



Exploring the integration of multiple methods of representation for the effective teaching of mathematics word problems

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Abstract—This study looks at the attitudes of policymakers regarding equity in the practice and policy of mathematics education. In addition to the culture of mathematics education, it also examines the broader culture. It explores the effects this has on teachers, lawmakers, and students, as well as how the disorderly flow of ideas from one subject to the next shapes how language is expressed, both orally and in writing. The findings are based on a flexible, essential instructional approach to mathematical word problems that improves learning outcomes. To facilitate meaningful learning, create inclusive learning environments, and make content accessible and flexible, teaching is crucial. Consequently, to maximise learning, educators must provide adaptive instruction for mathematical word problems. The emphasis on the fifth strand is "a consistent propensity to view mathematics as meaningful, practical, and worthwhile, along with a faith in one's own productivity and hard work." These authors claim that students excelled in conceptual understanding, procedural fluency, and strategic competence. Furthermore, a robust correlation was observed between procedural fluency and conceptual comprehension. Nonetheless, conceptual knowledge serves as the foundation for all other mathematical concepts.

Keywords: Multiple methods of representation, Teaching of mathematics word problems, Universal design for learning

To cite this article (APA): Molaba, S. E. (2026). Exploring the integration of multiple methods of representation for the effective teaching of mathematics word problems. *International Journal of Studies in Systematic Reviews*, 1(1), 57–65. <https://doi.org/10.66434/ijssr.v1i1.514>

I. INTRODUCTION

MATH word problems can be difficult for students who struggle with English (Moleko & Mosimege, 2021). This is because mathematics word problems require students to possess not only the ability to manipulate numbers but also other skills, many of which they do not have, such as recognising, understanding, interpreting, generating, communicating, and calculating numbers. Sitopu et al. (2024) claim that students have difficulty understanding and solving these problems because they lack a sufficient grasp of mathematical terminology. For many educators, understanding and teaching word problems in mathematics is a challenge. When taught to students, word problems offer numerous advantages, such as helping them connect and apply the material covered in class to real-world situations (Kim, 2020), enhancing their capacity for logical analysis, and stimulating their creative thinking. Researchers claim that, although word problems offer significant advantages, students have clearly had difficulty comprehending and solving them (Demirsoy, 2020). Within the framework of this research, word problems are mathematical puzzles expressed in words that represent actual events or circumstances. To solve these problems, students must first read, comprehend, and make sense of the text before they can ultimately convert it into algebraic mathematical expressions (Moleko & Mosimege, 2021).

In an interesting comparison, Moriyanti et al. (2019) explain the function of "representation" in mathematics. These authors claim that if the "real world" is divided into two distinct, strange-to-one-another lands (a land and mathematics), and if a river separates these lands, a bridge would be necessary to span the river. Spooner et al. (2019) see representation in this context as a "bridge" that links the abstract mathematical concept to daily life. Accordingly, Spooner et al. (2019)

view representations as the "key elements" necessary for understanding and effectively expressing mathematical concepts.

Teaching arithmetic word problems is challenging since it requires skills that most kids do not seem to have (Darnis & Dodd, 2021). Because they are unable to compose number sentences, fill in blanks, or solve arithmetic problems, learners' limited reading comprehension makes teaching word problems more difficult (Bobis et al., 2020). When completing word problems rather than matching numbers, most pupils make more mistakes. This is because word problems require complex mathematical computations (Mainali, 2022). Apart from other categories of knowledge, including B. linguistic knowledge and language analysis, which are proficiencies that most educators fail to cultivate, they acquire knowledge, such as B. linguistic analysis and linguistic knowledge that most teachers are unable to impart to their students (Henriksen et al., 2020). Nevertheless, teaching word problems is more challenging, particularly in classroom settings where English is both the language of instruction and a second language for the pupils (Lambert, 2020).

II. VALUE OF THE STUDY

This study examines policymakers' attitudes toward equity in mathematics education policy and practice. It examines both general culture and the culture of mathematics education. It examines the consequences this has for educators, legislators, and students, and how a mindset is formed and maintained by moving from topic to topic without order, which is expressed in spoken and written language (Telem, 2020). According to Kraft (2020), due to the difficulties and challenges of working with students whose experiences with mathematics differ from their own, it may be necessary to provide additional support as policies and curricula are developed (Li & Bates, 2019). More diverse views, ones that reflect the opinions and viewpoints of many students, and voices that are equal. A passion for mathematics

education and the potential to foster it in students of all characters may be required for mathematics instruction committees (Yeager et al., 2019).

According to Haegele et al. (2024), Universal Design for Learning (UDL) in adaptive physical education has been argued to be the answer to the problems in teaching students with and without disabilities together in physical education classes. So much so that, up until now, UDL has held a privileged and mostly unchallenged place in the scholarship and practice of adapted physical education. To further scholarly discourse, this article critically examines the scientific evidence supporting or refuting the use of UDL as a purportedly inclusive strategy. It does so by drawing on published theoretical and empirical studies on UDL in general and on physical education in particular. In closing, we issue a challenge to academics working in this area, including ourselves: carry out theoretically guided and empirically informed research on UDL in physical education.

III. LITERATURE REVIEW

Surur (2021) points out that the primary principle of MMR is to provide students with a variety of ways to acquire, process, and integrate information and knowledge. This principle's underlying presumption is distinct; it guides students in interpreting and comprehending the material presented to them. Information presented in the form of sounds or images may be easier for some children to understand than written information. Disparities in the student population were observed, which may be attributed to hearing, vision, language, culture, and learning-related obstacles.

As a result, while there is no perfect way to represent every student, it does offer the opportunity for representation to be impactful in educational activities (Moleko & Mosimege, 2021). The foundation of UDL is the idea that some pupils find it challenging to access traditional curricula, as these students have different needs and learning preferences. The goal of Universal Design for Learning is to produce expert learners who manage their own education (Novak, 2016). It also enables individuals by giving people greater autonomy over their lives and the ability to choose what they do and how they do it. This turns UDL into a proactive strategy that teachers can use to anticipate students' future needs and adjust their lesson plans accordingly (Deschaine & Whale, 2017). UDL aims to make the curriculum accessible to most students, not to meet the needs of every student in the classroom (Novak, 2016). Teachers should deliver instruction in a classroom that uses the UDL framework, but students are ultimately in charge of their own education (CAST Professional Learning, 2017).

UDL comprises three elements as a guiding tool for teaching: numerous opportunities for engagement, diverse representation options, and diverse means of action and expression. Ok et al. (2017) assert that UDL is designed to meet the individual needs of each learner by providing rigorous, adaptable, and varied education. Each UDL principle corresponds to a specific brain network, as explained in the following sections. The principles are designed to specifically address the learning associated with each network (Luhrs & McAnally-Salas, 2016). The focus of the study is on different representation options for mathematical word problems.

MMR provides options for language, mathematics expressions, and symbols

When necessary, tutors who speak the same language as their students might explain things in their native tongue. In this sense, tutors were quite significant. A common theme in the literature on various forms of representation is the application of various formats when giving students access to course materials.

Instructors can supplement the material offered through text-based readings and other media with video lectures and tutorials. Scott and Temple (2017) recommend that instructors use a variety of media in in-class lectures, including live lectures, recorded lectures for playback, and other audio recordings related to the subject matter. Younger students prefer interactive exercises in an online course, whereas older students prefer video lectures (Marks et al., 2016). They

advise faculty to offer both alternatives and use multiple forms of representation. According to Robinson and Wizer (2016), children with disabilities, English language learners, and students in general can all benefit from closed captioning.

MMR provides options for comprehension

Students fixed errors in the learning management system by using their technology skills. For example, students used their smartphones to type answers to online tests and assignments. These were either submitted via their cell phones on the course website or given to instructors for submission. MMR comprises three guidelines, namely, offering options for language, mathematical expressions, and symbols; offering options for perception; and offering options for comprehension (Ojageer, 2019). In terms of creating multiple representations, the study demonstrated the relationship among these three themes (Moleko & Mosimege, 2021). For example, the study's conclusions suggest that teachers must provide students with a variety of options for perception, language, comprehension, and mathematical expressions and symbols. To enable students to receive and analyse information, as different learners process, analyse, and integrate it in different ways (Henriksen et al., 2020). It is thought to be necessary to offer a variety of possibilities, highlighting and balancing these many aspects within the MMR formulation (Dack, 2019). The study contributes by showing the Importance of enhancing students' understanding of mathematical concepts. Lambert (2021) argues that this is made possible by the proper and appropriate use of language, mathematical expressions, and symbols to enable the information to be understood. One of the educational objectives that teachers should work to accomplish is the development of competent and resourceful learners, which the application of MMR helps shape (Moleko & Mosimege, 2021).

MMR enhances the effective teaching of mathematics word problems

To increase learning, flexible instruction on word problems in mathematics is crucial. Flexible teaching is essential to provide meaningful learning. It is crucial to create an inclusive learning environment and make knowledge accessible. Teachers must work to provide adaptable instruction on word problems in mathematics to maximise learning (Moleko & Mosimege, 2021). Accordingly, the purpose of the qualitative case study presented in this paper was to investigate how MMR, a component of UDL, may be used to support flexible teaching of mathematics word problems. Choy et al. (2017) reported that focus groups, reflection sessions, and observation sessions were conducted with five high school math teachers and a department head to gather data. The educators participated in a brief workshop on improving learning. Flexible instruction in word problems in mathematics is crucial. To provide meaningful learning, foster inclusive learning environments, and make knowledge accessible and flexible, teaching is essential. Teachers should therefore try to use the UDL principles, which were designed to acquaint and orient students to the methodology (Clarke et al., 2017). The study demonstrated that by offering a variety of comprehension options, including language, mathematical expressions, and symbols, as well as perception options, MMR can be used to provide flexible teaching of mathematics word problems. The study's conclusions advise teachers to modify their methods by incorporating the MMR principle to support and encourage flexible teaching of arithmetic word problems.

Teachers see things through the prism of their professional experiences and viewpoints. As a result, this study considers teachers' perspectives and knowledge in addition to their observational skills, providing insight into how professional understanding (Fernández & Choy, 2019). This study chose to focus on numerous representations as a discipline-specific perspective for noticing, since they are important for comprehending mathematics on the one hand, but can also be a hindrance to learning on the other. This comparative study examines the contribution of teaching experience on professional knowledge, perspectives, and noticing in both pre-service and in-service teachers (Friesen, 2017). The participants provided answers to a series of

questions covering various facets of perspectives and knowledge. Descriptive-based questions were employed to elicit theme-specific noticing from the teachers. Anhalt and Cortez (2016) found that, while quantitative approaches constituted most of the data analysis, a qualitative in-depth study was also conducted, focusing on how the instructors' professional knowledge informed their theme-specific noticing. The findings imply that both pre-service and in-service educators are not fully aware of the critical role that numerous representations play in mathematical learning and their significance within their respective disciplines (Hsieh et al., 2020). Nevertheless, the in-service teachers who took part stood out from the pre-service instructors, particularly in their theme-specific observations. Furthermore, the data suggests that educators use both local and global knowledge and perspectives when identifying crucial instances of handling numerous representations.

Teachers face challenges integrating the MMR to teach word problems in mathematics effectively

The ability to answer different kinds of word problems is a key component of the mathematics curriculum and a necessary precondition for general problem-solving abilities (Ghali et al., 2018). Research has demonstrated that word problem difficulty is influenced by three factors: the solver, the environment, and the issues' inherent qualities, such as linguistic and arithmetic features. However, little is known about how effective instruction affects students' ability to solve various kinds of word problems (Emanuel et al., 2021). This study manipulates linguistic (lexical consistency and nominalization) and mathematical (operations and carry/borrow) difficulty independently to investigate the relationship between students' perceptions of teaching quality and their performance on word problems.

The following are some of the qualities and strategies that teachers can implement in the MMR of mathematics word problems.

Proficiency in mathematics

It is important to consider that proficiency in mathematics generally involves analysing and characterising competency before examining instructional practices that might enhance students' mathematical skills in algebra and patterns. Lawson (2016) states that for students to interact with "mathematics successfully," they must be proficient in mathematics. Procedural knowledge is insufficient for the development of mathematical proficiency. Moss et al. (2016) also found that conceptual understanding is required.

Procedural knowledge can be thought of as knowing a series of acts, whereas conceptual knowledge is rich in linkages and networks (Ontario College of Teachers, 2016). The combination of conceptual and procedural understanding should lead us first to assess and characterize competency before examining instructional practices that may help students become more proficient in algebra and patterns. Ontario Council of Agencies Serving Immigrants (2016) states that for students to interact with "mathematics successfully," they must be proficient in the subject. Regarding these components, they can be used effectively. Most of the classroom education still relies exclusively on procedural comprehension, despite the importance of combining conceptual and procedural understanding (Sullivan & Artino, 2017). However, there has been a persistent push in North America over the past 20 years to expand the scope of instruction beyond only imparting procedural mathematical knowledge (van Garderen et al., 2019).

Mathematical proficiency model

According to Alex and Mammen (2018), possessing mathematical proficiency involves five interconnected and interdependent strands. The five strands provide a framework for discussing the concepts, aptitudes, knowledge, and attitudes that help students become more proficient mathematicians. Conceptual comprehension, procedural fluency, strategic competence, adaptable reasoning, and a constructive attitude are among them. This paradigm divides mathematical proficiency into five strands, with conceptual and procedural understanding making up two of them. Competencies intertwined, Courtad (2019), a model outlining the elements of mathematical

competency. According to this paradigm, conceptual comprehension is not just isolated facts but rather the integration of mathematical concepts that students should be familiar with (Etikan et al., 2016). The authors also point out that, with conceptual knowledge, pupils can recognize deeper connections between seemingly unrelated situations and their appropriate uses, thereby learning less. According to Liljedah et al. (2016), procedural knowledge is implied by the procedural fluency strand, which also comprises understanding of processes, including knowing when and how to employ them flexibly to execute tasks accurately and efficiently (Naderifar et al., 2017). Another component of Kilpatrick's model that is required for mathematical proficiency is strategic competence, which has been the subject of numerous studies (Ojageer, 2019). The capacity to formulate, depict, and resolve mathematical issues is known as strategic competency. Three areas of mathematical proficiency: conceptual comprehension, procedural fluency. According to these writers, conceptual comprehension was the area in which students excelled the most, followed by procedural fluency and strategic competency.

Furthermore, a high association was observed between procedural fluency and conceptual understanding. Researchers in mathematics education have argued that procedural fluency leads to strategic application of procedures, which both aid and benefit conceptual understanding, even though conceptual understanding is essential for the foundation of all other aspects of mathematical proficiency (Danesh & Nourdad, 2017). The mathematical proficiency model also includes adaptive reasoning, which is the ability to reason, reflect, explain, and justify logically.

Described as "the habitual inclination to see mathematics as sensible, useful, and worthwhile, coupled with a belief in diligence and one's own efficacy," the fifth strand is productive disposition. According to these writers, conceptual comprehension was the area in which students excelled the greatest, followed by procedural fluency and strategic competency. Furthermore, a high association was observed between procedural fluency and conceptual understanding. At the same time, conceptual knowledge serves as the foundation for all other mathematical concepts (Salihu et al., 2018).

However, to assess students' competency level, other research on mathematical proficiency (Saleme & Etchells, 2016). Typically focuses primarily on conceptual comprehension and procedural fluency. The degree to which procedural fluency and conceptual understanding are related, and the thoroughness, correctness, abstraction, and well-structure of the knowledge, all heavily influence how deeply a concept is understood (Sukhai & Mohler, 2016). Given varying opinions regarding procedural fluency instruction in the model and because procedural understanding was employed by other researchers in its stead, I choose to employ it for the objectives of this investigation. Subsequently, this study demonstrates the connections between procedural and conceptual understanding when students work with mathematics. Skills, competencies, aptitudes, and convictions (Collins, 2016).

Factors inherent qualities

Absence of involvement in class activities

The results of the study and the literature review show that low learner participation in multilingual English is more common in classrooms than in students' native tongues (Brown et al., 2016). When home languages are "banned," and only English is encouraged, many students may stop participating in class activities out of fear of being made fun of or teased for their poor English communication skills. Boonen et al. (2016) suggest that teachers should provide students as many opportunities as possible to express themselves, not just in English but also in their native tongues when feasible, to counter this threat. This includes expressing oneself via writing journals, dramatisation, recording, portfolios, and other means. To promote discussion and engagement, teachers must also carefully, actively, and deliberately use learners' native tongues as stimuli. It was suggested that code-switching be used to boost student involvement in

the classroom. Code swapping, according to Darsih (2018), encourages student involvement and allows students to use their native tongue as a resource for learning.

Lack of mother tongue content available

The absence of instructional materials in students' native languages was found to be an additional hindrance to the effective implementation of the approach (Cypress, 2017). Empirical data and literature research, respectively, showed that most instructional resources are still compiled only in English and, as a result, do not offer additional clarification in a language students find easier to understand than English (De Klerk & Palmer, 2020). Since these resources are typically not "reader-friendly," teachers must step in to help students understand the material. A potential remedy for this problem was identified as additional language training delivered by subject-matter experts in mathematics and English, respectively, to address language use. Fatmanissa and Kusnandi (2017), the mathematics teachers would provide the students with content in line with what the English teachers would have recommended as best practices to teach the problems that are in text format, and the English teachers, as language practitioners, would help to ensure that the teaching material is clear and simple.

Refusal of stakeholders to collaborate

The teachers may be reluctant to collaborate because it is challenging. For instance, math teachers might believe that their pedagogical content expertise is sufficient to teach MWP's and, as a result, may not perceive the need to collaborate with English teachers (Ergen, 2020). They do this while ignoring the fact that English teachers are "language specialists." However, it is possible the English instructors will not participate as planned because they do not fully understand their role in supporting the mathematics teachers. Mahofa et al. (2018) suggested that the purpose of the collaboration between mathematics and English professors should be made clear so that both parties could understand how they could support one another in the teaching process.

Language structures' impact on interpretation and meaning

Learners bring a variety of languages to multilingual classrooms, as documented in the literature and empirical research (Maher et al., 2018). The linguistic patterns of the various languages typically affect how learners comprehend and translate written material. It follows that learners' interpretations of mathematical terms in their native languages cannot be separated from their meanings in mathematics (Moleko & Mosimege, 2021). In this case, the teacher's role becomes difficult, as they must ensure a shared understanding and interpretation of the various words in the given situations. Nonetheless, it was shown that, in this case, discussing terminology was beneficial for ensuring MWP's (Collins, 2016). Language structures' impact on interpretation and meaning (Morin et al., 2017). Learners bring a variety of languages to multilingual classrooms, according to the literature and empirical research, due to the linguistic patterns they bring with them. Students typically learn about the various interpretations and meanings of terms used in both everyday speech and mathematical contexts (Moleko & Mosimege, 2020).

IV. OBJECTIVES OF THE STUDY

This study explores the integration of MMR to teach mathematics word problems effectively. Therefore, the objectives of the study are to explore ways in which MMR enhances effective teaching of mathematics word problems and determine the challenges teachers encounter when integrating MMR for effective teaching of mathematics word problems.

V. METHODS

Research paradigm

According to Kraft (2020), a research paradigm is a set of ideas that guide a researcher toward appropriate patterns of research activity and encompasses a variety of viewpoints regarding the nature of the world and research tasks. This study was based on an interpretivist paradigm.

According to Li and Bates (2019), interpretivism is a philosophy that seeks to understand human experiences and opinions by examining people's knowledge and worldviews. According to Yeager et al. (2019), the main goal of interpretivism is to understand human experiences and determine how people interpret the many events in which they are involved. Interpretivism is used because it helps to read and understand educators' experiences in overseeing teaching and learning in mathematics word problems using desktop creation. Yeager et al. (2019) exemplify this and explain that the main goal of interpretivism is to understand human experiences and how individuals make meaning of the events in which they participate. The interpretivist paradigm helps the researcher understand teachers' experiences as they explore MMR for the effective teaching of mathematics word problems. Through document analysis, reading textbooks, and reading journal articles.

Research approach

Data on educators' experiences in teaching mathematics word problems were collected using a qualitative method. Hellman et al. (2019) state that qualitative researchers aimed to understand the problem by exploring people's experiences at home or at work. Alghamdi et al. (2020) consider qualitative research a method aimed at understanding and describing the phenomenon. In addition, this approach allowed the researcher to explore the narrative researcher's strategy, one of the qualitative method's strategies. Kivunja (2018) states that the qualitative method aims to achieve a deeper understanding of complex issues. Hennink et al. (2020) claim that the qualitative approach is based on a naturalistic technique that aims to study the phenomena. Data on educators' experiences in exploring the MMR for effective teaching of mathematics word problems. Scott and Temple (2017) state that qualitative researchers aim to understand the context in which the study is conducted, in real-world settings.

Through reading books, articles, and journals, and examining documents, researchers learned about MMR for effective teaching of mathematics word problems. Because the qualitative approach is often used to examine and analyse texts relevant to complex ideas and phenomena, the researcher decided that it was acceptable for this study (Smith & McGannon, 2017). For this reason, Scott and Temple (2017) state that the qualitative method aims to achieve a deeper understanding of complex issues. Hennink et al. (2020) claim that the qualitative approach, based on a naturalistic technique that seeks to understand, is suitable for this study as it allowed the researcher to read a wide range of publications, including Books, essays, and magazines.

Research design

A desktop research design was used in this study. This suggests that the research was based on the literature, meaning that the data came from books, published journal articles, and document analysis. A secondary research strategy that involves synthesising, summarising, and compiling previous research is called a desktop research design (Ojageer, 2019). The desktop technique was used to identify the published literature on educators exploring MMR for the effective teaching of mathematics word problems. This allowed the researcher to examine previously published studies and gain further insight into how MMR enhances the effective teaching of mathematics word problems. The researcher provided further information on educators' responsibilities in exploring MMR for the effective teaching of mathematics word problems.

Secondly, to identify the challenges teachers encounter when integrating MMR to teach word problems effectively in mathematics. The use of many literature sources was the main advantage of the desktop research approach (Alkateeb, 2019). It was emphasized that this requires reading publications several times. This study explored MMR for the effective teaching of mathematics word problems, drawing on a variety of journal articles and textbooks. This gave me a better understanding of how extensive the question being investigated is.

Data collection techniques

The researcher used document analysis enabled by Google Scholar and other websites, as well as published books, articles, and journals, to

compile material. The methods researchers use to collect and examine data from various sources are called data collection techniques (Lambert, 2021). Part of the data collection and analysis process involved narrowing the scope of the literature review to meaningful dimensions. While reviewing the available books and documents, about 20 were found. Ten publications, books, and journal articles were selected after exploring MMR for the effective teaching of mathematics word problems. The ten books, articles, and journals were selected as the basis for this important literature review.

Table: Books and articles reviewed

Authors and year of publication	Titles
1. Van Garderen et al. (2019).	Special education teachers' perceptions of students with disabilities' abilities, instructional needs, and difficulties with visual representations in solving mathematics problems.
2. Salihi et al. (2018)	Children with learning difficulties in mathematics: Relating mathematics skills and reading comprehension.
3. Scott and Temple (2017).	A conceptual framework for building UDL in a special education distance education course.
4. Sukhai and Mohler (2016).	Creating a Culture of Accessibility in the Sciences.
5. Sullivan and Artino (2017)	How to Create a Bad Survey Instrument.
6. Al-Mutawah et al. (2019).	Conceptual understanding, procedural knowledge, and problem-solving skills in mathematics.
7. Moleko and Mosimege (2020)	Teachers' and learners' experiences for guiding effective teaching and learning of mathematics word problems.
8. Moleko and Mosimege (2021).	Flexible teaching of mathematics word problems through MMR.
9. Lambert (2021)	The magic is in the margins: Universal Design for Learning Math.
10. Chevalier et al. (2020).	Fostering computational thinking through educational robotics: a model for creative computational problem solving.

Data analysis

To examine and evaluate the study's data, the researcher used document analysis. A research technique called document analysis is used to analyse the content of a text and determine the goals of a particular organisation or person (Alex & Mammen, 2018). Additionally, document analysis is a research technique that examines words and phrases across a range of texts, including essays, speeches, and interviews (Courtad, 2019). Furthermore, Etikan et al. (2016) agree with Liljedah et al. (2016) that a wide range of resources, such as books, brochures, written works, transcripts, news reports, memoranda, Agendas, administrative documents, and visual media, can be examined using document analysis.

Step 1: Reading through all the data acquired

Step 2: Making a preliminary list of the themes or subtopics that the data revealed

Step 3: Reviewing the information again

Step 4: Linking the subtopics to the gathered data

Step 5: Identification of similarities and differences is done through matching wads.

Step 6: Converting the information into a story into a narrative

Ethical considerations

An application for research ethics clearance was completed and sent to the University of the Free State Ethics Committee for approval. According to Alderson and Morrow (2020), since educational studies involve information, they must all include research ethics. Ethics is defined by Awad et al. (2018) as a body of generally accepted moral principles that provides norms and societal expectations for appropriate behavior of subjects and respondents. Additionally, research ethics addresses what is ethically appropriate and inappropriate when dealing with participants or accessing stored data, as Alderson and Morrow

(2020) explain. Ethical clearance procedures were followed throughout the entire investigation. Each piece of writing, including books, papers, and textbooks, used in both the reference list and in-text reference included citations and acknowledgments for the study.

VI. RESULTS

Ways MMR enhances the effective teaching of mathematics word problems

To increase learning success, flexible word-problem instruction in mathematics is crucial. Flexible teaching is also essential in enabling meaningful learning, providing inclusive learning environments, and making content accessible. Therefore, teachers must work to provide adaptive instruction for mathematics word problems to maximise and optimise learning (Moleko & Mosimege, 2021). Accordingly, the purpose of the qualitative case study presented in this article was to examine how MMR, a component of UDL, can support the flexible teaching of mathematics word problems. Choy et al. (2017) used focus group discussions, reflection sessions, and observation sessions with five secondary school mathematics teachers and a departmental head to collect data. Educators participated in a short workshop on improving learning. Flexible instruction in solving word problems in mathematics is critical. Flexible teaching is crucial to making knowledge accessible, facilitating meaningful learning, and creating inclusive learning environments. Teachers should therefore strive to apply UDL principles, which are intended to familiarise students with the methodology and orient them to it (Clarke et al., 2017). The study demonstrated that MMR can be used flexibly to teach mathematical word problems by providing a variety of comprehension alternatives, including language, mathematical expressions, symbols, and perception. The study's findings recommend that teachers change their teaching methods, taking the MMR principle into account to support and promote flexible teaching of word problems. Instructors' perspectives and experiences are filtered through a lens. Thus, this research values teachers' perspectives and knowledge, in addition to their observational abilities, and provides insights into the nature of professional understanding (Fernández & Choy, 2019). Because multiple representations are crucial to comprehending mathematics, educators have chosen to approach them as a subject-specific observation viewpoint.

Nonetheless, they may also stand in the way of education. In this study, pre-service and pre-service teachers' perspectives, knowledge, and perceptions regarding the impact of teaching experience are compared (Friesen, 2017). A set of questions addressing various aspects of viewpoints and knowledge was addressed by the participants in their answers. To get teachers' opinions on a particular subject, descriptive questions were used.

As stated by Anhalt and Cortez (2016), although most data analysis used quantitative methods, a comprehensive qualitative study was also conducted to examine how students' topic-specific notetaking was affected by their instructors' expertise. Per Hsieh et al. (2020), the findings indicate a lack of understanding among pre-service and in-service teachers regarding the significance of multiple representations in mathematics learning and their roles within their respective fields. However, the subject-specific observations made by the participating teachers about the aspiring teachers set them apart. Further evidence from the data points to educators' use of both local and global knowledge and perspectives in determining critical cases to address multiple representations.

Teachers face challenges in integrating MMR to teach word problems effectively

The ability to answer different types of word problems is a central part of the mathematics curriculum and a prerequisite for general problem-solving skills (Ghali et al., 2018). Research has shown that the difficulty of word problems is influenced by three factors: the solver, the environment, and the problems' inherent qualities (such as linguistic and arithmetic features). However, little is known about how effective

teaching affects students' ability to solve different types of word problems (Murdoch & Szlam, 2017). In this study, linguistic (lexical consistency and nominalisation) and mathematics (operation and transfer/borrowing) difficulties are independently manipulated to examine the relationship between students' perceptions of instructional quality and word problem-solving performance. Below are some qualities and strategies that teachers can implement across multiple forms of representation (MMR) of mathematics word problems.

Proficiency in Mathematics

We need to analyse and characterise competency in general before we can address instructional practices that might improve students' mathematical skills in algebra and patterns. Lawson (2016) states that students need to be proficient in mathematics to engage with "mathematics successfully." Procedural Knowledge is not sufficient for the development of mathematical skills. Moss et al. (2016) also require conceptual understanding. Procedural Knowledge can be thought of as the Knowledge of a series of actions, while conceptual Knowledge is information that is rich in connections and networks (Ontario College of Teachers, 2016). The combination of conceptual and procedural understanding should first be used to broadly assess and characterise competency before we can address instructional practices that help students improve their knowledge of algebra and patterns. The Ontario Council of Agencies Serving Immigrants (2016) states that students must be proficient in the subject to interact with "mathematics successfully." These components can be used effectively. Most classroom instruction is still based solely on procedural understanding, although it is important to combine conceptual and procedural understanding (Sullivan & Artino, 2017). However, over the past 20 years, there has been a sustained push in North America to expand the scope of instruction beyond simply teaching procedural mathematical knowledge (van Garderen et al., 2019).

Mathematical proficiency model

Five linked and interdependent domains are included in the concept of mathematical knowledge, according to Alex and Mammen (2018). The five storylines offer a structure for discussing the ideas, abilities, information, and mindsets that support students in developing into more proficient mathematicians. Among them are, but are not restricted to, the following: the ability to think creatively, procedurally fluently, strategically, and with competence. The conceptual and procedural understanding strands comprise two of the five strands that make up this paradigm for mathematical competency. A model that describes the components of mathematical competency is called Competencies Intertwined Courtad (2019). This paradigm holds that conceptual understanding is an integration of mathematical ideas that students should be familiar with rather than merely isolated facts (Etikan et al., 2016). Liljedah et al. (2016) state that procedural knowledge is implied by the procedural language flow, which also includes the understanding of processes. The authors further argue that conceptual understanding and conceptual knowledge are related because they can recognise this relationship. Knowing when and how to use them flexibly to complete tasks accurately and effectively is also part of this (Naderifar et al., 2017).

Many studies have focused on strategic competence, which is another element of Kilpatrick's model that is necessary for mathematical knowledge (Ojageer, 2019). Strategic competence pertains to the capacity to formulate, represent, and solve mathematical problems. Conceptual understanding, procedural fluency, and mathematical competency are the three domains. After procedural fluency and strategic competence, the authors claim that conceptual understanding was the area in which students excelled. Moreover, a strong association was noted between conceptual comprehension and procedural fluency. Although conceptual understanding is the cornerstone of all other aspects of mathematical competence, researchers in mathematics education have argued that procedural fluency supports and advances conceptual understanding through strategic application (Danesh & Nourdad, 2017). Adaptive thinking, the capacity to reason,

reflect, defend, and explain a position logically, is another aspect of the model's mathematical competency. The fifth strand is "the habitual tendency to see mathematics as meaningful, useful, and worthwhile, coupled with a belief in hard work and one's own efficiency." According to these authors, conceptual understanding was the area in which students performed best, followed by procedural fluency and strategic competence. Moreover, a strong association was noted between conceptual comprehension and procedural fluency.

However, conceptual knowledge is the basis for all other mathematical ideas (Salihu et al., 2018). However, to assess students' proficiency levels, other research on mathematics skills has been conducted (Saleme & Etchells, 2016). Typically, it focuses primarily on conceptual understanding and procedural fluency. The degree to which procedural fluency and conceptual understanding are related and how thorough, correct, abstract, and well-structured the Knowledge is greatly influences how deeply a concept is understood (Sukhai & Mohler, 2016). Given the different opinions about procedural literacy instruction in the model and because other researchers have used procedural comprehension instead, I choose to use it for this research. I then demonstrate the connections between procedural and conceptual understanding when students work with mathematics. Skills, competencies, talents, and beliefs (Collins, 2016).

VII. DISCUSSION

This section's key themes are the discussion of the study's findings, conclusion, and recommendations. This study aimed to explore the integration of MMR to effectively teach mathematics word problems. This section aims to provide readers with a thorough understanding of the methodology used to arrive at the study's conclusions, along with a synopsis and detailed discussion of the results (Collins, 2019). The study's approaches and objectives have been covered in detail to give readers a clear understanding of the goals. The study's conclusion addresses participant recommendations, policy implementation, and intervention strategies. The section that follows addresses the results, an overview of the findings, the limitations and implications of the study, and, lastly, recommendations for additional research.

According to the data, for educators to be successful and perform their tasks well, they must fulfill their duties. Flexible teaching in mathematics is crucial for maximising learning success and creating inclusive environments. A qualitative case study examined the use of MMR as a UDL component to support flexible teaching of mathematical word problems. The study involved focus groups, reflection sessions, and observation sessions with five secondary school mathematics teachers and a department head. The findings suggest that MMR can be used to provide various alternatives for comprehension, including language, mathematical expressions, symbols, and perception. The study also considered teachers' perspectives and knowledge, revealing that both pre-service and in-service teachers are not fully aware of the critical role of multiple representations in mathematical learning. The study suggests that educators use both local and global knowledge and perspectives when addressing these representations.

This study examines the relationship between students' perceptions of instructional quality and their performance in solving word problems in mathematics. It focuses on linguistic (lexical consistency and nominalisation) and mathematical (operation and transfer/borrowing) difficulties to examine the impact of instructional quality on students' ability to solve different types of word problems. Proficiency in mathematics is essential for students to interact with "mathematics." Most classroom instruction is still based solely on procedural understanding, but it is important to combine conceptual and procedural understanding.

This study examined policymakers' attitudes toward equity in mathematics education policy and practice. It examines both general culture and the culture of mathematics education. It examines the consequences this has for educators, legislators, and students, and how a mindset is formed and maintained by moving from topic to topic

without order, which is expressed in spoken and written language.

The study explores the use of MMR in flexible teaching of mathematics word problems. It found that MMR offers various comprehension alternatives, including language, mathematical expressions, symbols, and perception (Bobis et al., 2020). However, neither pre-service nor in-service teachers are fully aware of the critical role of MMR in mathematical learning. The study also explores the challenges teachers face when integrating MMR, focusing on linguistic and mathematical difficulties. It emphasises the importance of combining conceptual and procedural understanding in classroom instruction (Alhassan et al., 2019).

VIII. CONCLUSION

The study's findings highlight the problems students who struggle in rural schools face, including difficulties interpreting, applying, and solving mathematics word problems. Nevertheless, it also shows how educators' involvement, focused activities, and creative thinking may provide beneficial support. To tackle these obstacles, a comprehensive strategy comprising augmented financial resources, refined education, and better involvement is needed. Stakeholders may work towards better meeting the needs of students in remote areas by putting these recommendations into practice. This study presents recommendations based on the research question, the literature review, and the organised findings to address the issue. It has been shown that educators encounter many challenges when delivering mathematics word problems, as students struggle to pass. As a result, this study recommends the following actions for department heads to manage the commerce stream effectively. Learners must be more playful and calmer, try presenting word problems with several correct answers, such as maths puzzles or games, to your pupil if they are anxious about them. This will help them feel more at ease and playful when doing them. They must either remove the numbers from word problems or create "numberless" problems to make them easier. They must use pictures to illustrate the question. Making sense of the situation can also be aided by presenting the information in the math problem using visual aids like drawings, diagrams, or hands-on manipulatives. They must relate the question and the story to real life to make it more fascinating and relevant for your pupil. They must keep an eye out for more complex questions; it is crucial, while teaching word problems, to look for anything that could get them stuck, such as language or large amounts of data.

IX. CONFLICTS OF INTEREST

There are no conflicts of interest in this study.

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