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Scaffolding word problem-solving instruction: Leveraging critical thinking and mathematics vocabulary

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Background: Solving mathematics word problems present a continuous challenge for both learners and teachers, particularly in Grade 3, where the development of critical thinking and mathematics vocabulary is still in its early stages. While reading comprehension strategies have been widely explored, the integration of mathematics vocabulary and critical thinking into instructional frameworks calls for investigation.

Aim: This study aimed to develop and explore a conceptual framework that integrates critical thinking and mathematics vocabulary to support both professional development of teachers and cognitive scaffolding for learners in word problem-solving.

Setting: The study was conducted in six diverse public as well as private schools in Gauteng province, South Africa. The languages of learning and teaching included both English and Afrikaans.

Methods: A qualitative approach was adopted, utilising a constructivist lens and participatory action research as the overarching design. Data were generated over three phases through semi-structured interviews, teacher diaries and voice recordings of intervention workshops. The word sum-wheel underpinned the study. A hybrid approach combining inductive and deductive analysis was employed.

Results: Findings indicated that the framework, in conjunction with the word sum-wheel, enhanced teachers' instructional practices through guided questioning, language scaffolding and the integration of play. Learners demonstrated improved comprehension, confidence and self-correction in mathematics word problems.

Conclusion: The critical thinking and mathematics vocabulary framework functioned effectively as a professional development tool and as a classroom-based cognitive support mechanism.

Contribution: This study introduces the critical thinking and mathematics vocabulary framework as a practical, theoretically grounded tool for teacher training and mathematics instruction.

Keywords: Bloom's Revised Taxonomy; critical and creative thinking; foundational mathematics; mathematics register; professional development; mathematics word problem-solving.

Introduction

This section begins by outlining the role of teacher development in learning, explaining the importance of teacher training and development in improving learner outcomes. It then identifies the instructional challenge by highlighting the need as raised by Grade 3 teachers and frames the gap in teaching word problem-solving specifically around critical thinking and mathematics vocabulary. Next, I introduce the framework of critical thinking and mathematics vocabulary (FCTMV) as coined by Swanepoel (2022) and explain its theoretical foundations.

Lastly, I discuss the FCTMV as a tool for scaffolding and introducing critical thinking and mathematics vocabulary in mathematics word problem-solving instruction. The FCTMV is also discussed in light of supporting learner-centred instruction and asking leading questions to initiate critical thinking. The section ends by highlighting the novelty of the FCTMV and how it differs from other teaching training tools.

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It is essential to position the FCTMV relative to existing teacher training models to highlight its novel contribution. Polya's (1957) four-step heuristic (understanding the problem, devising a plan, carrying out the plan and looking back) offers valuable procedural guidance but does not explicitly scaffold teachers' questioning across cognitive levels or foreground the linguistic and vocabulary demands of mathematics word problems. Bloom's taxonomy and Krathwohl's (2002) revision of Bloom's taxonomy are widely used to support teachers in translating theory into classroom practice (Nurmatova & Altun 2023) and advocate for the integration of creative thinking (Widiana et al. 2023). However, these tools do not always demonstrate how cognitive processes, mathematics vocabulary and word problem comprehension can be integrated into a single teacher training model for word problem-solving instruction. Furthermore, classroom word problem-solving strategies often rely on surface-level cues (e.g. keyword matching), which may promote procedural answering without meaningful sensemaking. The FCTMV addresses these gaps by integrating Bloom's cognitive progression with explicit mathematics vocabulary scaffolding and a structured word problem-solving process aligned with the word sum-wheel, functioning as both a professional development tool and a learner-facing cognitive scaffold (Table 1, Figure 1).

Teacher development and training serve as essential tools to support teachers (Andini & Supardi 2018; Sudirtha et al. 2022) and are of importance for the social value of the study. Throughout educational contexts across the globe, learning is scaffolded (Fajrin & Sunra 2024) from the unknown to the known. Learning is seen as an interactive process that takes place between the teacher and learners, among learners, between learners and the subject matter and within the learning environment (Adijaya et al. 2023). Teacher development is essential to ensure that there is simultaneous development between teachers' skills and learners' performance. Effective learning opportunities arise when there is interaction between the different types of learning, as described by Adijaya et al. (2023); effective learning emerges through interaction and is strengthened through scaffolding from lower-order to higher-order thinking.

This study addressed the need for a framework that could leverage the teaching of word problem-solving, as raised by Grade 3 teachers in a study conducted by Swanepoel (2022). Two of the main areas of concern voiced by teachers were critical thinking and mathematics vocabulary. As such, I decided to support teacher development by integrating critical thinking and mathematics vocabulary into Bloom's Revised Taxonomy. This led to the development of the FCTMV, highlighting the scientific value of the study. The purpose of the FCTMV is for teachers (initially) and learners (secondly) to think 'outside the box' (Wallis & Steptoe 2006), view mathematics word problem-solving through a lens of critical and creative thinking and understand mathematics vocabulary as the language associated with word problems.

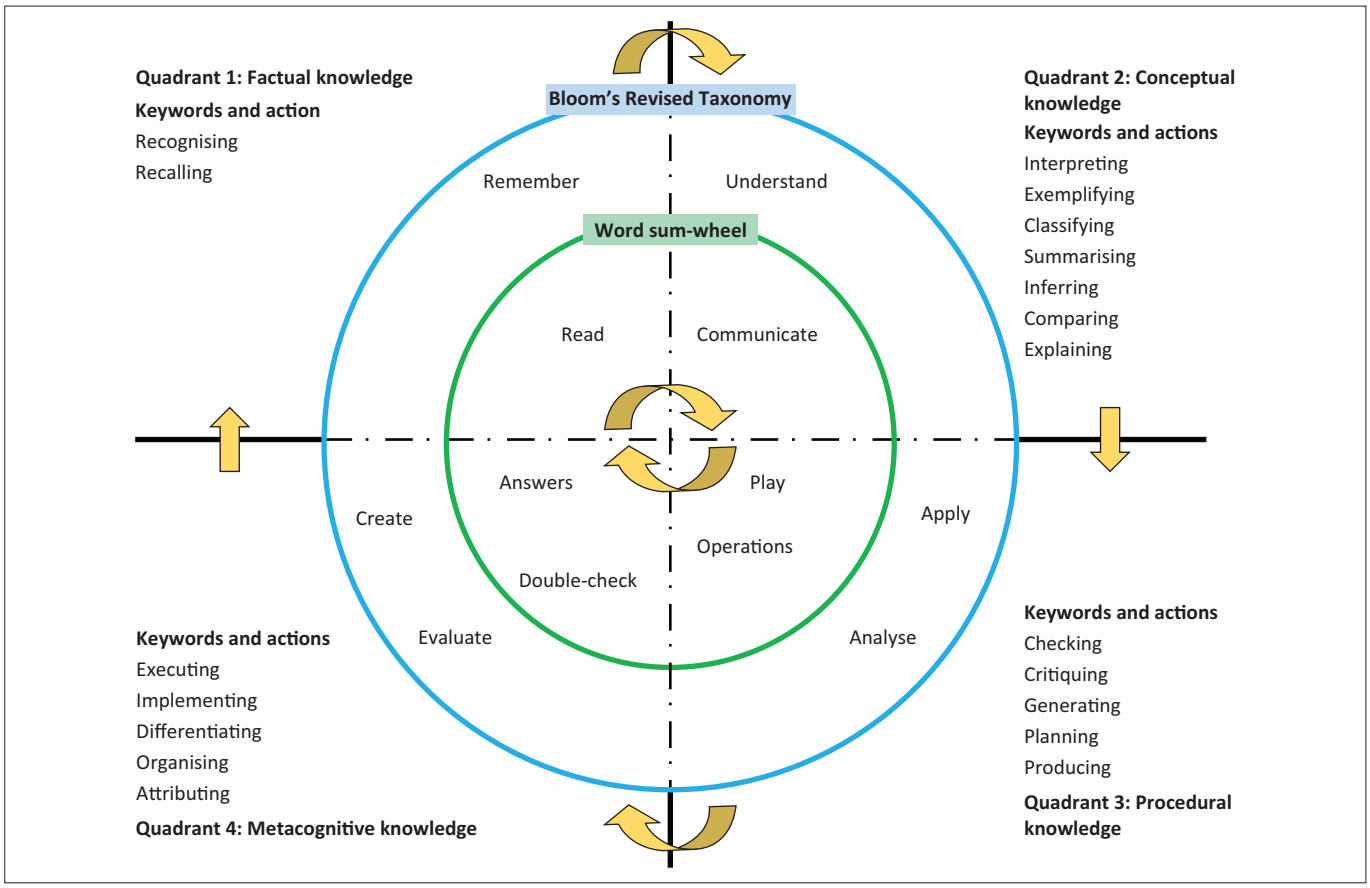
The FCTMV is a conceptual framework that is aimed at supporting mathematics word problem-solving teaching and learning. The FCTMV comprises Bloom's Revised Taxonomy and the word sum-wheel (Swanepoel 2022; Swanepoel & Luneta 2024). Change in mathematics word problem-solving is brought about through engaging the FCTMV.

TABLE 1: The framework of critical thinking and mathematics vocabulary.

Dimensions of cognitive processes†	Leading questions to be asked by teachers	Keywords and actions‡	Knowledge dimensions§
1 Remember *(Read)*¶	• 'What were the keywords in the word problem?' • 'What were the numbers in the word problem?' • 'What was the mathematics word problem (story) about?' • 'What did the question part of the mathematics word problem ask you?' • 'What was the essence of the mathematics word problem?'	• 'Recognising' • 'Recalling'	Factual knowledge
2 Understand *(Communicate)*	• 'What mathematics vocabulary was used in the word problem?' • 'What is the meaning of these mathematics vocabulary terms?' • 'Explain what you think should be done in order to solve the word problem.' • 'Identify keywords that indicate what operation should be used.' • 'Explain the mathematics word problem in your own words.'	• 'Interpreting' • 'Exemplifying' • 'Classifying' • 'Summarising' • 'Inferring' • 'Comparing' • 'Explaining'	Conceptual knowledge
3 Apply *(Play)*	• 'Can you take the essence of this mathematics word problem and apply it to a practical situation in life?' • 'Can you apply the information from this mathematics word problem to new situations?' • 'Have you ever been in the same position as the context on which this word problem is based? If yes, how did you solve it?'	• 'Executing' • 'Implementing'	Procedural knowledge
4 Analyse *(Operations)*	• 'Break the word problem down into smaller sections.' • 'Separate the mathematics vocabulary from the mathematics notation.' • 'What steps do you believe have to be followed in order for the mathematics word problem to be solved?'	• 'Differentiating' • 'Organising' • 'Attributing'	-
5 Evaluate *(Answers)*	• 'Follow the steps to solve this mathematics word problem, then evaluate the applicability of the results you get.' • 'Can you answer the question that has been asked?'	• 'Checking' • 'Critiquing'	Metacognitive knowledge
6 Create *(Double-check)*	• 'Using the same context of this mathematics word problem and using the same operations, create your mathematics word problem.'	• 'Generating' • 'Planning' • 'Producing'	-

Source: Swanepoel, N., 2022, 'Enhancing Grade 3 teachers' mathematics word problem-solving instruction through professional development initiatives', Doctoral thesis, University of Johannesburg

†, Different levels of knowledge according to Bloom's Revised Taxonomy; ‡, Krathwohl (2002:215); §, Sudirtha et al. (2022); ¶, The steps of the word sum-wheel have been matched to the different levels of thinking and reasoning to indicate the corresponding relationship between the word sum-wheel and the framework of critical thinking and mathematics vocabulary.



Source: Adapted from Swanepoel, N., 2022, 'Enhancing Grade 3 teachers' mathematics word problem-solving instruction through professional development initiatives', Doctoral thesis, University of Johannesburg

FIGURE 1: The integration of Bloom's Revised Taxonomy and the word sum-wheel as derived from the framework of critical thinking and mathematics vocabulary.

Ultimately, the FCTMV calls for asking questions about learning that takes place and thinking differently about how to arrive at an answer (Puccio, Klarman & Szalay 2023). The research question guiding this study asks, 'How does the FCTMV function as both a professional development tool for teachers and a cognitive support for learners in solving word problems?' The aim of the study was to develop and explore a conceptual framework that integrates critical thinking and mathematics vocabulary to support both professional development for teachers and cognitive scaffolding for learners in word problem-solving.

Background of the research

The FCTMV is founded on Bloom's Revised Taxonomy, which comprises six dimensions of cognitive processes, namely *remember*, *understand*, *apply*, *analyse*, *evaluate* and *create*. Each of these dimensions of cognitive processes provides a gateway for guiding teachers in phrasing and asking leading questions to learners. The leading questions serve as a springboard that allows teachers and learners to engage in critical and creative thinking, which in turn leads to metacognition (Sudirtha et al. 2022).

The literature is clear that for a teacher education and development tool to be effective, it must allow for scaffolding to take place and encourage learner activity while fostering interaction between the teacher and learners (Ghozelin, Hadiyanti & Kriswanto 2016; Pane & Darwis 2017; Sudirtha et al. 2022). At the same time, learners can also benefit from the framework and use guiding questions to think critically about the word problem and formulate an appropriate answer. What sets the FCTMV apart is the guidance it provides to teachers in the form of sample questions under each dimension of cognitive processes, along with examples of keywords and actions that teachers can refer to while teaching a word problem (see Table 1). While Sudirtha et al. (2022) warn against a teacher-centred classroom, the framework promotes active learning on the part of the learner, emphasising the nature of the framework to support teachers in creating a learner-centred teaching and learning environment. Learning that is fostered through the integration of the FCTMV is based on practical application, critical thinking and creative engagement with the content. Such learning allows metacognition to take place and makes learning meaningful (Kirom 2017; Sarnoko, Ruminiati, & Setyosari 2016). The FCTMV supports meaningful learning as part of teacher education and development (Adijaya et al. 2023). The literature review that follows provides more information on the language of mathematics, critical and creative thinking, asking leading questions and Bloom's Revised Taxonomy.

Literature

This section begins by outlining the language of mathematics, a primary aspect contributing to the challenges in word problem-solving. While teaching and learning should be viewed as reciprocal processes in mathematics word problem-solving instruction, it is vital to scaffold teachers' and learners' understanding of mathematics vocabulary. Next, the role of critical and creative thinking is explored as a foundational component for scaffolding instruction in word problem-solving. Thereafter, the focus shifts to the role of asking leading questions in scaffolding learners' thinking from lower-order thinking to higher-order thinking. Lastly, the literature explores Bloom's Revised Taxonomy and the role it plays in structuring cognitive growth.

Language of mathematics

Solving word problems is only possible once teachers and learners are able to think mathematically (Machaba, Sipholi & Motseki 2024; Setati, Molefe & Langa 2008). The use of the language of mathematics creates tension between learners' interaction with the mathematical meaning of word problems and the mathematical processes required to solve them (Machaba et al. 2024). Without understanding the language of mathematics, solving word problems would become very challenging (Machaba et al. 2024). What makes word problem-solving challenging is that the language used in word problems needs to be understood to such an extent that the problem solver is able to apply critical thinking. The language of teaching, learning and assessment is critical for acquiring mathematical comprehension and successfully interpreting word problems (Graven & Sibanda 2018). This perspective sheds light on the importance of accessing the language of teaching and learning so that learners' thought processes do not 'switch off' when they encounter a word problem (Machaba et al. 2024). Pimm (2019) explains the similarities between learning mathematics and learning a language 'since mathematics has particular ways of speaking, reading and writing' and that mathematics is a way of communicating (Pimm 2019; Wilkinson 2019; Zevenbergen 2001). The language of mathematics is also referred to as the mathematical register (Pimm 2019; Swanepoel 2022; Wilkinson 2018, 2019). Word problems are challenging: the answer needs to align with the original question and correspond to the context of the word problem. The biggest challenges that deter both teachers and learners from solving word problems are the unfamiliar context of the word problem, which is often different from that of the teachers' and learners' life-worlds; the specialised mathematics vocabulary, which differs from the everyday register used; and the language barrier where the language of learning and teaching (LoLT) is also different from the learners' home languages. Swanepoel (2022) notes that solving word problems is embedded in critical and creative thinking, an element that neither teachers nor learners are accustomed to applying as a means to understand the context of the word problem and answer it effectively. The intricate relationship between language and mathematics is highlighted by Essien (2018) and Essien and Moleko (2025). It is even more pronounced between multilingualism and the LoLT (Essien & Moleko 2025).

Critical thinking

Learners use strategies to solve word problems that emanate from textbook instruction (Kirkland & McNeil 2021:2). Instead, learners should be encouraged to face the word problem from a perspective where they use their knowledge of everyday events and occurrences. Solving word problems from this perspective allows learners to engage in critical thinking (Kirkland & McNeil 2021). Instead of 'activating and using their knowledge of the world', learners do not think 'outside the box' (Wallis & Steptoe 2006) to delve into their natural problem-solving abilities; they make use of a strategy such as looking at keywords to determine what the word problem requires of them. When learners see words, such as 'take away' or 'in total', they perform a calculation based on what they presume the keywords are telling them to do (Greer 1993; Kirkland & McNeil 2021). Although there is a specific place for a strategy, such as isolating keywords and solving a word problem accordingly, this limits learners' critical thinking and prevents them from thinking about the context of the word problem realistically. Fitzpatrick et al. (2019) argue that the use of matching keywords to the operations and numbers in a word problem ends up as a game where the objective is to find an answer to the problem, by using all the numbers, operations and keywords. However, Kirkland and McNeil (2021) point out that this 'game of word problems' may likely indicate a lack of reading comprehension. This furthermore indicates that without intentionally comprehending the meaning of the keywords, critical thinking cannot be applied. Thus, for critical thinking to be applied in solving word problems, learners need to have adequate knowledge of the keywords, which is reflected in sound reading comprehension. Examining the integration of critical and creative thinking within the framework, *critical thinking* and *creative thinking* are not opposite sides of the spectrum; instead, they complement each other.

Creative thinking

Creativity is an essential component in developing innovative ideas aimed at supporting society and bringing about change (Amabile, Burnside & Gryskiewicz 1999). Creativity is linked to 'thinking outside the box' (Wallis & Steptoe 2006), an essential ingredient in implementing innovation across various spheres of society (Puccio et al. 2023). Puccio, Murdock and Mance (2007:29) defined creative problem-solving (CPS) as a 'comprehensive cognitive and affective system built on our natural creative processes that deliberately ignites creative thinking and, as a result, generates creative solutions and change'. The first step in solving a problem is to engage in creative thinking (Raz, Reiter-Palmon & Kenett 2023). This process often begins with asking thoughtful questions that clarify the nature of the problem. Sasson Lazovsky, Raz and Kenett (2025) explain that 'when developing

questions, the asker must articulate and express the problem or perplexity they encounter and transition from perplexity to the formulation of the problem and expression of a question'.

When taking a closer look at the FCTMV, first the teacher and later on the learner are encouraged to ignite their own creativity and critical thinking by asking leading questions that lead them to understand the context of the word problem, the meaning of the mathematics vocabulary and what the word problem is asking them to do. This new approach to solving word problems is supported by the integration of critical and creative thinking (Puccio et al. 2023). It is vital to understand that the framework is not about reinventing the metaphorical wheel. Instead, this is about strengthening and accommodating problem solvers' existing problem-solving strategies within a new perspective by asking leading questions, activating critical thinking and critically examining the meaning of the words in a word problem while giving the problem solver some leverage to think 'outside the box' (Wallis & Steptoe 2006).

Within the FCTMV, creativity is not treated as an 'additional'; instead, creativity is embedded across the framework as a progression of increasingly flexible sensemaking and strategy generation (Table 1, Figure 1). At the lower-order levels (*remember* and *understand*), learners demonstrate creativity by rephrasing the word problem, clarifying mathematics vocabulary and constructing a coherent understanding of the problem context. At *apply*, creativity is evident when learners connect the problem to real-life experiences, model it using drawings or manipulatives and test whether the chosen operation fits the context. At *analyse*, learners engage creatively by breaking down multi-step problems, separating linguistic from numerical information and exploring alternative solution pathways. At *evaluate*, creativity is enacted through justification and revision as learners verify the realism of their answers, identify errors and propose corrections. Finally, at *create*, learners generate their own word problems using similar contexts and operations. In this way, creativity is enacted through rewording, re-representing, strategy flexibility and problem generation across the FCTMV, rather than being confined to the final level.

Asking leading questions

The FCTMV makes the asking of leading questions applicable to both the teacher and the learners. The physical act of asking questions serves as a catalyst for the problem solver to think critically about the questions and their answers while allowing for an element of creative thinking. Sasson Lazovsky et al. (2025) support this notion by stating that 'In everyday life, people constantly ask questions to interact with others, make informed decisions, and navigate the world around them. It is through questioning that we can solve problems and adapt to new situations, making it an essential skill for personal and professional development'.

Through the composition of the FCTMV, attention was given to the act of asking leading questions as a means to unlock the meaning of word problems. Question-asking is a fundamental tool for gaining information, requesting clarification or understanding a particular topic or subject (Sasson Lazovsky et al. 2025). Questions range from simple to complex, encouraging both basic understanding and deeper exploration. Questions can be open ended, allowing for broad exploration and discussion, or they can be closed ended, seeking specific answers (Ortlieb et al. 2012; Sasson Lazovsky et al. 2025).

The process of asking leading questions enables learners to connect their background knowledge to the context of the word problem while integrating the mathematical register creatively, with the thinking being scaffolded from lower order to higher order (Sasson Lazovsky et al. 2025). Wiranata, Widiana and Bayu (2021) explain that the process of thinking in word problem-solving is an important element that teachers should continually pay attention to.

Verbal skills are presumed to be the cornerstone of mathematics word problem-solving, continually interacting with mathematical processes during word problem-solving (Strohmaier et al. 2022). Verbal skills, such as discussing word problems and asking questions, were found to be the most consistent predictor of successful word problem-solving strategies (Strohmaier et al. 2022). In a similar study, Peng et al. (2020) categorised 'verbal skills' needed in word problem-solving as skills required from phonological processing to oral comprehension. It was ascertained that reading comprehension has a more substantial effect than phonological processing on problem solvers' abilities to solve word problems.

The FCTMV contains different question types. As the level of knowledge increases, so do the questions, ranging from basic information retrieval questions to higher levels of synthesis and integration (Sasson Lazovsky et al. 2025). This is evident in the scaffolding of knowledge dimensions ranging from quadrant one to quadrant four in Figure 1. Bloom's Revised Taxonomy is the vehicle used to facilitate critical and creative thinking through the use of leading questions.

Bloom's Revised Taxonomy

Bloom's Revised Taxonomy provides a structured teaching approach that fosters metacognition and supports the development of critical and creative thinking. This framework is the backbone of the FCTMV. Learning activities were implemented using Bloom's Revised Taxonomy. Implementing the FCTMV has shown to be effective in enhancing learners' knowledge acquisition (Gunawan & Palupi 2016). The taxonomy comprises two key dimensions: (1) the cognitive process dimension, which includes remembering, understanding, applying, analysing, evaluating and creating and (2) the knowledge dimension, which encompasses factual, conceptual, procedural and metacognitive

knowledge (Adijaya et al. 2023; Gunawan & Palupi 2016). Learning activities aligned with the revised taxonomy are designed to be innovative and varied, explicitly targeting the development of learners' metacognitive abilities (Sudirtha et al. 2022).

Competent teachers can transform ordinary teaching experiences into engaging, meaningful interactions that promote learner enjoyment, active participation and improved learning outcomes (Andini & Supardi 2018; Sudirtha et al. 2022). Learner performance is closely linked to teacher competence (Sudirtha et al. 2022). One of the key aims of teaching is to involve learners in meaningful learning experiences that foster metacognition. This requires teachers to attend to how learners think, reason and engage with problems (Lestari, Selvia & Layliyyah 2019; Putri & Dirgantoro 2018; Sudirtha et al. 2022).

What distinguishes this taxonomy is its emphasis on reflection and metacognitive awareness. Learners are guided to reflect on what they know and do not know by engaging with leading questions, which fosters honesty about their understanding. This reflective process encourages learners to identify and correct their errors, thereby deepening their understanding and knowledge. Bloom's Revised Taxonomy not only serves as a framework for teacher development but also supports learners' learning. The higher-order cognitive processes (applying, analysing, evaluating and creating) form a foundation for critical and creative thinking. During these activities, the use of mathematics vocabulary becomes essential, as it enables learners to articulate their understanding of factual, conceptual, procedural and metacognitive knowledge found within mathematical word problems.

Ultimately, the FCTMV serves as a scaffolding structure. It begins with lower-order thinking (factual and conceptual knowledge). It progressively builds towards higher-order thinking (procedural and metacognitive knowledge), enabling learners to reason more deeply and to communicate more effectively (Sudirtha et al. 2022; see Figure 1).

Research methods and design

This qualitative study was conducted through the lens of constructivism and employed participatory action research as its research design. Six schools from Gauteng province were selected as research sites. This study included both public and private schools to include contextual variation typical of South African schooling contexts and to capture diversity in schooling conditions (class size and access to resources). Although many other schools were approached to take part in the study, only these six schools provided access to the researcher during COVID-19. The LoLT ranged from English to Afrikaans, with an emphasis on including Grade 3 teachers as co-researchers in the study. Grade 3 teachers were purposively selected based on the criterion that they have been teaching Grade 3 learners for more than 2 years consecutively. Grade 3 teachers were selected to take part in the study, as Grade 3 is the final grade in the foundation phase and requires adequate reading comprehension and reasoning skills. Furthermore, Grade 3 is the transition point from 'learning to read' to 'reading to learn' (Harlaar, Dale & Plomin 2007:116) before learners move to Grade 4.

During the pre-intervention phase, data were generated through pre-intervention semi-structured interviews. During the intervention phase, data were generated through voice recordings of six intervention workshops and the collection of teachers' diaries. During the post-intervention phase, data were generated through post-intervention semi-structured interviews. Data analysis employed a hybrid approach combining inductive and deductive methods. Four pre-determined categories were identified through deductive data analysis, while inductive analysis was informed by thematic analysis. For the discussion of this study, attention is given to two of these pre-determined categories, which gave rise to the FCTMV: (1) critical instructional practices for mathematics word problem-solving instruction and (2) professional development initiatives. During six fortnightly workshops, Grade 3 teachers participated as co-researchers. A hybrid approach was used: English-speaking participants met online via MS Teams, while Afrikaans-speaking participants met face-to-face because of geographical proximity; all discussions were recorded. Workshops lasted approximately 2 h, and all participants received researcher-developed booklets to support interactivity. Workshop content included Fuller's (1969) concerns-based model of teacher development, Gardner's (1983) multiple intelligences (MIs) theory, Shulman's (1986) model of pedagogical reasoning and action, pedagogical content knowledge (Hill, Ball & Schilling 2008), reading comprehension and mathematics register and mathematical modelling (Blum & Borromeo Ferri 2009) and mathematics proficiency (Kilpatrick 2009).

Conceptual framework: Framework of critical thinking and mathematics vocabulary

The word sum-wheel (Swanepoel 2022; Swanepoel & Luneta 2024) served as the driving force behind the study and refers to six steps taken to support teachers in teaching mathematics word problems: (1) read with understanding, (2) communicate and ask questions for clarity, (3) play and interactive strategies to understand the word problems, (4) match the operations to the context and vocabulary of the word problem, (5) calculate the answers of the word problem and (6) double-check the answers. For this study, steps one to three will be examined in detail, as these three steps led to the development of the FCTMV.

Step one of the word sum-wheel requires the problem solver to read the word problem as they would a comprehension passage: by looking for clues, checking meaning and considering its context. Step two encourages the problem solver to ask questions to stimulate critical and creative thinking, including leading questions that

explore the meaning behind the words in word problems and encourage thinking 'outside the box' (Wallis & Steptoe 2006). Step three requires the problem solver to be actively involved in creating new knowledge through play and being interactive. While the word sum-wheel is a teacher training and development tool in itself, it elevates the FCTMV as another valuable tool for teacher training and development.

The FCTMV was developed based on research conducted by Swanepoel (2022) and serves as a framework to bring together a multitude of aspects that impact the teaching and understanding of mathematics word problems. Recognising that understanding mathematics word problems relies on the same foundational skills as reading comprehension, this framework guides teachers in integrating critical and creative thinking while developing learners' mathematics vocabulary. Referencing Table 1, the first column refers to the dimensions of cognitive processes. These questions start with lower-order thinking questions (remember, understand) and gradually build to higher-order thinking questions (apply, analyse, evaluate and create). The second column lists examples of leading questions that illustrate to teachers what types of leading questions can be asked under each level of thinking and reasoning. The third column provides the teacher with examples of keywords and actions to be incorporated with the corresponding level of thinking and reasoning. As the levels of knowledge increase in thinking order, so do the complexity of the keywords and actions related to it. The last column connects the knowledge dimensions to the levels of thinking and reasoning. This suggests that metacognition is involved in higher-order thinking and reasoning, which requires metacognitive knowledge. This resonates with questions that require the problem solver to think beyond standard guidelines and function at a level that creates new knowledge. The FCTMV is a platform that teachers can use to systematically and creatively expose learners to mathematics vocabulary. This framework outlines the keywords and actions that learners must be able to achieve, providing teachers with the desired outcomes that learners are expected to attain. Teachers' instruction of mathematics vocabulary is guided by providing examples of leading questions that learners can ask to activate their knowledge of mathematics vocabulary (Ferlazzo & Sypnieski 2018).

Here is a practical demonstration of how the framework for critical thinking and mathematics vocabulary can be used: the framework supports both lower- and higher-order thinking by guiding teachers to scaffold learners' reasoning through the purposeful use of leading questions, keywords and action words. At the lower-order 'Understand' level, for example, a teacher may use the word problem: 'Thandi has five apples. She gives her friend two apples. How many apples does she have left?' The teacher poses the question, 'What does the word *gives* tell us?', scaffolding learners' understanding by prompting them to explain the action in their own words and to identify the keyword *gives* as a signal to subtract. The action word *explain* helps learners interpret the context, clarify meaning and summarise the problem in a meaningful way. At the higher-order *analyse* level, a more complex problem might be: 'Sipho bought three packs of crayons. Each pack has eight crayons. He gave four crayons to his sister. How many crayons does Sipho have now?' The teacher scaffolds critical thinking by asking, 'What steps do you think we need to follow and why?' prompting learners to break the problem into parts, identify the keywords *each* and *gave* and differentiate between operations (multiplication and subtraction). The related action words *organise* and *attribute* support learners in analysing the structure of the problem, making logical decisions and justifying their reasoning. In both cases, the framework helps the teacher align questioning strategies with the learners' developmental level, building progressively from understanding to deep analysis. Table 1 illustrates the FCTMV.

The integration of Bloom's Revised Taxonomy and the word sum-wheel highlights the process of scaffolding, as shown in Figure 1. The two concentric circles illustrate the relationship between these two key features of the FCTMV. The smaller circle houses the six steps from the word sum-wheel, while the larger circle houses the levels of dimensions of cognitive processes. Quadrants 1 and 2 represent lower-order thinking prompts and keywords, along with lower-order levels of knowledge. Quadrants 3 and 4 represent higher-order thinking prompts and keywords, along with the higher-order levels of knowledge. There is a progression from Quadrant 1 through Quadrant 4 in a clockwise direction, as indicated by the arrows. Figure 1 and Table 1 should be viewed as complementary to each other rather than as two distinct frameworks.

Ethical considerations

Ethical clearance to conduct this study was obtained from the University of Johannesburg, Faculty of Education Research Ethics Committee (No. Sem 2-2019-030). Informed consent was provided by participants.

Results

In response to the research question, investigating how the FCTMV functions as both a professional development tool for teachers and cognitive support for learners, the implementation of the framework has been shown to significantly enhance teaching and learning in mathematics word problem-solving. For teachers, the framework offered structured professional development by introducing pedagogical strategies aligned with the word sum-wheel and Bloom's Revised Taxonomy, enabling teachers to scaffold instruction more effectively and guide learners through purposeful questioning. For learners, improved problem-solving abilities were observed as a result of consistent instructional support, explicit focus on mathematics

vocabulary and the use of leading questions. As illustrated in Figure 1, the progression across the four quadrants of the framework reflects the development of learners' critical thinking, with each quadrant's keywords and teacher actions linked to increasingly complex cognitive tasks. This interconnected process not only empowered teachers with practical tools but also scaffolded learners' mathematical reasoning, demonstrating the dual function of the framework in classroom practice. In the section to follow, critical instructional practices used to support mathematics word problem-solving teaching and learning will be discussed in light of the implementation of the FCTMV.

Discussion

A linguistic approach to understanding and teaching mathematics word problems

Through the guidance of the FCTMV aligned with the first step of the word sum-wheel (Swanepoel & Luneta 2024), teachers introduced a systematic linguistic approach to analyse and understand mathematics word problems, starting with breaking the word problem into smaller sections, activating background knowledge and defining the meaning of mathematics vocabulary to understand the language of mathematics. Co-researcher explained:

> 'It is important that [*we*] as teachers use the proper vocabulary so that we make sure that the children understand the language or the vocabulary of the maths, so that you are breaking down that barrier that is there, and make it easier'. (School English-B, Teacher 1, Grade 3)

Teachers found that when they broke a mathematics word problem into short sentences and condensed the information, learners were able to read with understanding. This correlates with the lower-order thinking questions found under 'remember' and 'understand' according to Bloom's Revised Taxonomy, which takes hands with creating factual and conceptual knowledge (Sudirtha et al. 2022). Including this strategy proved successful in guiding teachers' instruction on mathematics word problems while also helping learners understand what they read (Orton & Frobisher 2002; Swanepoel 2016). Along with keeping sentences short, it was found that when teachers activate learners' prior knowledge and explicitly teach the meaning of mathematics vocabulary to learners, they are able to understand mathematics word problems (Ahmadi et al. 2013; Khoshaim 2020). Both teachers and learners had to become fluent in the 'language of mathematics' by making time to explicitly use the mathematics register (Xu et al. 2022). It was also found that, in many cases, teachers had to become familiar with the mathematical register before teaching it to learners. This is evident from co-research:

> 'We all dislike [*mathematics word problems*], but I think we dislike it because it is so hard to convey, to convey it understandably to a child. I think it is just about you having to understand it well, yourself, and then you have to be able to explain it to your children and how you are going to convey it so that it really makes sense to them'. (School Afrikaans-D, Teacher 1, Grade 3)

Scaffolding mathematical thinking through communication

Constant communication and asking leading questions for clarification, as seen in the word sum-wheel (Swanepoel & Luneta 2024), served as a key area of development in unlocking word problem-solving instruction through the FCTMV. Throughout the research, teachers utilised constant communication to create opportunities for learners to continually ask questions about mathematics word problems (Swanepoel 2022). Learners were encouraged to ask as many questions as possible. The co-researcher explained the main role of asking questions to learners:

> '… is to see do the learners understand. And if they do not understand you go back to your previous knowledge and you take one aspect at a time'. (School English-B, Teacher 1, Grade 3)

The purpose of learners asking questions throughout the completion of the mathematics word problem was for teachers to ascertain learners' comprehension of the word problem (Swanepoel 2016; Vance & Smith 2021). Similarly, teachers asked leading questions throughout the instruction of mathematics word problems to guide learners' thinking and assess whether they comprehended what the mathematics word problem was asking them to do. Linking back to the FCTMV, this relates to the lower-order thinking questions found under 'remember' and 'understand' and gradually transitions to higher-order thinking questions, such as 'apply' and 'analyse', according to Bloom's Revised Taxonomy. This involves creating factual and conceptual knowledge, as well as procedural and metacognitive knowledge (Sudirtha et al. 2022).

Verbal feedback was a strategy proposed by many teachers, claiming that if learners were able to provide a verbal answer instead of a written one, it meant that learners understood what had been asked. Furthermore, teachers noted that through the inclusion of constant communication, learners made a point of remembering to have two answers: one answer as part of the calculation and a second answer in the sentence answer. This aligns with step five of the word sum-wheel (Swanepoel & Luneta 2024). Lastly, learners also remembered to double-check (step six of the word sum-wheel) their answers by going back to the mathematics word problem and verifying that the mathematics register matches the calculation and the answers generated.

Not only was the FCTMV instrumental in supporting teachers' ability to solve word problems, but, as noted by teachers, the FCTMV, along with the word sum-wheel, has supported learners' abilities. Teachers have found that through the use of constant communication, asking leading questions and allowing learners to ask questions freely,

learners have begun to revisit the questions and the operation(s) they used and are now starting to double-check their answers.

This is a result of learners understanding the process of mathematics word problem-solving, the word sum-wheel, along with the mathematics register. The practice of learners checking answers has led to the elimination of learners' instant gratification and their tendency to rush through solving mathematics word problems. Based on learners' improved performance in mathematics word problem-solving, teachers' instruction in mathematics word problem-solving has been enhanced.

Using play to activate higher-order thinking in mathematics word problems

The third element in the word sum-wheel is 'play', which is an umbrella term encompassing the integration of peer and group instruction, the inclusion of practical and real-life experiences in mathematics word problem-solving instruction and the application of the MI theory in mathematics word problem-solving instruction. The 'play' element gives rise to the opportunities that are presented by the higher-order questions as proposed by Bloom's Revised Taxonomy, some of which include questions resulting from 'apply', 'analyse', 'evaluate' and 'create'. Procedural and metacognitive knowledge is created through participation, such as when opportunities for 'play' are implemented. The co-researcher stated:

> '[*Learners learn best*] physically with a game, and it is fun for me to teach through play, then it does not feel like work'. (School Afrikaans-D, Teacher 1, Grade 3)

The inclusion of peer engagement, where teachers allow learners to turn to each other and teach the mathematics word problem to one another, proved to be very successful. Group engagement was also effective in allowing learners to teach and learn in unconventional ways. Learners appreciated the variation in routine. Teachers found that when learners were able to freely discuss the word problem with each other and explain it to one another, they understood the content and context of the problem better. Through the use of peer and group engagement, learners were given the freedom to discover the meaning of the mathematics word problem and to experiment with solutions to the problems while working in their groups. One significant finding was the importance of integration, where mathematics word problem-solving is integrated into practical activities (Ariba & Luneta 2018).

Additionally, the foundation of asking leading questions and maintaining constant communication is integrated into other learning programmes, such as language and life orientation. Teachers have found that as there is little to no time reserved for explicit mathematics word problem-solving instruction, it should be adhered to and attended to in as many informal and integrated ways as possible. In addition, teachers have also noted that practical activities, such as baking and art, as well as physical activities, can be incorporated into mathematics word problem-solving instruction (Khoshaim 2020). This is especially true when learners are asked questions that contain mathematical vocabulary and have to process the question in light of the context, with their comprehension of the question incorporating the mathematics register. Lastly, through the integration of concrete materials and manipulatives, learners are given the opportunity to concretely experience what they are reading in the mathematics word problem. Some learners require the reassurance that concrete manipulatives provide to grasp the essence of a mathematics word problem. There should be time allocated for learners to actively engage with these concrete materials and manipulatives, allowing them to experiment and discover how the mathematics register, number operations and relationships complement each other.

Implications for practice and future research

Future research should explore how the FCTMV is implemented across diverse classroom contexts, including multilingual and under-resourced environments. Longitudinal studies could examine how sustained use of the framework in professional development affects teachers' instructional practices and learners' progression through different levels of cognitive and metacognitive understanding. In particular, there is a need to investigate how teachers adapt leading questions and vocabulary prompts to suit learners' varying cognitive readiness and how these scaffolds influence learner outcomes in mathematics word problem-solving. Additionally, future studies could assess the effectiveness of using the FCTMV as a formative assessment tool to track and support learners' growth from lower- to higher-order thinking. Comparative studies across provinces, languages of learning and teaching and phases of schooling may also provide insights into the framework's scalability and adaptability in broader educational systems.

Strengths and limitations

This strength of the study include the innovative FCTMV framework, which supports both teacher development and learner cognition, and its participatory design involving teachers as co-researchers. The research is contextually relevant to multilingual classrooms and aligns well with Bloom's Revised Taxonomy. However, limitations include a small sample size, a short implementation period and a lack of quantitative learner performance data. Additionally, potential researcher bias and limited scalability were noted, along with minimal focus on linguistic diversity beyond English and Afrikaans contexts.

Conclusion

One of the advantages of using Bloom's Revised Taxonomy is that learners' engagement is maximised (Wiranata et al. 2021). Researchers who delve into the advantages of using Bloom's Revised Taxonomy note that this taxonomy leads to positive adjustments in personal factors such as learners'

curiosity, learner confidence and willingness to participate (Wiranata et al. 2021). This is not only evident in the literature but was also found in this study. Through an increase in learners' curiosity and willingness to participate, teachers' word problem-solving instruction using the FCTMV as a teaching tool became successful. The integration of Bloom's Revised Taxonomy and the word sum-wheel, as derived from the FCTMV, can be used as a practical tool during teacher training sessions or classroom planning to scaffold learners' development from lower- to higher-order thinking. In professional development workshops, facilitators can guide teachers through each quadrant by demonstrating how to formulate and sequence leading questions, integrate appropriate mathematics vocabulary and align instruction with specific knowledge levels from Bloom's Revised Taxonomy. In classroom settings, the framework helps teachers plan lessons by selecting questions that match learners' cognitive readiness while gradually introducing more complex vocabulary and tasks. Teachers can also use the quadrants as a formative assessment tool to track learners' responses and identify whether they are working at factual, conceptual, procedural or metacognitive levels. Over time, repeated exposure to this structure empowers both teachers and learners to navigate mathematics word problems with increased confidence, clarity and depth of reasoning.

In answering the question of how word problem-solving instruction is scaffolded through the FCTMV, one needs to consider including learners in teaching and learning, leaning towards inclusive, interactive, learner-centred practices that not only focus on the mathematical aspect of word problem-solving but also acknowledge the linguistic element of word problem-solving. The FCTMV becomes a tool that emphasises the reciprocal relationship between teachers and learners. While the immediate focus of the FCTMV is geared towards teachers, learners are on the receiving end of transformation in teaching and learning.

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Competing interests

The author declares that no financial or personal relationships inappropriately influenced the writing of this article.

CRediT authorship contribution

Nadia Swanepoel: Conceptualisation, Data curation, Formal analysis, Investigation, Methodology, Project administration, Writing – original draft, Writing – review & editing. The author confirms that this work is entirely their own, has reviewed the article, approved the final version for submission and publication and takes full responsibility for the integrity of its findings.

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References

Adijaya, M.A., Widiana, I.W., Agung Parwata, I.G.L. & Suwela Antara, I.G.W., 2023, 'Bloom's taxonomy revision-oriented learning activities to improve procedural capabilities and learning outcomes', *International Journal of Educational Methodology* 9(1), 261–270. https://doi.org/10.12973/ijem.9.1.261

Ahmadi, M.R., Ismail, H.N. & Abdullah, M.K.K., 2013, 'The importance of metacognitive reading strategy awareness in reading comprehension', *English Language Teaching* 6(10), 235–244.

Amabile, T.M., Burnside, R.M. & Gryskiewicz, S.S., 1999, *User's manual for KEYS: Assessing the climate for creativity*, Center for Creative Leadership, Greensboro, NC.

Andini, D.M. & Supardi, E., 2018, 'Teacher's pedagogic competence on learning effectiveness with control variables teacher's educational background', *Journal of Office Management Education* 3(1), 1–7. https://doi.org/10.20448/jeelr.v9i2.3804

Ariba, O. & Luneta, K., 2018, 'Nurturing creativity in early years' mathematics via art-integrated mathematics lessons', *The International Journal of Childhood Learning* 25(4), 1–21. https://doi.org/10.18848/2327-7939/CGP/v25i02/31-48

Blum, W. & Borromeo Ferri, R., 2009, 'Mathematical modelling: Can it be taught and learnt', *Journal of Mathematical Modelling and Application* 1(1), 45–58.

Essien, A., 2018, 'The role of language in the teaching and learning of early grade mathematics: An 11-year account of research in Kenya, Malawi and South Africa', *African Journal of Research in Mathematics, Science and Technology Education* 22, 1–12. https://doi.org/10.1080/18117295.2018.1434453

Essien, A.A. & Moleko, M., 2025, 'Research on language and multilingualism in mathematics education in sub-Saharan Africa', *Africa Education Review* 21(10), 25–49. https://doi.org/10.1080/18146627.2025.2455577

Fajrin, M.F. & Sunra, L., 2024, 'Scaffolding in English classroom: A case study on the teaching of English language to eight-year students', *EduLine: Journal of Education and Learning Innovation* 4(3), 455–463. https://doi.org/10.35877/454RI.eduline3007

Ferlazzo, L. & Sypnieski, K.H., 2018, 'Teaching English language learners: Tips from the classroom', *American Educator* 42(3), 12.

Fitzpatrick, C.L., Hallett, D., Morrissey, K.R., Yıldız, N.R., Wynes, R. & Ayesu, F., 2019, 'Response sentences, examples, and authenticity do not help children solve real wor(l)d problems', *Learning and Instruction* 61, 111–125. https://doi.org/10.1016/j.learninstruc.2018.10.002

Fuller, F.F., 1969, 'Concerns of teachers: A developmental conceptualization', *American Educational Research Journal* 6, 207–226. https://doi.org/10.3102/00028312006002207

Gardner, H., 1983, *Frames of mind*, Basic Books, New York, NY.

Ghozelin, V.M., Hadiyanti, A.H.D. & Kriswanto, Y.B., 2016, 'Improving student activities and learning outcomes using Co-Ruf-Si learning media (Education Letter Box) based on word square on people's sovereignty and government system materials in Indonesia class VIIIC SMP', *Journal of Citizenship Education* 6(2), 980–993.

Graven, M. & Sibanda, L., 2018, 'Can mathematics assessments be considered valid if learners fail to access what is asked of them?', *South African Journal of Childhood Education* 8(1), 1–12. https://doi.org/10.4102/sajce.v8i1.505

Greer, B., 1993, 'The mathematical modeling perspective on wor(l)d problems', *Journal of Mathematical Behavior* 12(3), 239–250.

Gunawan, I. & Palupi, A.R., 2016, 'Bloom's taxonomy – revision of the cognitive domain: A foundational framework for learning, teaching and assessment', *Premiere Educandum: Journal of Basic Education and Learning* 2(2). https://doi.org/10.25273/pe.v2i02.50

Harlaar, N., Dale, P.S. & Plomin, R., 2007, 'From learning to read to reading to learn: Substantial and stable genetic influence', *Child Development* 78(1), 116–131. https://doi.org/10.1111/j.1467-8624.2007.00988.x

Hill, H.C., Ball, D.L. & Schilling, S.G., 2008, 'Unpacking pedagogical content knowledge: Conceptualizing and measuring teachers' topic-specific knowledge of students', *Journal for Research in Mathematics Education* 39(4), 372–400. https://doi.org/10.5951/jresematheduc.39.4.0372

Khoshaim, H.B., 2020, 'Mathematics teaching using word-problems: Is it a phobia?', *International Journal of Instruction* 13(1), 855–868. https://doi.org/10.29333/iji.2020.13155a

Kilpatrick, J., 2009, 'The mathematics teacher and curriculum change', *PNA Revista de Investigación en Didáctica de la Matemática* 3(3), 107–121. https://doi.org/10.30827/pna.v3i3.6185

Kirkland, P.K. & McNeil, N.M., 2021, 'Question design affects students' sense-making on mathematics word problems', *Cognitive Science* 45(4), e12960. https://doi.org/10.1111/cogs.12960

Kirom, A., 2017, 'The role of teachers and students in the multicultural-based learning process', *Journal of Al-Murabbi* 3(1), 69–80.

Krathwohl, D.R., 2002, 'A revision of Bloom's taxonomy: An overview', *Theory into Practice* 41(4), 212–218. https://doi.org/10.1207/s15430421tip4104_2

Lestari, W., Selvia, F. & Layliyyah, R., 2019, 'Open-ended approach to students' metacognitive ability', *At-Ta'lim: Journal of Education* 5(2), 93–106.

Machaba, F.M., Sipholi, K. & Motseki, P., 2024, 'Multilingual students' solution strategies in solving linear programming problems: A case of national curriculum vocational level 3 mathematics students', *Journal of Culture and Values in Education* 7(2), 115–135. https://doi.org/10.46303/jcve.2024.15

Nurmatova, S. & Altun, M., 2023, 'A comprehensive review of Bloom's taxonomy integration to enhancing novice EFL educators' pedagogical impact', *Arab World English Journals* 14(3), 24. https://doi.org/10.24093/awej/vol14no3.24

Ortlieb, E., Bowden, R., Inman, A., Hu, B., Pate, R.S., Gauthier, L.R. et al., 2012, *Educational research and innovations*, CEDER, Corpus Christi, TX.

Orton, A. & Frobisher, L., 2002, *Insights into teaching mathematics*, Continuum, London.

Pane, A. & Darwis, D.M., 2017, 'Study and learning', *FITRAH: Journal of the Study of Islamic Sciences* 3(2), 1–20. https://doi.org/10.24952/fitrah.v3i2.945

Peng, P., Lin, X., Ünal, Z.E., Lee, K., Namkung, J., Chow, J. et al., 2020, 'Examining the mutual relations between language and mathematics: A meta-analysis', *Psychological Bulletin* 146(7), 595–634. https://doi.org/10.1037/bul0000231

Pimm, D., 2019, *Routledge revivals: Speaking mathematically (1987): Communication in mathematics classrooms*, vol. 4, Routledge, Abingdon.

Polya, G., 1957, *How to solve it: A new aspect of mathematical method*, 2nd edn., Princeton University Press, Princeton, NJ.

Puccio, G.J., Klarman, B. & Szalay, P.A., 2023, 'Creative problem-solving', in V.P. Glăveanu (ed.), *The Palgrave encyclopedia of the possible*, pp. 298–313, Springer International Publishing, Cham.

Puccio, G.J., Murdock, M.C. & Mance, M., 2007, *Creative leadership: Skills that drive change*, Sage, Thousand Oaks, CA.

Putri, K. & Dirgantoro, S., 2018, 'Metacognitive skills approach in learning mathematics metacognitive skills', *Jurnal Didaktik Matematika* 3(1), 1–10.

Raz, T., Reiter-Palmon, R. & Kenett, Y.N., 2023, 'The role of asking more complex questions in creative thinking', *Psychology of Aesthetics, Creativity, and the Arts* 19(6), 1505–1525. https://doi.org/10.1037/aca0000658

Sarnoko, S., Ruminiati, R. & Setyosari, P., 2016, 'The application of the SAVI approach assisted by learning videos to improve social studies activities and learning outcomes for fourth grade students of SDN I Sanan Girimarto Wonogiri', *Journal of Education: Theory, Research and Development* 1(7), 1235–1241. https://doi.org/10.20448/jeelr.v9i2.3804

Sasson Lazovsky, G., Raz, T. & Kenett, Y.N., 2025, 'The art of creative inquiry – From question asking to prompt engineering', *The Journal of Creative Behavior* 59(1), e671. https://doi.org/10.1002/jocb.671

Setati, M., Molefe, T. & Langa, M., 2008, 'Using language as a transparent resource in the teaching and learning of mathematics in Grade 11 multilingual classroom', *Pythagoras* 2008(1), 14–25. https://doi.org/10.10520/EJC20899

Shulman, L.S., 1986, 'Those who understand: Knowledge growth in teaching', *Educational Researcher* 15(2), 4–14. https://doi.org/10.3102/0013189X015002004

Strohmaier, A.R., Reinhold, F., Hofer, S., Berkowitz, M., Vogel-Heuser, B. & Reiss, K., 2022, 'Different complex word problems require different combinations of cognitive skills', *Educational Studies in Mathematics* 109(1), 89–114. https://doi.org/10.1007/s10649-021-10079-4

Sudirtha, I.G., Widiana, I.W. & Adijaya, M.A., 2022, 'The effectiveness of using revised Bloom's taxonomy-oriented learning activities to improve students' metacognitive abilities', *Journal of Education and e-Learning Research* 9(2), 55–62. https://doi.org/10.20448/jeelr.v9i2.3804

Swanepoel, N. & Luneta, K., 2024, 'The development of the word sum-wheel to enhance Grade 3 teachers' mathematic word problem-solving instruction', *Perspectives in Education* 42(4), 232–249. https://dx.doi.org/10.38140/pie.v42i4.7373

Swanepoel, N., 2016, 'Teaching English reading comprehension to Grade 2 First Additional Language learners', Masters dissertation, Faculty of Education, University of Pretoria.

Swanepoel, N., 2022, 'Enhancing Grade 3 teachers' mathematics word problem-solving instruction through professional development initiatives', Doctoral thesis, University of Johannesburg.

Vance, E.A., & Smith, H.S., 2021, 'Asking great questions: Part of a theory of communication in interdisciplinary collaborations', *JSM Proceedings*, pp. 995–1008, viewed 19 June 2025, from https://par.nsf.gov/biblio/10310043

Wallis, C. & Steptoe, S., 2006, 'How to bring our schools out of the 20th century', *TIME*, 18 December, 50–56.

Widiana, I.W., Triyono, S., Sudirtha, I.G., Adijaya, M.A. & Wulandari, I.G.A.A.M., 2023, 'Bloom's revised taxonomy-oriented learning activity to improve reading interest and creative thinking skills', *Cogent Education* 10(2), 2221482. https://doi.org/10.1080/2331186X.2023.2221482

Wilkinson, L.C., 2018, 'Teaching the language of mathematics: What the research tells us teachers need to know and do', *Journal of Mathematics* 51, 167–174. https://doi.org/10.1016/j.jmathb.2018.05.001

Wilkinson, L.C., 2019, 'Learning language and mathematics: A perspective from linguistics and education', *Linguistics and Education* 49, 86–95. https://doi.org/10.1016/j.linged.2018.03.005

Wiranata, D., Widiana, I.W. & Bayu, G.W., 2021, 'The effectiveness of learning activities based on revised bloom taxonomy on problem-solving ability', *Indonesian Journal Of Educational Research and Review* 4(2), 289–298. https://doi.org/10.23887/ijerr.v4i2.37370

Xu, C., Lafay, A., Douglas, H., Di Lonardo Burr, S., LeFevre, J.A., Osana, H.P. et al., 2022, 'The role of mathematical language skills in arithmetic fluency and word-problem solving for first-and second-language learners', *Journal of Educational Psychology* 114(3), 513. https://doi.org/10.1037/edu0000673

Zevenbergen, R., 2001, '"Cracking code" of mathematics classrooms: School success as a function of linguistic, social and cultural background', in J. Boaler (ed.), *Multiple perspectives on mathematics teaching and learning*, pp. 201–223, Ablex Publishing, London.