoning. While mathematics teachers may be more comfortable with numerical data than colleagues in other subjects, this comfort does not necessarily translate into the complex interpretive work required for data-driven instruction, such as understanding the reason behind learners' underperformance, what prior knowledge they lack, and which instructional approaches might be suitable to address specific barriers.

Much of the research on teacher data use (Kanjee, 2020; Mandinach & Gummer, 2016; Mandinach & Schildkamp, 2021; Schildkamp & Lai, 2013; Wiliam, 2011; Young, 2017) is not subject-specific and typically focuses on the primary or secondary levels. There is currently little evidence specifically on the use of data by senior phase mathematics teachers teaching Grades 7-9 in South African schools in their teaching practice. It is critical to investigate whether teachers systematically collect and analyse data. Do teachers leverage data for instructional practices or merely report on learner performance? What kind of data do they find most imperative? Given the persistence of mathematics underachievement by South African learners and the CAPS curriculum's explicit expectations that teachers use assessment data formatively, these questions are particularly urgent.

This study, which utilised data collected from mathematics teachers in Gauteng Province, South Africa, through semi-structured interviews and classroom observations, begins to fill this gap. The purpose of this study was to examine how senior phase mathematics teachers in the Gauteng North District, South Africa, use learner performance data to inform and shape their instructional practices.

LITERATURE REVIEW

2.1. Policy Expectations and the Promise of Data-Driven Instruction

Internationally and within South Africa, data-driven instruction is positioned as a central mechanism for improving teaching quality and learner achievement. Educational policies, professional standards, and theoretical frameworks consistently emphasise the systematic use of learner performance data to inform instructional decisions (Mandinach & Gummer, 2016; Schildkamp et al., 2020). In the South African context, CAPS explicitly mandates the use of formative and summative assessment data to monitor learner progress and provide instructional support (DBE, 2019). This policy emphasis aligns with broader conceptions of teacher professionalism, such as Shulman's pedagogical content knowledge, which implicitly foregrounds teachers' capacity to interpret learner understanding and adapt instruction accordingly. However, while policy frameworks assume that teachers will naturally engage in data-informed practices, the literature suggests that this assumption oversimplifies the complexity of instructional decision-making, particularly in contexts characterised by systemic inequality and resource constraints.

2.2. Teachers' Data Use: Perceived Value Versus Classroom Practice

A consistent theme in the literature is the gap between teachers' stated appreciation of data use and their actual classroom practices. Several studies report that teachers recognise the importance of data for improving learner outcomes but struggle to integrate it meaningfully into instruction (Remesal, 2011; Datnow & Hubbard, 2016). In mathematics education specifically, Cowie and Cooper (2017) found that teachers often perceived data-driven instruction as burdensome and misaligned with their pedagogical beliefs, particularly when data use was associated with accountability rather than learning. In contrast, other studies suggest that teachers' limited use of data stems not from resistance but from inadequate training, time constraints, and weak institutional support (Kanjee & Moloi, 2014; Schildkamp et al., 2020). These divergent findings point to a critical tension in the literature: whether teachers' limited data use reflects attitudinal barriers or systemic and organisational constraints.

2.3. Mathematics Teachers and the Assumption of Data Expertise

The literature frequently assumes that mathematics teachers possess an inherent advantage in data use due to their familiarity with numerical information. This assumption is reinforced in the South African curriculum, where mathematics teachers are required to teach data handling, including data collection, analysis, and interpretation (DBE, 2011). However, empirical evidence challenges this position by demonstrating that proficiency in mathematical data content does not automatically translate into pedagogical data literacy (Mandinach & Schildkamp, 2021). Teaching learners to calculate statistical measures differs fundamentally from using assessment data to diagnose misconceptions, identify learning gaps, and design responsive instruction. Studies indicate that while mathematics teachers may be comfortable with test scores and percentages, they often struggle with the interpretive and inferential demands of instructional data use, particularly when learners' errors are conceptually rooted (Venkat & Spaull, 2015). This distinction underscores the need to reconceptualise data use in mathematics education as a pedagogical rather than purely technical competence.

2.4. Structural and Contextual Constraints on Data Use

A substantial body of research highlights the influence of structural conditions on teachers' capacity to engage in meaningful data use. In South Africa, curriculum overload, large class sizes, and high teaching workloads significantly limit opportunities for analysing learner data and reflecting on instructional practices (Pournara et al., 2015; Taylor, 2016). Teachers often prioritise curriculum coverage over diagnostic engagement with learner work, even when assessment data indicate persistent learning gaps (Graven & Buytenhuys, 2011). Similar patterns are evident internationally, where accountability pressures and time constraints encourage surface-level data use focused on reporting rather than instructional improvement (Anderson & Kumari, 2009). These findings suggest that data-driven instruction cannot be understood solely as an individual teacher skill but must be situated within broader organisational and systemic conditions that either enable or constrain instructional agency.

2.6. Data Literacy and Professional Learning

Research consistently identifies data literacy as a prerequisite for effective data-driven instruction, yet it also emphasises that data literacy develops most effectively through collaborative professional learning rather than individual effort. Studies on professional learning communities demonstrate that teachers' ability to interpret data and translate it into instructional action improves when they engage in collective inquiry, shared reflection, and peer support (Henderson & Corry, 2021; Jita & Mokhele, 2014). In contrast, teachers working in isolation often struggle to move beyond basic data recording to deeper analytical practices (White & Anderson, 2011). These findings highlight the importance of school culture, leadership, and organisational structures in shaping how data is used, reinforcing the view that data-driven instruction is a socially mediated practice rather than a purely technical process.

2.7. Instructional Implications and Conceptual Tensions in Mathematics Education

While data-driven instruction is widely promoted as a means of improving learning outcomes, the literature also raises important conceptual concerns, particularly in mathematics education. Boaler (2016) cautions that an overreliance on easily quantifiable performance data may narrow instructional focus, privileging procedural fluency over conceptual understanding and problem-solving. This critique exposes a fundamental tension in data-driven instruction: the data most readily available to teachers, such as test scores and item-level results, may not capture the depth of mathematical reasoning that contemporary curricula seek to develop. Without careful consideration of what data are collected and how they are interpreted, data use risks reinforcing reductive teaching practices rather than supporting meaningful mathematical learning.

2.8. Implications for Research in the South African Senior Phase

Despite growing international scholarship on data use in education, there remains limited empirical research focusing specifically on senior phase mathematics teachers in South Africa. Existing studies tend to prioritise assessment systems, accountability, or primary schooling, offering limited insight into how Grade 7–9 mathematics teachers interpret learner performance data and enact instructional responses in everyday classroom practice (Kanjee, 2020). Moreover, few studies triangulate teachers' reported data use with classroom observations, leaving a gap between espoused beliefs and enacted instruction. Addressing these gaps is particularly urgent given persistent mathematics underachievement and the explicit expectations of formative data use embedded in CAPS. By examining how senior phase mathematics teachers in the Gauteng North District engage with learner performance data, the present study responds directly to these limitations and contributes contextually grounded insights into data-driven instructional practices in South African mathematics classrooms.

Consequently, the main question guiding this study is:

How do senior phase mathematics teachers in the Gauteng North District of South Africa use learner performance data to inform their instructional practices?

Sub-Research Questions:

1. What data do senior phase mathematics teachers use to inform their instructional practices?
2. What specific instructional strategies do senior phase mathematics teachers implement based on learner performance data, and how do they tailor them to meet diverse classroom needs?

3. THEORETICAL FRAMEWORK

This study is anchored in Argyris's (1997) Theory of Action, which provides a robust framework for understanding how teachers use learner performance data to inform instructional decision-making. The theory of action explains how individuals' beliefs, assumptions, and prior experiences shape their actions and how these actions, in turn, influence outcomes. Within educational contexts, the theory emphasises intentional, reflective, and evidence-informed practice, making it particularly suitable for examining data-driven instructional practices in mathematics classrooms.

The theory of action has its roots in Lewin's (1946) action research, which conceptualised change as a cyclical process of planning, action, and reflection. This approach was later adapted for educational research by Corey (1949) and further refined by Argyris (1957, 1997) into a framework that explicitly links professional actions to intended outcomes. Subsequent theoretical contributions by Vygotsky (1978) and Engeström (1987) extended this perspective by situating learning and decision-making within social and cultural contexts. As such, the theory of action conceptualises teaching as a social, collaborative, and reflective process in which practitioners collectively identify problems, implement solutions, and evaluate their effectiveness

(Kentzer et al., 2019).

Within this framework, teachers engage in a systematic process of identifying instructional challenges through evidence, designing informed interventions, implementing these interventions, and monitoring their impact on learner achievement (Argyris, 1997). This cyclical process aligns closely with data-driven instruction, where learner performance data serve as the primary evidence base for instructional planning and adjustment. Hopkins (2014) highlights that the theory of action explicitly links teachers' instructional actions to learner outcomes, reinforcing the central role of formative assessment in improving teaching quality.

In mathematics classrooms, this process involves teachers using formative and summative assessment data to clarify learning goals, pose higher-order questions, provide targeted feedback, and establish supportive learning relationships (Hopkins, 2013; Walker & Loots, 2018). Through continuous data analysis, teachers can identify learning gaps, determine the need for differentiation, and tailor instructional strategies to meet the diverse needs of learners (van Geel et al., 2017). Moss and Brookhart (2012) further emphasise that the learning target theory of action supports teachers in planning, monitoring, and evaluating instruction by aligning assessment evidence with instructional intentions.

Importantly, the theory of action recognises that teachers do not operate in isolation. Teachers enter the profession with established beliefs, prior experiences, and pedagogical knowledge, all of which influence how they interpret learner performance data and select instructional responses (Kentzer et al., 2019). These internal theories-in-use shape how data are understood and enacted in practice, making the framework particularly useful for exploring variability in teachers' data use.

In this study, the theory of action provides an analytical lens for examining how senior phase mathematics teachers in the Gauteng North District use learner performance data to inform their instructional practices. Specifically, the framework guides the investigation of the types of learner performance data teachers collect and use, including formal assessments, informal classroom assessments, learner work, and diagnostic tools. This directly addresses Sub-Research Question 1 by situating data use as the starting point of the action cycle. How teachers interpret learner performance data and translate it into instructional actions, such as reteaching, differentiation, use of alternative representations, or targeted learner support. This aligns with Sub-Research Question 2 by examining the connection between data interpretation and the selection of instructional strategies.

4. METHODOLOGY

4.1. Research Approach

This study adopted a qualitative case study research approach to explore how senior-phase mathematics teachers use learner performance data to inform their instructional practices. Qualitative research prioritises depth of understanding and the meanings participants attribute to their experiences rather than numerical generalisation (Creswell & Creswell, 2018). This approach is particularly appropriate for investigating complex instructional processes, as it allows participants to articulate their perspectives, interpretations, and contextual realities (Creswell & Poth, 2016).

Consistent with Merriam's (2002) view that qualitative inquiry seeks to understand how individuals construct meaning from their experiences, this study focused on teachers' interpretations and enactments of data use in mathematics classrooms. Data were generated through semi-structured interviews and classroom observations, enabling the collection of complementary data on teachers' data literacy, interpretive practices, and instructional responses. The integration of multiple data sources strengthened the depth and credibility of the findings.

4.2. Selection of Participants

Purposive sampling was employed to select mathematics teachers from five public schools in the Gauteng Province, South Africa. Purposive sampling is appropriate in qualitative research when participants are deliberately selected based on their relevance to the research phenomenon and their capacity to provide rich, information-dense data (Patton, 1990). In this study, participants were required to be senior-phase mathematics teachers to ensure familiarity with the Curriculum and Assessment Policy Statement (CAPS) and recent curriculum and assessment reforms.

The participating teachers represented a range of teaching experiences, providing diverse perspectives on data use practices. Participation was voluntary, and informed consent was obtained after the purpose and procedures of the study were clearly explained to the participants. To protect participants' identities, school names were withheld, and pseudonyms were used in all reporting, in accordance with the Protection of Personal Information Act No. 4 of 2013 (Adams et al., 2021). The selection of schools was both purposive and convenient, facilitating access while remaining aligned with the study's objectives. The relatively small sample size reflects the qualitative nature of the study, as well as time and scope constraints, and is consistent with the aim of achieving depth rather than breadth of understanding.

Ethical clearance was obtained from the University of the Free State Faculty of Education Research Ethics Committee prior to data collection (Reference No. UFS-HSD2024/2082). Permission was also secured from the Gauteng Department of Education and the participating schools. Participants received written information outlining the study's aims, ethical safeguards, and their rights, including the right to withdraw without penalty. Audio recordings of interviews were stored securely and were accessible only to the researchers.

4.3. Data Collection

Data were collected through semi-structured interviews and classroom observations. Semi-structured interviews were used to elicit teachers' experiences, reflections, and perspectives regarding the use of learner performance data for instructional decision-making. This method allows for flexibility while ensuring alignment with the research questions and encourages participants to elaborate on their experiences in depth (Roulston & Choi, 2018).

Interviews were conducted with five senior-phase mathematics teachers in a quiet meeting room at their respective schools to ensure confidentiality and comfort. Each interview lasted approximately 15-20 minutes and was facilitated by the lead researcher, who acted as a neutral moderator. Interviews were conducted primarily in English, with occasional code-switching to IsiZulu and Sepedi to enhance clarity and promote authentic expression. With participants' consent, all interviews were audio-recorded and transcribed verbatim.

Following the interviews, each participating teacher was observed twice while teaching different mathematics topics, resulting in a total of ten lesson observations. Observations were conducted during regular school hours and aimed to capture how learner performance data were enacted in instructional practices. An observation protocol (Appendix I), grounded in the Theory of Action, guided the observations. Four dimensions of data-driven instruction were examined: adaptive instruction, purposeful teaching, feedback provision, and the scheduling of learning time.

All lessons were video recorded to ensure accurate documentation and to allow repeated viewing during analysis. Contextual information, including grade level, class size, and lesson duration, was recorded for each observation. Observation data were deductively coded using predetermined categories derived from the observation rubric, enabling systematic comparison across teachers and the identification of patterns in data-driven instructional practices.

4.4. Data Analysis

Data analysis commenced with the verbatim transcription of interview recordings using Microsoft Word, followed by a cross-check against the original audio files to ensure accuracy. A combined deductive–inductive analytical approach was employed. Deductive coding was informed by the Theory of Action, while inductive coding allowed for the emergence of unanticipated themes from the data.

Video-recorded lesson observations were analysed using Braun and Clarke's (2019) six-phase thematic analysis process: familiarisation with the data, initial coding, theme development, theme review, theme definition, and reporting. Analytical categories included the use of assessment data in lesson planning, instructional adjustments, differentiation strategies, feedback to learners, monitoring of learner understanding, and pacing and time allocation. This approach, supported by Soiferman (2010) and Stemler (2000), enabled a comprehensive and systematic analysis of both interview and observational data.

To enhance trustworthiness, member checking was conducted by sharing preliminary findings with participants for verification of accuracy and interpretation. Coding was revisited at multiple stages to ensure consistency, and triangulation was achieved by comparing interview data with classroom observation evidence. Furthermore, two researchers independently coded a sample transcript and engaged in a discussion to resolve discrepancies and reach a consensus, thereby strengthening the analytic rigor and credibility.

4.5. Findings

This section presents the findings from the semi-structured interviews and classroom observations conducted with senior phase mathematics teachers. The findings are organised explicitly around the two sub-research questions guiding the study. First, the section examines the types of data that senior phase mathematics teachers use to inform their instructional practices. Second, it examines how teachers utilize learner performance data to inform instructional strategies in mathematics classrooms, with a particular focus on adaptive instruction, purposeful teaching, feedback practices, and the allocation of learning time. To contextualise these findings, the section begins with a brief overview of the participating teachers' profiles.

1. Teachers' Profiles

Table 1 summarises the demographic characteristics of the participating senior phase mathematics teachers, including their teaching experience, grades taught, professional roles, and highest educational qualifications. This contextual information is important for interpreting variations in teachers' data use and instructional practices reported in subsequent sections

Table 1: Demographic Information of Participants.

Participant Code (Pseudonym)	Role/Position	Teaching Experience (Years)	Grade(s) Taught	Subject Area	Additional Role/Responsibility	Highest Education
T1	Departmental Head (DH) (Mathematics)	18	Grade 8 & 9	Mathematics	Supervises mathematics teachers	B.Ed Hons
T2	Senior Mathematics Teacher	15	Grade 9	Mathematics	Mentor to novice teachers	National Diploma
T3	Experienced Mathematics Teacher	12	Grade 8	Mathematics	None	Degree
T4	Mathematics Teacher	10	Grade 9	Mathematics	None	Degree
T5	Novice Mathematics Teacher	5	Grade 8	Mathematics	None	Degree

T5

Novice Mathematics Teacher 5 Grade 8Mathematics None Degree

Note. Pseudonyms are used to maintain confidentiality.

As shown in Table 1, the sample included teachers with a wide range of teaching experience (5–18 years), representing novice, mid-career, and highly experienced practitioners. Participants also differed in professional roles, with one teacher serving as a departmental head and another as a mentor to novice teachers. This diversity provided a useful lens for examining how teachers at different career stages and leadership positions engage with learner performance data.

2. What data do teachers use

Addressing the first sub-research question, "What data do senior phase mathematics teachers use to inform their instructional practices?" the findings reveal that teachers draw from a diverse, rich array of data that extends beyond standardized assessments. Table 2 shows that teachers claim to use data more often, particularly formal assessment data, classroom observations, and background information on learners (for example, home situations).

Table 2: Data Types Used by Teachers.

Data Type	T1	T2	T3	T4	T5	Total Users	Pattern Observed
Formal Assessment Data		✓		✓	✓	3/5 (60%)	Mid-career and novice teachers explicitly mentioned
District diagnostic tests		✓				1/5	Senior teacher uses at term beginning
Common tests analysis				✓		1/5	Used for comparison with other classes
Previous year's results					✓	1/5	Novice teacher uses as a starting point
Continuous assessments					✓	1/5	Ongoing throughout the term
Classroom Observation Data	✓		✓	✓		3/5 (60%)	Mix of experience levels
Group work observation	✓					1/5	DH identifies misconceptions
Written work analysis			✓			1/5	Mid-career teacher
Oral responses			✓			1/5	Mid-career teacher
Informal observations/rough work				✓		1/5	Mid-career teacher observes thinking
Learner Background Information	✓			✓	✓	3/5 (60%)	Leadership and newer teachers
Parent communication (WhatsApp)	✓					1/5	DH uses for home situation data
Learner Support Agent data				✓		1/5	Mid-career teacher
Community context understanding					✓	1/5	Novice teacher considers challenges

As illustrated in Table 2, teachers reported using multiple forms of data to inform their instructional practices, with formal assessment data, classroom observation data, and learner background information each cited by 60% of participants. While formal assessment data were commonly referenced, the table also highlights the use of more informal and contextual data sources, such as observations of learner work and information about learners' home and community contexts. These patterns suggest that teachers' data use extends beyond standardised assessments, although the frequency and depth of use vary across individuals.

During the semi-structured interviews, three themes emerged: Formal assessment data, classroom observations, and learner background data.

4.6. Formal Assessment Data

Most teachers reported using formal assessment data to inform their instructional practices. Teachers recognise the value of learner data and use it to inform their instructions. Teachers showed a dependency on externally provided assessments, and the district's data analysis influenced their instructional practices. The findings also indicate a rapid growth in the data use culture in schools; however, teachers differ in their confidence and depth of engagement with data.

Below are some teachers' articulations:

"At the beginning of each term, we use diagnostic tests sent by the district, it helps us to identify gaps." T2

"I look at the common tests analysis from the district. That shows me if my class is on par with others or if we're behind. It's eye-opening sometimes." T4

"I use previous year's results too, especially when I get a new class. It gives me a starting point. And then continuous assessments throughout the term" T5

4.7. Classroom observations

Another type of data that arises from the semi-structured interviews is that teachers use to inform their instructional practices in classroom observations. When teachers were asked how they identify learners who are struggling during their lessons, these were some of the responses:

"Group work! That's where you see who understands and who's looking at other people's work. Learners explain to each other, and you can hear their misconceptions right there." T1

"For me, it's written work and oral responses during lessons." T3

"I'd say informal observations during lessons. When I'm walking around while they're working, I see their thinking process. Their rough work tells stories"T4

These findings indicate that informal and classroom-based data play a crucial role in identifying learners who are struggling during a lesson.

4.8 Learners background information

During semi-structured interviews, teachers were asked how they get access to learners' background data: these were teachers' articulations:

"WhatsApp groups with parents share concerns and get information about home situations. It's basic but powerful data about what's affecting learning." T1

"I use the data from the Learner Support Agent (LSA) to understand my learners, which also helps me change the way I teach." T4

"I believe also that we must understand the community where our learners come from. Many of our learner's face challenges our instructional decisions must account for this. It's not just about mathematics." T5

These findings illustrate that learners' background data is important in informing teachers' instructional decision-making.

3. Mathematics teachers' data-driven instructional practices

Addressing the second research question, "what specific instructional strategies do senior phase mathematics teachers implement based on the use of learners' performance data, and how do they tailor them to meet diverse classroom needs?", the analysis of classroom observations reveals that mathematics teachers face challenges in improving their instructional practices. During the observation session, we observed four aspects: adaptive instruction, purposeful teaching, providing feedback, and scheduling of learning time.

4.8. Adaptive instruction

Adaptive teaching is an instructional approach that clearly recognizes differences among learners (Grecu, 2023). During observation, teachers T1 and T4 demonstrated strong adaptive practices in their mathematics classroom lessons. We observe T1 teaching grade 8 Algebraic Expressions. A mental mathematics test was administered, and feedback was given back to learners. From the mental mathematics, the teacher was able to see which learners were lagging. T1 grouped learners who are struggling with those who performed well in the mental maths. During the administration of a formative assessment, struggling learners worked in collaboration with high-performing learners. T4, on the other hand, who was also teaching the same topic as T1, after observing that learners did not perform well in the classwork, adjusted the task's difficulty by providing learners with an expanded opportunity from a grade 7 textbook. T1 and T4 lessons demonstrated intentional scaffolding, with additional support provided to struggling learners and peer teaching among learners.

Below is a narrative vignette from T1 lesson on Algebraic Expressions in Grade 8

After administering a mental maths test to a Grade 8 class, T1 grouped the learners. The teacher grouped those who struggled to expand algebraic expressions with those who did well in the test.

"Class, I am going to mix things up today. I will group you in groups of 3."

"Themba, I noticed that you got all ten questions correct. I will really appreciate it if you could work with Njabulo and Thando. Njabulo and Thando, please do not be afraid to ask questions; that is how we learn.

Throughout the lesson, T1 observed all the groups and watched as learners participated, smiling as they were able to solve problems they had previously struggled with.

On the other hand, a lesson from T5 revealed a uniform instruction. T5 taught algebraic expressions in a Grade 8 class.

T5 asked learners to open their DBE workbook to the same page. T5 explained how to determine the numerical value of algebraic expressions by substitution once, clearly, and thoroughly.

"You have 15 minutes to complete the task."

T5 sits and occasionally looks up to ensure that learners are working on their tasks. Some learners manage to complete their work on time. Others are still working on the problem when T5 stands and starts corrections.

"Let's do corrections, we are all done, right? So, let's all look at the chalkboard and do corrections."

T5 worked on the corrections with the same learners, while the struggling learners copied the solutions. Their misunderstanding was unaddressed and buried under a layer of correct answers they don't comprehend.

In contrast, T2, T3, and T5, whose lessons on Algebraic expressions were also in different grades, showed limited adaptive instruction. While T2 offered individual support during an administration of classwork, it was limited to learners who were engaged in the lesson and seemed to understand what was needed from the task. The task seemed challenging, and the teacher did not reduce its difficulty. T3 and T5 used the DBE workbook to administer the formative assessment. Their lesson had the same pacing for all the learners; some learners seemed not to have finished working on a task. However, the teacher proceeded with making corrections and assigned homework for learners to complete at home. These findings indicate significant variability in teachers' ability to translate learner performance data into adaptive instruction.

4.9. Purposeful Teaching

Purposeful teaching is an instructional planning that aligns with learners' data (Malin, 2021). The purposeful teaching was not observed in the teachers' lesson planning. Lesson objectives observed from teachers' lesson plans did not align with learners' performance gaps. All the teachers observed used the lesson plans and a tracker obtained from the district, and none of them modified those plans. These documents, lesson plans (Figure 3), and trackers (Figure 2) had objectives that did not align with learner data. These patterns suggest that purposeful, data-driven planning can be done at the school level by a teacher.

A	B	C	D	F	G	H	I	J	K	L
Gr8 ATP Term 3 (with Curriculum Coverage Calculator)										
Date	Lesson	Grade 8 ATP with Curriculum Coverage (Term 3)	Tick	Actual Curriculum Coverage	Expected Coverage	DBE workbook Pages	Sasol Inzalo Pages	Prescribed Textbook/Any Other Resource	Mental Maths; Class Activities; Homework Activities	Progress
WEEK 1										
FORMAL ASSESSEMENT TASK: PROJECTN.B The project must cover a combination of topics from Term 1 to Term 3 and must be completed before the end of Term 3.										
		ALGEBRAIC EXPRESSIONS 09 - 12 July 2025(3 Mental Maths Activities; 3 Classwork Activities, 2 Homework Activities and 1 Informal Test)								
09/07/2025	1	Baseline Assement : (Siyavula online/ DBE Workbook Revision Section/Own Test)								
		Expand and simplify algebraic expressions								
		Use commutative, associative and distributive laws for rational numbers and laws o exponents to:								
10/07/2025	2	• Add and subtract like terms in algebraic expressions	☐		0,7	Work book 1: Pages 66-69	Book 1: pages 145-164			
11 - 12/07/2025	3 & 4	• Multiply integers and monomials by:				Workbook 1: Pages 88-89	Book 1: pages 145-164			
		– monomials	☐		1,4					
		– binomials	☐		2,1					
		– trinomials	☐		2,8					

Figure 2: Example of a tracker used by (T1, T3, and T5).

Figure 2 presents a Grade 8 ATP (Annual Teaching Plan) Term 3 tracker that includes a curriculum coverage calculator for monitoring lesson progress. The document shows how teachers should pace their teaching. It shows them how many activities should be completed in a week, which textbooks they should use to source those activities. Figure 3 shows a Grade 8 mathematics lesson plan from Gauteng Province that focuses on algebraic expressions, specifically expanding and simplifying them. The one-hour lesson aims to teach learners to multiply integers with monomials, binomials, and trinomials using various laws. It includes sections for homework review, prior knowledge assessment, and a mental math warm-up where learners write equivalent expressions for given algebraic terms. Teachers are expected to implement these plans as written.

Gauteng Province
Grade 8 Lesson Plan 2
Term 3

1. TOPIC: Algebraic expressions: (Lesson 2)

2. DATE: **DURATION: 1 Hour**

3. OBJECTIVES: By the end of the lesson learners should know and be able to:

Expand and simplify algebraic expressions:

- Use commutative, associative and distributive laws for rational numbers and laws of exponents to Multiply integers and monomials by:
  - Monomials
  - Binomials
  - Trinomials
- Simplify algebraic expressions involving the above operations.

4. RESOURCES: DBE workbook Bk 1 and 2) ; Sasol Inzalo ,Siyavula online practice, School textbook

5. REVIEW AND CORRECTION OF HOMEWORK (suggested time:5 minutes)

Marking of previous homework and reviewing concepts taught in previous lesson.

6. PRIOR KNOWLEDGE:

- laws of exponents
- commutative, associative and distributive properties
- like and unlike terms
- addition and subtraction of like terms

7. MENTAL MATHS: (Suggested time:5 minutes)

Write an equivalent expression for each of the following algebraic expressions.

Algebraic Expression	Equivalent Expression
$4m + 7m - 5m - m$	
$9ab - 3c + 8ba + c$	
$7f + f + f - 3$	
$3y^2 - y^2$	
$2y^2 - 3xy^2 + 4xy^2$	

Figure 3: Example of a lesson plan from the district observed from T1,T3 and T5.

4.10. Providing feedback

All teachers observed provided immediate, corrective feedback; however, the depth and quality of the feedback were different. Feedback is defined as information about the gap between what learners have mastered (learning outcomes) and what they should have mastered (objectives and standards). Feedback should lead to interventions aimed at reducing this divide, thereby improving learning outcomes (Boud & Dawson, 2023). In addition, feedback can be a powerful tool to improve learners' achievement. T1 and T4 provided the most vigorous feedback practices. During corrections, learners were asked to explain how they arrived at their answers and then had to demonstrate it on the board. T1 further used learners' errors for teachable moments. During corrections, learners were asked to reflect on the task and correct their own work.

T4 lesson on Geometry 2D shapes in Grade 9:

“Thabo, please help with the corrections for our classwork?”

Thabo approached the board, chalk trembling slightly in his hand. Thabo drew a kite and drew lines that indicated that a kite has 2 pairs of adjacent sides equal.

“Walk us through your thinking, Thabo. What is the name of that 2D shape you drew, and what do you mean by those dashes you drew on a shape?”

“Ma'am, this is a kite, a kite has 2 pairs of adjacent sides,” Thabo explained to the class.

“Is that all, Thabo? I think you forgot something.”

Thabo looked confused. “Ma'am, maybe you can help me.”

Thabo sat down and smiled.

“Ok, thank you, Thabo. Now, class, Thabo forgot to mention something. Who can help him?”

Three hands shot up. The error had become a bridge to deeper understanding

On the other hand, T2 provided sufficient feedback, although the learners' reflection was limited. T3 and T5 demonstrated weaker feedback strategies; during corrections, learners' reasoning was not probed, and self-evaluation was not encouraged. The findings indicate that reflective and exploratory feedback is less consistently practiced in mathematics classrooms.

4.11. Scheduling of learning time

Time has a significant impact on learning outcomes (Wedel, 2021). During classroom observations, T1 consistently allocated instructional time to concepts identified as areas of learner weaknesses. The lesson was flexible and adjusted in real-time according to learner responses. T4 attempted to extend the time for discussing challenging topics; however, the allocated time was insufficient. For T2, T3, and T5, there was no evidence of time allocation based on learners' difficulties, which may be attributed to the limited instructional time.

T4 was observed teaching a Grade 9 lesson on Geometry 2D shapes:

"Five more minutes on your classwork,". T4 announced that while watching, learners struggled to calculate the size of the unknown angles and provide reasons. Learners needed more time. However, time seemed to have run out.

"Ok! Looks like you still need more time. I will give you 10 minutes." T4 moved between desks, offering hints, redirecting misconceptions. Learners seemed less stressed.

But when the ten minutes had elapsed, half the class still looked uncertain. "Ok, I see you are still not done. Please complete extra practices on page 89 at home. We will do corrections first thing tomorrow morning."

4.12. Discussions

This study examined how senior-phase mathematics teachers in Gauteng use learner performance data to inform instructional practices. While teachers acknowledged the importance of data and reported using multiple sources, including formal assessments, classroom observations, and learner background information, the findings reveal a persistent gap between espoused beliefs and enacted practices. Consistent with prior research (Datnow & Hubbard, 2016; Schildkamp, 2019), data use was largely superficial, with limited evidence of systematic integration into lesson planning or instructional adaptation.

Teachers predominantly relied on formal assessment data, often from district-provided diagnostic tests and common examinations. Although these data informed broad judgments about learner performance, they rarely translated into differentiated instruction or targeted remediation. This pattern reflects international concerns that test-based data, while useful for accountability, offer insufficient diagnostic insight for instructional improvement (Young & Kim, 2010; Zhao et al., 2016).

Classroom observations and informal learner interactions, arguably the most actionable sources of formative data, were underutilised. When employed, these practices were inconsistent and lacked structured follow-up. Teachers who demonstrated adaptive instruction (e.g., grouping learners by performance, adjusting task difficulty) did so intuitively rather than through systematic data analysis. This finding underscores the conceptual distinction between possessing data and exercising data literacy, as highlighted by Mandinach and Gummer (2016).

Purposeful teaching was notably absent. All observed teachers implemented district-mandated lesson plans and trackers without modification, even when learner data indicated significant gaps. This reliance on standardised planning tools constrains teacher agency and limits responsiveness to learner needs, echoing concerns raised by Kanjee and Moloi (2014) regarding structural barriers to data-driven decision-making in South Africa.

Feedback practices varied considerably. While some teachers leveraged learner errors as teachable moments and encouraged reflection, others provided corrective feedback without probing reasoning or fostering self-assessment. Research suggests that the quality of feedback is critical for learning gains (Boud & Dawson, 2023); however, observed practices indicate that feedback remains procedural rather than dialogic.

Finally, time allocation emerged as a systemic constraint. Teachers rarely adjusted pacing based on learner difficulties, prioritising curriculum coverage over conceptual understanding. This finding aligns with evidence that rigid pacing guides and accountability pressures undermine adaptive instruction (Pournara et al., 2015; Taylor, 2016).

Overall, the study highlights a paradox: teachers value data but lack the capacity, autonomy, and institutional support to use it meaningfully. Data-driven instruction, therefore, cannot be reduced to access to data; it requires robust data literacy, collaborative professional learning, and structural flexibility. Without these conditions, the promise of data-driven decision-making risks remaining aspirational rather than transformative.

5. CONCLUSION

This qualitative study has shed light on the significant challenges that mathematics teachers face in leveraging data for instructional practices when teaching different topics as mandated by the CAPS curriculum in South Africa. Despite the policy's aim to make education more inclusive and improve learner achievement, the current study's findings indicate that inadequate training, lack of collaboration, lack of data literacy, and limited time for leveraging data for instruction impede meaningful data use.

Insights gathered from the semi-structured interviews and detailed lesson observations have revealed a significant lack of data literacy among teachers. This lack of data literacy not only obstructs the smooth use of data in instruction but also prevents teachers from enriching their teaching with the depth and inclusivity that data-driven instructional practices can offer. Therefore, addressing these challenges and enhancing teachers' data literacy is crucial for improving learners' achievement in mathematics and fostering a more inclusive educational environment.

5.1. Implications of the Study

The findings of this study have significant implications for education policy, classroom practice, and future research related to data-driven instructional practices in senior-phase mathematics classrooms in South Africa.

5.2. Implications for education policy

At a policy level, the findings highlight the need for a stronger and more explicit alignment between curriculum policy expectations and practical guidance on data use. While CAPS mandates formative and summative assessment, it provides limited direction on how teachers should interpret learner performance data and translate it into instructional action. Revising the Mathematics CAPS and Annual Teaching Plans (ATPs) to include explicit, topic-specific guidance on data-driven decision-making, adaptive instruction, and differentiated teaching strategies would strengthen teachers' capacity to respond meaningfully to learner needs.

In addition, the widespread use of standardised district lesson plans, often implemented without modification, suggests that current policy structures may unintentionally constrain teacher agency. Policymakers should consider granting teachers greater professional autonomy to adapt lesson plans based on learner performance data, while still maintaining curriculum coherence and accountability. Such flexibility would better support authentic data-driven instruction rather than compliance-oriented data use. Finally, policy initiatives should prioritise systematic professional development in data literacy, not as isolated workshops but as sustained programmes embedded within district and school improvement strategies. This includes strengthening the role of School Management Teams (SMTs) in leading and supporting data-driven instructional practices at the school level.

5.3. Implications for classroom practice

For classroom practice, the study underscores the importance of moving beyond surface-level data use toward purposeful instructional responsiveness. Although teachers reported using multiple data sources, classroom observations revealed limited translation of data into adaptive instruction, purposeful lesson planning, and differentiated feedback. Teachers would benefit from targeted professional learning opportunities that focus on interpreting learner errors, diagnosing misconceptions, and using formative assessment evidence to adjust pacing, task difficulty, and instructional strategies. Collaborative professional practices also emerged as a critical need. Schools should foster structured opportunities for collaborative data discussions, such as professional learning communities (PLCs), where teachers jointly analyse learner work, reflect on instructional challenges, and share data-driven teaching strategies. Such collaboration can strengthen teachers' confidence, reduce feelings of isolation, and foster deeper engagement with data.

In addition, teacher education institutions and in-service training providers should emphasise pedagogical data literacy, distinguishing between mathematical content knowledge and the instructional use of assessment data. Strengthening teachers' capacity to use feedback dialogically, allocate time flexibly based on learner needs, and design responsive learning tasks is essential for improving learner outcomes in mathematics.

5.4. Implications for future research

The study also points to several directions for future research. Given the small-scale, qualitative design, further studies involving larger and more diverse samples across provinces would help establish broader patterns of data use among senior-phase mathematics teachers. Comparative studies across subjects could also shed light on whether the challenges identified are specific to mathematics or reflect systemic issues in data-driven instruction more generally. Future research should also explore the role of digital technologies and learning analytics in supporting data-driven instructional practices, particularly within the context of the Fourth Industrial Revolution (4IR). Investigating how digital assessment tools, dashboards, and learner tracking systems can enhance teachers' interpretive capacity and instructional responsiveness would be valuable. Ultimately, longitudinal research examining how sustained professional development in data literacy affects teachers' instructional practices and learner outcomes over time would provide valuable insights into how data-driven instruction can be meaningfully integrated into South African classrooms.

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APPENDIX 1

Classroom Observation Rubric
Teacher:
Class:
Number of learners:
Lesson duration:

Adaptive Instruction		
Indicator	Observation	Notes
1. Learners grouped based on prior performance/needs		
2. Tasks adjusted based on learner readiness		
3. Additional support or enrichment provided		
4. Pacing modified in response to learner understanding		

Purposeful Teaching		
Indicator	Observation	Notes
1. Lesson objectives align with learners perfomance gaps		
2. Teacher references prior assessment results		
3. Activities address learner misconceptions		
4. Questioning probes previously identified weaknesses		

Providing Feedback		
Indicator	Observation	Notes
1. Teacher gives specific, immediate feedback		
2. Feedback addresses misconceptions		

3. Learner errors used for re-teaching		
4. Learners encouraged to reflect and revise work		

Scheduling Learning Time		
Indicator	Observation	Notes
1. More time allocated to identified weak areas		
2. Teacher monitor time on task		
3. Activity sequence based on learner progress		
4. Lesson pacing adjusted based on difficulties		