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The experiences of teaching inference skills to three Grade 10 financial mathematics learners

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Education is a public good, it is delicate, it is fragile, but it is the best possible investment we can make.
—Audrey Azoulay, Director-General of UNESCO, 2022

Abstract
Despite decades of research conducted into literacy and numeracy skills there is a dearth of research outlining the combination of inference-making comprehension skills in mathematics. With South Africa's fragile economy and education in crisis it is vital that something is done to address these injustices. The purpose with this study was to address the reading comprehension and mathematics challenges in Grade 10. A conceptual framework was used to identify the core constructs to answer the research question: What are the experiences of teaching inference skills to 3 Grade 10 financial mathematics learners during a 10-week intervention programme (IP)? We focussed on 3 Grade 10 learners, LA, LB and LC, in financial mathematics (mathematical literacy) in an urban school in the Western Cape. A quasi-experimental study was employed utilising a case study design within an interpretivist paradigm. Data collection tools included interviews, observations, document analysis and pre- and post-tests which were used for both inductive and deductive data analysis. Evidence from the study show that the 10-week IP had a positive impact on the 3 learners' understanding of inference skills and their ability to think more critically about the financial mathematics problem sums (hereafter, problems). We conclude that if teachers intentionally set out to juxtapose literacy strategies with the teaching of mathematics it can improve learners' marks. We argue that the explicit teaching of inference comprehension strategies assisted 3 at-risk Grade 10 learners to develop critical thinking skills giving them a better understanding on how to solve Grade 10 financial literacy mathematics problems.

Keywords: case study; explicitly stated information; financial mathematics; inference skills; interpretivist study; intervention programme (IP); mathematical literacy; problem sums; quasi-experimental study; reading comprehension

Introduction
The purpose of juxtaposing literacy and numeracy is to build more inclusive, peaceful, just and sustainable societies, with the United Nations Educational Scientific and Cultural Organisation ([UNESCO], 2023) reporting that in 2020, 87% of people have learned to read and write. However, in an emerging economy such as South Africa, the fragility of our current literacy and numeracy rates abounds with new challenges of inequality and injustice.

Given that for the past 10 to 15 years, the Western Cape Education Department (WCED) has been involved in the national Systemic Tests in Language and Mathematics for Grades 3, 6 and 9 as well in the Progress in International Reading Literacy Study ([PIRLS], Howie, Combrinck, Roux, Tshele, Mokoena & McLeod Palane, 2017), it was not surprising that the 2023 WCED assessments for Grade 9 learners again yielded subpar results; 20.7% for mathematics and 20.5% for home language (see Table 1). These are the provincial average percentages achieved by all learners. The scores achieved by school X (pseudonym to retain the school's identity) in the WCED's systemic assessment of mathematics and home language indicate fluctuations in mathematics yet consistent improvements in home language.

Table 1 Scores of Grade 9 learners at School X in the WCED's systemic assessment (Thwala, 2024)

	2019		2021		2022	
	Mathematics	Home language	Mathematics	Home language	Mathematics	Home language
School X	19.3	68.1	23.2	81.1	20.1	77.3
Province	22.7	53.6	21.6	50.1	18.8	50.2

Despite decades of research conducted into literacy and numeracy skills there is a dearth of research outlining the combination of inference-making skills in mathematics. Hence, the purpose with this article is to

emphasise the multidimensional and complex challenges in South Africa's education system, particularly with regard to reading comprehension and mathematical proficiency, and what could be done to improve this dire situation.

Financial mathematics (mathematical literacy) plays a crucial role with a significant weight of 35% in the mathematical literacy and 15% in the mathematics curriculum for Grade 10 learners (Department of Basic Education [DBE], 2019). Classified as an application topic, financial mathematics, as defined by the DBE (2019:13), presents scenarios relevant to everyday life, the workplace, business environments and broader societal, national and global issues. This topic encompasses a wide array of concepts, such as finance, financial documents, growth, tariff systems, income, expenditure, profit/loss, budgeting, interest, banking, loans and investments (DBE, 2019; Pournara, 2011).

As teacher and researcher, the author identified a research gap when evaluating Grade 9 learners' performance in mathematics and home language. Since the author had recently completed an honours degree in inclusive education at a local university and acted as head of Grade 10 mathematics and a member of the school based support team (SBST), the author identified learners grappling with learning barriers in mathematics. We chose to conduct a small-scale IP where we attempted to support the at-risk learners to address the gaps in their understanding, focusing on the topic of financial mathematics. This article forms part of a larger research project which focused on five Grade 10 learners, however, due to limited space we focus on only three cases: LA, LB and LC.

The three leaners attended Grade 10 financial mathematics classes but experienced more scholastic challenges. They emerged as the most at-risk and the least performing learners in the class achieving below 40% in their final exam for this subject. Financial mathematics, which is the central mathematics topic of this research, involves scenario-based problems and draws on various aspects of mathematical knowledge such as simple interest, exchange rates, taxation (value added tax [VAT]), compound interest, discount, timeline, salary increase, as well as profit and loss (DBE, 2019; Pournara, 2011). We developed a 10-week IP, juxtaposing four comprehension strategies (My turn-your turn, Think aloud, Anticipation guide and Feature matrix) for Grade 10 financial mathematics. The intention was to extend the learners' critical thinking skills according to Bloom's revised taxonomy's higher-order thinking skills (remembering, understanding, applying, analysing, evaluating and creating). This study is of global theoretical and educational importance because we investigated the juxtaposition of effective literacy teaching strategies for making inferences in financial mathematics.

Literature Review

With this literature review we explore a few concepts. Firstly, we discuss financial mathematics (mathematical literacy) and provide a brief history on the pedagogy of teaching problems. Secondly, we briefly discuss the PIRLS tests and what inference teaching constitutes. Thirdly, we provide a short discussion on intrinsic and extrinsic reading motivation and creating a supportive learning environment. Finally, we discuss the IP in some detail about reading comprehension strategies.

The National DBE's Amended Curriculum and Policy Statement ([CAPS], 2011:157) for the Senior Phase (Grades 7–9) curriculum underscores the critical importance of "higher order understanding" as a subskill in the development of comprehension and critical language awareness in all subject areas. Learners read between the lines, use their background knowledge to go beyond the text and draw conclusions based on evidence from the text (Johnson & Johnson, 2017; Rice, Wijekumar, Lambright & Bristow, 2024).

The Grade 10 CAPS (DBE, 2019) curriculum for financial mathematics extends learners' knowledge, emphasising the importance of working with growth formulae as opposed to iterative calculations. Learners are encouraged to connect their understanding of the topic to real-life scenarios, in accordance with the Further Education and Training (FET) CAPS Amendments (DBE, 2019:27). Financial mathematics is a content area in the curricula for mathematics and mathematical literacy in South Africa. It is a field of mathematics that deals with applying mathematical principles to solve financial problems drawing on concepts from probability, statistics, economic theory and other mathematical tools to address financial challenges, often involving scenarios and word problems (Pournara, 2011).

The CAPS document encourages educators to design assessment tasks aligned with the cognitive levels of Bloom's taxonomy (Morton & Colbert-Getz, 2017). This alignment is particularly relevant for inference skills, which overlap with Bloom's levels of understanding (comprehending the meaning of facts) and applying (utilising facts, rules, concepts and ideas). In this research project we primarily focused on financial mathematics (mathematical literacy) word problems that involved the following key concepts: simple interest, exchange rates, taxation (VAT), compound interest, discount, timelines, salary increases and profit and loss.

Pournara (2011) emphasises the potential of financial mathematics in the school curriculum. He underscores the practical application of simple and compound interest formulae ($A = P(1+i \cdot n)$ and $A =$

P(1+i) n). These formulae enable individuals to make sense of how the value of money changes over time. The concept of interest is introduced as early as Grade 7 in the South African mathematics curriculum (DBE, Republic of South Africa [RSA], 2011). While most secondary school textbooks introduce learners to simple interest first, followed by compound interest with annual compounding, very few delve into the complexities of daily interest calculations and monthly compounding. These nuanced aspects are essential for learners to gain a more realistic understanding of financial mathematics (Pournara, 2011).

To provide a brief history of problem-solving in mathematics, Schoenfeld (1987:284) states that in 1945 mathematics instruction was mostly rote instruction with drill-and-practice and memorising theories with little understanding. The behaviourist believed that "mind" and "thinking" were hopeless concepts and that all behaviour could be explained by stimulus-response chains. From 1954 George Pálya and his colleagues began rethinking mathematics and plausible reasoning. They believed that methods and rules of discovery inventions for solving problems were required. More recently, in his article, Schoenfeld (1987:287) states that Pálya believed that he learned mathematics through "a study of patterns of productive thinking that enabled him to be successful at mathematical problem-solving." Schoenfeld (1987:290) continues that "a large part of what comprises competent problem-solving behaviour consists of the ability to monitor and assess what one does while working problems." He offers that when teachers ask learners guiding questions such as What are you doing? and Why are you doing it?, he believes that their problem-solving performances can improve mathematical understanding.

PIRLS is a comprehensive global test of learners' reading proficiency and it is conducted with Grade 4, and in South Africa, Grade 6 learners. PIRLS evaluates learners based on four essential comprehension processes: "focus on and retrieve explicitly stated information", "make straightforward inferences", "interpret and integrate ideas and information" and "evaluate content and textual elements" (Howie et al., 2017:6). South Africa has been an active participant of the PIRLS study with involvement in 2001, 2006, 2011, 2016 and 2021. The 2021 PIRLS results were concerning, with the country ranking last out of the 57 participating countries. The average reading score for South African learners was significantly lower compared to the international average, and the results further show that 82% of Grade 4 learners were unable to read for meaning (Ndhlovana & Charamba, 2023).

Inference reading skills are crucial for understanding the requirements of problem-solving. Many learners encounter challenges when confronted with word problems in financial mathematics, which are a core component of the subject due to its real-world applications (Murray, 2012). Solving word problems demands that learners not only understand the language used but also interpret the concrete information presented in the problem, create a mental model of the problem based on the information provided, formulate a solution plan and execute the necessary calculations (Desoete, Roeyers & De Clercq, 2003).

According to O'Brien, Cook and Lorch (2015), inference reading skills encompass the process of integrating information in the text and between the text and the reader's general knowledge of the subject matter. Barth and Elleman (2017:32) assert that in literacy "inference making is the most potent predictor of comprehension among adolescent readers, with less skilled adolescent readers demonstrating lower accuracy and slower formation of text- and knowledge-based inferences compared to their skilled counterparts." They contend that explicit instruction in inference making can result in significant improvements in reading comprehension, particularly among struggling readers in the middle grades. This proposition gains support from a recent synthesis and a meta-analysis (Barth, Barnes, Francis, Vaughn & York, 2015) examining the effects of teaching the making of inferences on reading comprehension among elementary and secondary grade learners.

Reading motivation is categorised as intrinsic and extrinsic and is linked to inference generation (Schaffner & Schiefele, 2013). Wigfield, Guthrie, Tonks and Perencevich (2004) assert that individuals who are intrinsically motivated engage in activities for the inherent value of the activity itself, out of genuine interest, and are driven by their internal desires rather than external incentives. They argue that it is essential to consider whether a decline in motivation is an inevitable process or whether it may be enhanced by altering the educational experiences provided to children.

Extrinsic motivation for reading, as defined by Unrau and Schlackman (2006:82), "is the desire to participate in an activity due to a reward system or external social demands." They further propose that extrinsic rewards can potentially have adverse effects, diminishing intrinsic motivation, devaluing the love for learning, conveying misleading messages and fostering a counterproductive competitive atmosphere.

Creating a supportive learning environment is essential for effective teaching and learning (Hattie, 2009). The physical layout and design of the classroom can influence learners' engagement and participation (Barrett, Davies, Zhang & Barrett, 2015). For instance, a well-organised classroom

can encourage independent exploration and problem-solving. In the context of financial mathematics where learners often work on word problems, an organised and conducive environment can enhance the comprehension of complex problems.

The teacher-learner relationship is a critical component of the classroom environment (Claessens, Van Tartwijk, Van der Want, Pennings, Verloop, Den Brok & Wubbels, 2017). Effective teachers build positive relationships with their learners, which can lead to greater motivation and engagement. When learners feel connected to their teacher, they are more likely to participate actively in the learning process.

Intervention programme (IP)

The complete IP spanned 10 weeks, which included a pre-test, a post-test and an 8-week teaching programme. Table 2 explains the IP including the Grade 10 financial mathematics curriculum concepts and literacy pedagogical strategies taught. The importance of the classroom environment is highlighted, encompassing supportive learning, physical layout, teacher-learner relationships, collaborative learning and effective classroom management (Hattie, 2009; Vygotsky, 1978).

Table 2 The 10-week IP showing the Grade 10 financial mathematics concepts and comprehension pedagogical strategies (Thwala, 2024)

Week	Date	Time	Mathematical content	Comprehension strategy
1	17.02.2021	15:00 – 16:00	Pre-tests	
2	24.02.2021-25.02.2021	15:00 – 16:00	Simple interest	My turn-your turn
3	03.03.2021-04.03.2021	15:00 – 16:00	Exchange rates	Think aloud
4	10.03.2021-11.03.2021	15:00 – 16:00	Taxation (VAT)	Anticipation guides
5	17.03.2021-18.03.2021	15:00 – 16:00	Compound interest	My turn-your turn
6	24.03.2021-25.03.2021	15:00 – 16:00	Discount	Feature matrix
7	30.03.2021-31.03.2021	15:00 – 16:00	Timeline	Anticipation guides
8	14.04.2021-15.04.2021	15:00 – 16:00	Salary increase	Feature matrix
9	21.04.2021-22.04.2021	15:00 – 16:00	Profit and loss	Think aloud
10	23.04.2021	15:00 – 16:00	Post-tests	

Rouijel, Bouziane and Zohri (2019) state that explicit and purposeful teaching of comprehension strategies has positive effects on developing learners' critical thinking skills. Think aloud and My turn-your turn are two strategies in which teachers intentionally express their thoughts on a text inviting learners to respond to their questions. In this way they transfer their thought processes to their learning by drawing attention to the important points while reading aloud. This opens the learners' minds and they can focus on how their teacher is explaining the concept. They ask predicting questions, they verbalise a confusing point, they make inferences by discussing word meanings by linking their prior knowledge to the new information and they demonstrate how to correct their reading to better understand a text. All these skills make learners' thoughts more visible.

Adams, Pegg and Case (2015) introduce Anticipation guides as a reading comprehension strategy that is intended to guide learners in understanding a variety of texts by including a set of statements which the group of learners read and discuss – either agreeing or disagreeing by providing reasoned arguments, drawing from their prior knowledge. This stimulates and agitates their curiosity, thereby setting a clear purpose for their reading. The activation of prior knowledge plays a pivotal role in the learner's ability to incorporate new information and ideas into their existing cognitive frameworks.

The critical thinking skills used in the feature matrix strategy are designed to help learners organise and synthesise information from a text by categorising it into a matrix or chart format (Chin & Brown, 2002). By visually representing key features and details, learners can better understand the relationships within the text and identify relevant information more efficiently.

Within the IP, we intentionally focused on using a variety of higher-order questioning techniques. They were used as a tool to observe the learners' ability to understand the material, to trigger their thinking, ignite inquiry, thus establishing dialogic and interactive relations, and to increase their learning levels (Ismalinda, Fortunasari, Masita, Hidayat & Wulandari, 2023). These techniques are described below.

Johnson and Johnson (2017) suggest that predicting questions activate learners' prior knowledge and generate expectations before they delve into word problems. An example from this study was that the learners were presented with a word problem about compound interest: "Based on the information given, what will the final amount be after 5 years?"

Connecting questions guide learners to making connections between the text and their own lived experiences. They foster engagement by relating the content to their familiar situations (Slavin, 2014, 2015). An example from this study was: "Can you think of a time when Joe had to deal with currency exchange while traveling? How was

it similar to or different from the scenario presented in this problem?"

Rice et al. (2024) suggest that inference questions may vary; they may ask word meanings, use surrounding information to infer the meaning of a word, interpret the link between concepts, connect information across texts, identify causes of events, use prior knowledge to fill in the information, integrate the text information with the learners' prior knowledge and integrate information across a few texts. An inference question on taxation problems from this study was: "What can we conclude about the impact of 14% VAT on the total cost of an item? How does it affect the final price?"

Clarification questions encourage clarification and ensures a deeper comprehension of the text (Johnson & Johnson, 2017). In a timeline-related word problem, a clarification question in this study was: "Is there anything in the timeline that you find unclear or that needs further explanation?"

Paraphrasing and summarising questions encourage learners to rephrase key information from the text in their own words (Rice et al., 2024). It promotes active engagement and comprehension by asking learners to articulate their own understanding of the concept. An example of a summarising question in this study was: "Can you summarise the steps involved in calculating simple interest in your own words?"

Conceptual Framework

The conceptual framework of this study on the teaching of inference skills in Grade 10 financial mathematics is drawn from two key theoretical perspectives of Bloom's revised taxonomy (Anderson, Krathwohl, Airasian, Cruikshank, Mayer, Pintrich, Raths & Wittrock, 2001) and Vygotsky's theory of social constructivism (1978). These theories collectively guided the exploration of LB's cognitive development and the impact of the IP over the 10 weeks. We used these theories to understand the roles of cognitive development and collaborative learning when LB participated in the financial mathematics IP using a variety of literacy pedagogical approaches focusing on the teaching of inference skills.

Bloom's revised taxonomy (Anderson et al., 2001) provides a framework for categorising cognitive processes and thinking skills. The taxonomy's six categories, ranging from remembering to creating, were used to understand, analyse and track the cognitive development of the learners during the IP through the use of verbatim quotations and cognitive verbs. Lessons were designed to align with the DBE's amended CAPS (2019) curriculum objectives, incorporating both lower-order and higher-order cognitive skills. Bloom's revised taxonomy (Anderson et al., 2001) served as a structured approach to scrutinise the learners' cognitive development, comprehension skills and higher-order thinking abilities during the IP.

Vygotsky's theory of social constructivism (1978) was foundational in this study, emphasising the role of social interaction in cognitive development. The comprehension strategies aligned with Vygotsky's social constructivism theory are emphasising interaction, collaboration and the development of metacognition (Vygotsky, 1978). Wibowo, Wangid and Firdaus (2025:432) confirm that "cognition is the internalisation of social interaction." During the IP, as facilitators and the more knowledgeable others (MKO) (Vygotsky, 1978) with a higher level of ability than the learners, we provided them with a variety of financial mathematics problems within a variety of literacy strategies. We allowed the learners to interact with each other and share their understanding of the word problem processes. As we all (the MKOs) used language to discuss the problem processes, the learners soon began to internalise the thinking structures necessary to successfully complete the problems. By providing a safe environment, giving the learners the freedom to creatively develop their cognition, we were cognisant of working within their zone of proximal development (ZPD) (Vygotsky, 1978). Our initial role was to guide the learners in understanding the mathematical processes until they internalised these problem-solving practices. This was done to mediate and scaffold the learners' learning experiences, ensuring that they were challenged within their capabilities. By doing this we were promoting cognitive advancement and attempting to improve their comprehension skills.

Method

This article forms part of an extensive research initiative that centred around five Grade 10 learners. However, owing to space constraints, we exclusively delved into three cases, LA, LB, and LC, while referring to the group that played a vital role in encouraging these three learners' learning and social interactions.

This research was grounded in an interpretivist paradigm, emphasising a deep understanding of learners' perceptions (Kivunja & Kuyini, 2017). A quasi-experimental study was adopted (Muzari, Shava & Shonhiwa, 2022). A single case study design focused on Grade 10 learners in School X, conveniently selected due to our affiliation with the school (Cohen, Manion & Morrison, 2017). The learners were from economically disadvantaged areas surrounding the school. Purposive sampling was used to select three case studies, LA, LB and LC, as they were all underachieving in financial mathematics. One Grade 9 financial mathematics teacher provided us the opportunity to engage with him, to gain further

insight and to complement this case study (Creswell & Creswell, 2022).

We aimed to contribute insight into the effectiveness of the IP on the three cases' comprehension skills and higher-order thinking abilities when attempting to solve financial mathematics word problems. Hence, the main research question was: What are the experiences of teaching inference skills to three Grade 10 financial mathematics learners during a 10-week intervention programme (IP)?

In the data collection phase, semi-structured interviews, participant observations, pre- and post-tests (Table 3) as well as the three learners' written work during the IP were used to gather comprehensive insight into the impact of teaching inference-comprehension skills.

Table 3 Revised pre- and post-test questions (Thwala, 2024)

Question number (no.)	Question
1	Find the interest charged on a loan of R1,500 at 12% per annum (p.a.) for 3 years.
2	A computer costs R5,999. The shop requires a 10% deposit and the rest will be paid in equal monthly instalments over a 3-year period at an interest rate of 14% simple interest p.a. (per annum, which means per year). Find the monthly instalments.
3.1	What is the value of the deposit?
3.2	Hence, determine the amount Claire borrows.
3.3	What will the amount of her monthly instalment be?
4.1	What is the total amount Amanda will have after 5 years?
4.2	What is the interest that Amanda received each year?
4.3	What is the total interest earned?

As part of the data collection, we referred to the learners' exercise books that they used during the IP and in their financial mathematics class. The problems and references to the variety of comprehension strategies – My turn-your turn, Think aloud, Anticipation guide and Feature matrix – were set out on a daily basis. The comprehension texts were the word problems where we encouraged the following critical thinking skills: predicting, connecting, inferencing, clarifying, paraphrasing and summarising.

A semi-structured interview with one Grade 9 teacher was conducted before the IP, providing rich, in-depth data (Creswell & Creswell, 2022). Participant observations during the IP involved a structured schedule to capture data on the three learners' engagement and interactions (Cohen et al., 2017; Tesoro, 2017). This data collection tool yielded candid information, exhibiting LA, LB and LC's authentic personalities, unhindered by the need to showcase their best behaviour.

We developed a pilot pre-test using the author's content knowledge as he had taught this subject since 2001. We had hoped to pilot this test with teachers who had taught Grade 8, 9 and 10 financial mathematics, however, due to the coronavirus pandemic (COVID-19), we refined the pre-test, which was also used as the post-test (see Table 3). Only two corrections were suggested.

The findings from the pre-test were pivotal in shaping the content and direction of the teaching phase of the IP on topics taught in Grade 10. Guided by these insights, we were able to effectively plan and implement the teaching/input phase over the course of the next 8 weeks. At the end of the 8-week teaching/input period, the same test was conducted as post-test.

The written work generated by LA, LB and LC, together with the results of the pre- and post-test, served as crucial resources enabling us to assess and analyse the essential phenomena under investigation.

We followed a systematic and rigorous approach in the data analysis employing inductive and deductive data analysis, participant-centred presentation, member checking and auditing for validity and reliability. The various data collection instruments ensured triangulation. However, we were aware that using only three participants may have led to limited breadth of results, limiting the generalisability of the study.

Despite being the teacher, we attempted to mitigate bias by recording observations, subsequently cross-referencing them with the input provided by teachers to ensure accuracy. Verbatim transcriptions of the interviews and secure storage of all data collection instruments were undertaken. To ensure impartiality and avoid misconceptions regarding study outcomes, we disseminated the findings to the participants for their verification, prioritising well-being and respect throughout the research process. We were aware of the power position that we held, recognising the need to establish a distinct environment during the interviews. We attempted to work diligently to foster a positive rapport and atmosphere with LA, LB and LC.

Ethical considerations were prioritised, with ethical clearance obtained from the relevant university (ethics reference number: EFEC 13-9/2020) and from the WCED (ethics reference number: 20200930-8349). Informed consent forms from the principal, the Grade 9 teacher and the participants were secured and guidelines were

strictly adhered to, ensuring transparency, anonymity and voluntary participation.

Results

In this section we present the findings and discussion on the impact of a 10-week IP on the mathematics comprehension skills of Learners LA, LB and LC.

Learner LA

Table 4 Quotations from LA indicating his cognitive growth during the 8-week IP (Thwala, 2024)

The development of thinking skills	Thinking level	Verbatim quotes of Learner LA's responses
Lower order	Remembering	*The principal amount refers to the initial amount that was invested by Sizwe* (Week 2, My turn-your turn).
	Understanding	*At first, I struggled dealing with deposits but after I saw how Sir and other learners did them during their turns, I then understood* (Week 2, My turn-your turn).
	Applying	*Once Sir showed us how to convert the currencies, I found it easy to convert currencies on my own* (Week 3, Think aloud).
	Analysing	*I disagree with the statement, half-yearly and bi-annually refers to the same thing* (Week 7, Anticipation guide).
	Evaluating	*Even though we have calculated the final amount, to find the interest we have to subtract the initial amount from the final amount* (Week 5, My turn-your turn).
	Creating	No example
Higher order		

Discussion

The group activity during Week 2 was the My turn-your turn comprehension strategy (see Table 4). In this week LA displayed the cognitive development skill of remembering. The learners were given a scenario where they had to identify variables of the simple interest formula. LA recalled that "[t]*he principal amount refers to the initial amount that was invested by Sizwe*." This example links to Sobral's (2021:149) work where he posits that the cognitive development skill of understanding is associated with "determining the meaning of instructional messages, including oral and written communication."

In the same comprehension activity in Week 2, LA eventually showed that he understood the concept of deposits. He stated the following: "*At first, I struggled in dealing with deposits but after I saw how Sir and other learners did them during their turns, I then understood*." This indicates that the concept of deposits was scaffolded by the teacher as the MKO, until LA came to understand the complex mathematical processes. He was then able to use his logical reasoning skills and was able to verbalise his thought structures (Wibowo et al., 2025:433). According to their ZPD, we initially collaborated and engaged with the learners allowing them to finish the activities and find their own solutions under our supervision (Schoenfeld, 1987:284).

By Week 3, LA stated that "[o]*nce Sir showed us how to convert the currencies, I found it easy to convert currencies on my own*." LA had become proficient at the cognitive skill of application since he was able to do the conversion calculations independently after participating in the Think aloud comprehension strategy. He was confident in explaining his thought processes when converting the currencies. In this example, LA was able to link the cognitive skill of application with operative verbs and sequences such as "calculate, solve problems" and "demonstrate" (Suwarto, Dominik & Arief, 2023). This is another example of us scaffolding the mathematical processes for the group of learners, keeping in mind that they were under our supervision, and we were assisting and guiding them to solve the problems (Wibowo et al., 2025:434).

In his list of terms associated with the cognitive skill of evaluating, Adesoji (2018:293) uses words such as "compares, contrasts, critiques, explains, interprets" and "justifies." During a My turn-your turn comprehension strategy activity in Week 5, LA argued that "[e]*ven though we have calculated the final amount, to find the interest we have to subtract the initial amount from the final amount*." He was able to evaluate the word problems by not only answering the question, but by being able to give a detailed explanation and justification for the answer.

In Week 7, LA was able to display higher-order cognitive development skills such as analysing and evaluating. Adams et al. (2015) argue that analysis is required to identify the assertions upon which an argument is based and to break down information into its component parts.

After participating in the Anticipation guide, LA was able to correctly analyse word problems by examining and forming an opinion on a given scenario. The group of learners were tasked to read a passage and complete the statements by saying whether they agreed (A) or disagreed (D) with them. LA's comment was: "*I disagree with the statement, half-yearly and bi-annually refer to the same thing*." The learners would work through the passage and statements offering their justifications.

There was no evidence of LA reaching the creating level of cognitive development.

Learner LB

Table 5 Quotations from LB indicating his cognitive growth during the 8-week IP (Thwala, 2024)

The development of thinking skills	Thinking level	Verbatim quotes of Learner LB's responses
Lower order	Remembering	*The final amount is the total amount that Sizwe will get at the end of the 3 years* (Week 2, My turn-your turn).
	Understanding	*1 euro costs R19,50, the amount in euros must be multiplied by R19,50 to get the equivalent rand value* (Week 3, Think aloud).
	Applying	*Getting the percent of a number was easy to do, the text gave us the percent – we just had to divide by 100 and multiply by the number* (Week 6, Feature matrix).
	Analysing	*I enjoyed the Feature matrix as I could tell apart on whether the salary increase was done or not* (Week 8, Feature matrix).
	Evaluating	No example
	Creating	*Though the initial price was given, the VAT was not included so the total cost is after the VAT is included, for example if an item is R50, which does not include VAT at 14%, then the total cost is after VAT is added*. (Week 4, Anticipation guide)
Higher order		

Using the My turn-your turn comprehension strategy in Week 2 (see Table 5), LB demonstrated the cognitive ability of remembering. The learners were given a scenario in which they were tasked to identify and find variables of the simple interest formula. LB stated that "[t]*he final amount is the total amount that Sizwe will get at end of the 3 years*." He was able to successfully remember, identify and verbalise the final amount from the activity (Adams et al., 2015).

During the Think aloud comprehension strategy in Week 3, LB was able to verbalise how he rephrased information into his own words. He grouped items into categories and contrasted them demonstrating his understanding of the information (Adams et al., 2015). He stated that "*one-euro costs R19,50, the amount in euros must be multiplied by R19,50 to get the equivalent rand value*." This explanation shows that he understood the concept of exchange rates and he continued to explain to the group, in his own words, how to convert currencies.

LB demonstrated the application cognitive skill in Week 6 during the Feature matrix. LB stated that "*getting the percent of a number was easy to do, the text gave us the percent – we just had to divide by 100 and multiply by the number*." LB correctly identified the method of calculating a percentage and applied this knowledge to calculate the discount. Adesoji (2018:295) says that using acquired knowledge, facts and rules to solve problems in groups is an example of the application cognitive skill.

During Week 8 in a Feature matrix activity, the group of learners had to compare and contrast whether or not a salary increase had been implemented. LB showed that he could analyse the content as he correctly differentiated when an increase was implemented and when it was not. Analysing refers to separating material into its component parts and determining how those parts relate to one another and to a larger structure (Sobral, 2021:149). LB stated that "*I enjoyed the Feature matrix as I could tell apart whether the salary increase was done or not*." LB used the mastery of language to competently share his thinking structures (Wibowo et al., 2025:433).

Creating new knowledge is when participants are able to "create", "design", "develop", "discuss" and "modify" (Adesoji, 2018:295). This happened during Week 4 using the Anticipation guide comprehension strategy. LB correctly disagreed with a given statement in the text by stating that "[t]*hough the initial price was given, the VAT was not included so the total cost is after the VAT is included. For example, if an item is R50, which does not include VAT at 14%, then the total cost is after VAT is added.*" In this explanation, LB showed that he understood the concept of VAT – he could state an opinion, agree or disagree, explain his justification and give a practical example of how it was calculated, therefore, reaching the level of creating. Wibowo et al. (2025:433) would agree that this would be an inspirational example of the effects of social learning where the learners were engaged in a social activity, discussing challenging problems

until they were able to effectively share their thinking processes.

There was no clear evidence of LB reaching the evaluating level of cognitive development.

Learner LC

Table 6 Quotations from LC indicating his cognitive growth during the 8-week IP (Thwala, 2024)

The development of thinking skills	Thinking level	Verbatim quotes of Learner LC's responses
Lower order	Remembering	*The unknown variable is the (P) principal amount. It is stated in the question* (Week 5, My turn-your turn).
	Understanding	*The third question says that the investment grew at a simple interest rate, so we must use the simple interest formula. To calculate the interest rate, we need to make (i) the subject of the formula* (Week 2, My turn-your turn).
	Applying	*To get how much the iPod cost in rands, if she buys it now, we have to multiply the cost in pounds by the exchange rate. By saying: Cost in rands = (cost in pounds) × exchange rate* (Week 3, Think aloud).
	Analysing	No example
	Evaluating	*In simple interest, the interest is only calculated on the principal amount and not on the interest earned during prior periods. This will lead to the borrower paying less interest* (Week 2, My turn-your turn).
	Creating	*The difference between the selling price and the cost is profit. For example, if we buy the bag of 90 chocolates for R333 and we sell them for R4 each, the difference between income and expenses is R360 − R333 = R27. Therefore, we make R27 profit from selling the chocolates.* (Week 9, Think aloud)
Higher order		

During a My turn-your turn comprehension activity in Week 5 (see Table 6), LC was able to retrieve explicitly stated information in the maths question. He stated that "*The unknown variable is the (P) principal amount. It is stated in the question.*" In this example, LC was able to exhibit the cognitive skill of remembering when he was able to recall the facts that he had previously learned (Adesoji, 2018:295).

Also, during a My turn-your turn exercise, but earlier in Week 2, LC showed that he understood when to use the simple interest formula. He stated in his own words: "*The third question says that the investment grew at a simple interest rate, so we must use the simple interest formula. To calculate the interest rate, we need to make (i) the subject of the formula.*" This is an example of the cognitive skill of understanding.

LC demonstrated the cognitive skill of application when working with exchange rates in a Think aloud exercise in Week 3. He commented that "[t]*o get how much the iPod cost in rands, if she buys it now, we must multiply the cost in pounds by the exchange rate. By saying: Cost in rands = (cost in pounds) × exchange rate*", LC used his prior knowledge of exchange rates to correctly explain how to calculate the cost of the iPod in rands, thereby showcasing the cognitive skill of application (Anderson et al., 2001:68).

The cognitive skill of evaluation is when learners are able to assess, evaluate, prioritise, predict and justify (Nayef, Yaacob & Ismail 2013:165). In a My turn-your turn activity in Week 2, LC was able to evaluate the concept of simple interest by stating that "[i]*n simple interest, the interest is only calculated on the principal amount and not on the interest earned during prior periods. This will lead to the borrower paying less interest.*" His ability to comprehensively explain the concept of simple interest in his own words and justify his reasons demonstrated that he could evaluate.

"Creating requires using existing knowledge and skills to generate a new, original product or idea. It involves synthesising information, ideas, or elements into a new whole" (Anderson et al., 2001:154).

During Week 9, while working on a Think aloud activity, LC demonstrated the cognitive skill of creating. Anderson et al. (2001:154) state that "[c]reating requires using existing knowledge and skills to generate a new, original product or idea. It involves synthesising information, ideas or elements into a new whole." LC expounded that "[t]*he difference between the selling price and the cost is profit. For example, if we buy the bag of 90 chocolates for R333 and we sell them for R4 each, the difference between income and expenses is: R360 − R333 = R27. Therefore, we make R27 profit from selling the chocolates.*" LC was able to generate and create a relevant example from existing knowledge.

There was no clear evidence of LC demonstrating the cognitive skill of analysing.

Conclusion

In this article we argue that the explicit teaching of inference comprehension strategies assisted three at-risk, struggling Grade 10 learners to develop

critical thinking and problem-solving skills giving them a better understanding of Grade 10 financial mathematics problems.

During the IP, LA, LB and LC displayed commendable progression in their cognitive development, transitioning from lower- to higher-order thinking skills using the My turn-your turn, Think aloud, Anticipation guides and Feature matrix comprehension strategies, significantly contributing to their advancement. The three learners actively participated in the comprehension activities, willingly sharing their opinions and maturing to reach the expectations we had with this IP. The post-test results indicate a positive impact on inference-comprehension skills, emphasising the need for targeted interventions and teaching strategies to bridge the gap between explicit information and inferred insights.

Central to the study, the IP was meticulously designed to enhance Grade 10 learners' reading comprehension skills in the context of the FET subject, financial mathematics. The objectives of the IP included introducing comprehension strategies, enhancing cognitive development and motivating learners struggling with understanding Grade 10 financial mathematics. Pre- and post-tests played a crucial role in assessing the impact of the IP, providing a baseline and shaping the 8-week teaching phase. We maintain that the carefully selected comprehension strategies, aligned with the two theoretical perspectives that underpinned this research – Bloom's Revised Taxonomy (Anderson et al., 2001) and Vygotsky's theory of social constructivism – contributed to the success of the intervention. We were able to track the learners' progression from lower- to higher order-thinking skills, demonstrating the impact in guiding the assessment of their systematic cognitive growth.

This research project was limited to exploring three learners' Grade 10 financial mathematics content knowledge during an IP of only 8 weeks at one school in the Western Cape. We limited the teaching resources to using only four pedagogic comprehension strategies. These strategies were effective in fostering inferential thinking skills and bridging the gap between explicit and inferred information. To achieve this, we recommend that all higher education institutions (HEIs) provide student teachers with professional development opportunities to enhance their understanding and incorporation of comprehension strategies within financial mathematics. This should contribute to creating more effective and engaging learning experiences for learners.

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Authors' Contributions

ST is the original author and JC was his supervisor.

Notes

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ii.
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References

Adams AE, Pegg J & Case M 2015. Anticipation guides: Reading for mathematics understanding. *Mathematics Teacher*, 108(7):498–504. https://doi.org/10.5951/mathteacher.108.7.0498

Adesoji FA 2018. Bloom taxonomy of educational objectives and the modification of cognitive levels. *Advances in Social Sciences Research Journal*, 5(5):292–297. https://doi.org/10.14738/assrj.55.4233

Anderson LW, Krathwohl DR, Airasian PW, Cruikshank KA, Mayer RE, Pintrich PR, Raths J & Wittrock MC (eds.) 2001. *A taxonomy for learning, teaching, and assessing. A revision of Bloom's taxonomy of educational objectives*. New York, NY: Longman.

Barrett P, Davies F, Zhang Y & Barrett L 2015. The impact of classroom design on pupils' learning: Final results of a holistic, multi-level analysis. *Building and Environment*, 89:118–133. https://doi.org/10.1016/j.buildenv.2015.02.013

Barth AE, Barnes M, Francis D, Vaughn S & York M 2015. Inferential processing among adequate and struggling adolescent comprehenders and relations to reading comprehension. *Reading and Writing*, 28(5):587–609. https://doi.org/10.1007/s11145-014-9540-1

Barth AE & Elleman A 2017. Evaluating the impact of a multistrategy inference intervention for middle-grade struggling readers. *Language, Speech, and Hearing Services in Schools*, 48(1):31–41. https://doi.org/10.1044/2016_LSHSS-16-0041

Chin C & Brown DE 2002. Student-generated questions: A meaningful aspect of learning in science. *International Journal of Science Education*, 24(5):521–549. https://doi.org/10.1080/09500690110095249

Claessens LCA, Van Tartwijk J, Van der Want AC, Pennings HJM, Verloop N, Den Brok PJ & Wubbels T 2017. Positive teacher-student relationships go beyond the classroom, problematic ones stay inside. *The Journal of Educational Research*, 110(5):478–493. https://doi.org/10.1080/00220671.2015.1129595

Cohen L, Manion L & Morrison K 2017. *Research methods in education* (8th ed). New York, NY: Routledge.

Creswell JW & Creswell JD 2022. *Research design: Qualitative, quantitative, and mixed methods approaches* (6th ed). Thousand Oaks, CA: Sage.

Department of Basic Education, Republic of South Africa 2011. *Curriculum and Assessment Policy*

Statement Grades 7-9 Mathematics. Pretoria: Author. Available at https://www.education.gov.za/Portals/0/CD/National%20Curriculum%20Statements%20and%20Vocational/CAPS%20SP%20%20MATHEMATICS%20GR%207-9.pdf?ver=2015-01-27-160141-373. Accessed 31 December 2025.

Department of Basic Education 2019. *National Curriculum Statement. Curriculum and Assessment Policy Statement: Amendments. Grades 10-12. Mathematics.* Pretoria, South Africa: Author.

Desoete A, Roeyers H & De Clercq A 2003. Can offline metacognition enhance mathematical problem solving? *Journal of Educational Psychology*, 95(1):188–200.

Hattie J 2009. The black box of tertiary assessment: An impending revolution. In LH Meyer, S Davidson, H Anderson, R Fletcher, PM Johnston & M Rees (eds). *Tertiary assessment & higher education student outcomes: Policy, practice & research*. Wellington, New Zealand: Ako Aotearoa.

Howie SJ, Combrinck C, Roux K, Tshele M, Mokoena GM & McLeod Palane N 2017. *PIRLS Literacy 2016: South African highlights report*. Pretoria, South Africa: Centre for Evaluation and Assessment. Available at https://repository.up.ac.za/server/api/core/bitstreams/c0390486-6b60-4904-85c4-2657bed55095/content. Accessed 31 December 2025.

Ismalinda S, Fortunasari, Masita E, Hidayat M & Wulandari BA 2023. Teachers' question types and questioning strategies: A classroom interaction analysis. *Indonesian Research Journal in Education (IRJE)*, 7(2):336–350. https://doi.org/10.22437/irje.v7i2.20757

Johnson DW & Johnson RT 2017. The use of cooperative procedures in teacher education and professional development. *Journal of Education for Teaching*, 43(3):284–295. https://doi.org/10.1080/02607476.2017.1328023

Kivunja C & Kuyini AB 2017. Understanding and applying research paradigms in educational contexts. *International Journal of Higher Education*, 6(5):26–41. https://doi.org/10.5430/ijhe.v6n5p26

Morton DA & Colbert-Getz JM 2017. Measuring the impact of the flipped anatomy classroom: The importance of categorizing an assessment by Bloom's taxonomy. *Anatomical Sciences Education*, 10(2):170–175. https://doi.org/10.1002/ase.1635

Murray H 2012. Problems with word problems in mathematics. *Learning and Teaching Mathematics*, 13:55–58. Available at https://www.amesa.org.za/Hanlie.pdf. Accessed 31 December 2025.

Muzari T, Shava GN & Shonhiwa S 2022. Qualitative research paradigm, a key research design for educational researchers, processes and procedures: A theoretical overview. *Indiana Journal of Humanities and Social Sciences*, 3(1):14–20. Available at https://indianapublications.com/articles/IJHSS_3(1)_14-20_61f38990115064.95135470.pdf. Accessed 30 December 2025.

Nayef EG, Yaacob NRN & Ismail HN 2013. Taxonomies of educational objective domain. *International Journal of Academic Research in Business and Social Sciences*, 3(9):165–175. https://doi.org/10.6007/IJARBSS/v3-i9/199

Ndhlovana SN & Charamba E 2023. The efficacy of translanguaging: A critical review of selected South African mathematics and science intermediate phase classrooms. *JOLLT Journal of Languages and Language Teaching*, 11(3):373–389. https://doi.org/10.33394/jollt.v11i3.7904

O'Brien EJ, Cook AE & Lorch RF, Jr (eds.) 2015. *Inferences during reading*. Cambridge, England: Cambridge University Press.

Pournara C 2011. The compound interest formula as a model of compound growth. In H Venkat & AA Essien (eds). *Proceedings of the Seventeenth National Congress of the Association for Mathematics Education of South Africa (AMESA)* (Vol. 1). Johannesburg, South Africa: AMESA. Available at http://www.amesa.org.za/AMESA2011/Volume1.pdf#page=374. Accessed 31 December 2025.

Rice M, Wijekumar K, Lambright K & Bristow A 2024. Inferencing in reading comprehension: Examining variations in definition, instruction, and assessment. *Technology, Knowledge and Learning*, 29(3):1169–1190. https://doi.org/10.1007/s10758-023-09660-y

Rouijel EH, Bouziane A & Zohri A 2019. The effect of explicit instruction in critical thinking on higher-order thinking skills in reading comprehension: An experimental study. *European Journal of English Language Teaching*, 5(1):114–126. https://doi.org/10.5281/zenodo.3382955

Schaffner E & Schiefele U 2013. The prediction of reading comprehension by cognitive and motivational factors: Does text accessibility during comprehension testing make a difference? *Learning and Individual Differences*, 26:42–54. https://doi.org/10.1016/j.lindif.2013.04.003

Schoenfeld AH 1987. Pólya, problem solving, and education. *Mathematics Magazine*, 60(5):283–291. https://doi.org/10.2307/2690409

Slavin RE 2014. Making cooperative learning powerful. *Educational Leadership*, 72(2):22–26.

Slavin RE 2015. Cooperative learning in elementary schools. *Education 3-13*, 43(1):5–14. https://doi.org/10.1080/03004279.2015.963370

Sobral SR 2021. Bloom's taxonomy to improve teaching-learning in introduction to programming. *International Journal of Information and Education Technology*, 11(3):148–153. https://doi.org/10.18178/ijiet.2021.11.3.1504

Suwarto FX, Dominik T & Arief S 2023. The implementation of Bloom's Taxonomy reasoning values in formal education learning: A philosophical contemplation of dialectical thinking based on Bloom's Taxonomy reasoning. *Russian Journal of Agricultural and Socio-Economic Sciences*, 2(134):50–58. https://doi.org/10.18551/rjoas.2023-02.06

Tesoro HA 2017. *Fundamentals of educational research*. New Delhi, India: Arcla Press.

Thwala SE 2024. The impact of teaching inference skills in Grade 10 Financial Mathematics during a ten-week intervention programme. MEd dissertation.

Cape Town, South Africa: Cape Peninsula University of Technology. Available at https://etd.cput.ac.za/bitstream/20.500.11838/4005/1/Sibusiso_Thwala_213295296.pdf. Accessed 29 December 2025.

United Nations Educational Scientific and Cultural Organisation 2022. *Transforming education for the future*. Paris, France: Author. Available at https://unesdoc.unesco.org/ark:/48223/pf0000382765. Accessed 31 December 2025.

United Nations Educational Scientific and Cultural Organisation 2023. *Message from Ms Audrey Azoulay, Director-General of UNESCO on the occasion of International Literacy Day*. Paris, France: Author. Available at https://unesdoc.unesco.org/ark:/48223/pf0000386707_eng. Accessed 31 December 2025.

Unrau N & Schlackman J 2006. Motivation and its relationship with reading achievement in an urban middle school. *The Journal of Educational Research*, 100(2):81–101. https://doi.org/10.3200/JOER.100.2.81-101

Vygotsky LS 1978. *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.

Wibowo S, Wangid MN & Firdaus FM 2025. The relevance of Vygotsky's constructivism learning theory with the differentiated learning primary schools. *Journal of Education and Learning (EduLearn)*, 19(1):431–440. https://doi.org/10.11591/edulearn.v19i1.21197

Wigfield A, Guthrie JT, Tonks S & Perencevich KC 2004. Children's motivation for reading: Domain specificity and instructional influences. *The Journal of Educational Research*, 97(6):299–310. https://doi.org/10.3200/JOER.97.6.299-310