Examining the challenges that seventh grade learners face in understanding mathematics word problems: A case study of Ovikange primary school

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Abstract
In this study, we investigated learners' perceptions of the underlying factors contributing to challenges in their comprehending and solving mathematical word problems. The participants consisted of 63 seventh-grade learners from an elementary school in Namibia. The study utilised a mixed methods approach with an exploratory assessment design. Data collection was conducted through a sequential mixed-methods approach using a pen and paper technique. Participants first completed an assessment test and then provided their perceptions about the test and the challenges they encountered during the test. Data analysis was carried out in two distinct stages. Firstly, the word problem solving assessment test was graded, and the scores were recorded and analysed with descriptive statistics (frequency and scores). Secondly, the learners' perceived challenges in attempting the mathematical word problem solving assessment test were examined by comparing their test scores to how they rated the test questions' level of difficulty. The results indicated that most learners performed poorly in the word problem solving assessment test, highlighting an existing challenge in comprehending word problems. Furthermore, the learners' perceptions of each test question did not align with their overall performance and the total number of learners who successfully passed each question. Learners expressed the view that their primary challenge in generating accurate procedural solutions for mathematical word problems stemmed from a lack of understanding the mathematical language used in the texts. Based on our findings, we recommend enhancing learners' comprehension skills for mathematical vocabulary. practicing explicit reading can be beneficial, as difficulties in understanding word problems often hinder mathematics problem-solving abilities.

Keywords: *mathematics, word problems, mathematics comprehension, learning difficulties, problem solving*

Introduction

This paper reports on the findings of a study conducted in 2014 as part of the research requirement for a bachelor's honours degree at the University of Namibia. The research phenomenon was identified at Ovikange Primary School in the Omusati region in the northwestern part of Namibia. Researchers often select familiar research sites for various reasons, including access and ease (Clarke & Davison, 2020). Thus, this school was selected as a site for conducting this study due to the researcher's familiarity with the school, stemming from consecutive three-year engagement in School Based Study (SBS) activities within its premises. Being familiar with a school as a research site can make it easier for the researcher to navigate and access participants (Lanza, 2008). The first SBS in mathematics was conducted in 2012, and one of the researchers noticed that learners in grade 7 had trouble solving word problems. The same challenges were still in existence during the SBS conducted at that school for more than 11 weeks in 2014. Being in the same classroom with the same pupils, enabled one of the researchers to clearly identify challenges which were barriers to the teaching and learning of mathematics at primary school level. It is common knowledge that mathematics has a significant influence on how people navigate the many facets of their private, social, and civic lives (Anthony & Walshaw, 2009). It is therefore, essential for primary school learners to be able to make connections between the mathematics content taught in the class to their everyday life situations (Thorton & Statton, 2011). Thus, one way to build the foundation is through instilling fundamental skills in learners for solving mathematical word problems. According to Rosli et al. (2020) learners' foundation of solving word problems could be enhanced via instilling fundamental skills for solving mathematical word problems. The findings of this study might help improve learners' understanding and ability to making connections effectively in solving mathematical word problems. There are several Mathematics Learning Difficulties (MLD) that Namibian

learners experience as they learn the mathematics subject (Hamukwaya & Haser, 2021). Failure to promptly address the MLDs may culminate in the establishment of a weak cognitive underpinning of the learning of mathematics, which, in turn, has the potential to exert deleterious consequences upon the educational trajectories and broader life trajectories of the affected learners (February et al., 2022). Some learners believe that mathematics is a difficult subject, thus they struggle to learn it (Jatileni & Hamukwaya, 2022). However, at Ovikange primary school it became evident during teaching practice that learners find it difficult to understand and solve mathematical tasks that are presented in words compared to the ones presented in numbers with short instructions. Word problems differ from standard mathematics tasks because they are written in sentences rather than mathematical symbols. This requires learners to read and understand the text before solving the problem.

Learners have difficulties comprehending word problems hence inhibiting them from being able to transform the sentences into an appropriate mathematical form (Rosli et al., 2020). In their studies, Atkins (2018) and Pongsakdi et al. (2020) employed textual descriptions to outline situations and questions, necessitating the execution of mathematical operations derived from the given descriptions. Word problems are conventionally characterized as verbal depictions of problem scenarios introduced within an educational context. These scenarios involve one or more inquiries, the solutions to which can be derived through the application of mathematical operations to numerical information provided within the problem statement or derived from it (Atkins, 2018; Verschaffel et al., 2020).

Word problems in mathematics serve diverse purposes, such as adding variety to practicing basic mathematical operations and preparing learners to apply mathematics skills in real-life situations beyond the classroom (Pongsakdi et al., 2020). While all learners should become increasingly proficient in mathematics as an obligatory subject at primary school level (Mainali, 2021), some learners struggle to extract the mathematics from the English statements. This seems to be more a problem of the English language understanding than it is a mathematics understanding issue (Maluleke, 2019). From literature, three key elements can be summed up as influencing the difficulty of word problems: linguistic considerations, numerical factors as well as the way that linguistic and numerical elements interact (Pongsakdi et al., 2020).

However, proficiency in English language should enable learners to cope with mathematical challenges of daily life and enable them to continue their study of mathematics in high school and beyond (Tai & Wei, 2020). Although the language of mathematics is based on rules that must be learnt, it is important that learners move beyond rules to be able to express things in the language of mathematics (Tai & Wei, 2021). This paper investigated the perceptions of Grade 7 learners at Ovikange primary school in Namibia concerning the factors that underlie the difficulties they encounter when solving mathematical word problems.

Literature review

Mathematics education worldwide has gone through reform processes in which mathematics educators are urged to start rethinking ways of presenting mathematics to learners in exciting yet educative ways (Kilpatrick, 2020). Some mathematics educators teach this subject through the lenses of arts (Graven & Heyd-Metzuyanim, 2019; Hawari & Noor, 2020). Others use information communication technology to make mathematics learning fun and exciting to the learners (Attard & Holmes, 2020; Das, 2019; Kurbonov & Istamova, 2021; Mayer, 2020). Prior to these reform processes, mathematics was seen as a set of rules and procedures that had little to do with learners' experience (Schoenfeld, 2022). Also, traditionally, mathematics was regarded as a very difficult and challenging subject and only certain individuals were believed to be born with an ability to do well in mathematics (Schoenfeld, 2022). Although this view was accepted in most societies, there has been a shift in this view. At present mathematics is regarded as a tool of solving problems essential in all our societies (Maass et al., 2019). Currently, mathematics is seen as a dynamic subject that seeks to understand patterns that permeate both the societies around us and the mind within us (Genc & Erbas, 2019).

Over the past 50 years mathematical word problem solving has been the focus of tremendous amount of research (Pongsakdi et al., 2020; Strohmaier et al., 2022; Verschaffel et al., 2020). These research studies are evidence that word problems are among the most difficult kinds of problems that mathematics learners encounter (Verschaffel., 2000). Mathematical word problem difficulties are sometimes linked

to the language of the mathematics statement (Maluleke, 2019; Pongsakdi et al., 2020). For example, Pongsakdi et al. (2020) investigated how mathematical word problem characteristics were related to linguistic and numerical factors and their difficulty level. Unfortunately, their results did not show a clear link between word problem difficulty level and characteristics relating to linguistic and numerical factors (Pongsakdi et al., 2020). However, their results indicated that word problem solving performance on both easy and difficult items was strongly related to learners' text comprehension and arithmetic skills. According to Strohmaier et al. (2022) mathematical word problem solving is influenced by different characteristics of the task and the cognitive skills of the person solving it.

Furthermore, Strohmaier et al. (2020) suggest that there are significant disparities in the influence of distinct cognitive abilities on the accurate resolution of diverse word problem tasks. Nonetheless, prior research have seldom correlated these attributes with a comprehensive understanding of which specific set of individual cognitive skills is requisite for solving each type of word problem (Strohmaier et al., 2022). Strohmaier et al. (2022) found that verbal skills were the most consistent predictor of learners' ability to successfully solve word problems. Arithmetic skills only predicted the correct solution of word problems containing calculations while spatial skills predicted solution rates in the presence of a visual representation. In contrast, general reasoning skills emerged as more pertinent in addressing simpler problems amenable to heuristic mathematical word problems solutions (Strohmaier et al., 2022).

Like in other parts of the world, mathematics word problem solving is a contested issue in education in Namibia. Namibian learners necessitate enhanced proficiency in word problem-solving skills, particularly in algebra as highlighted by Iilonga and Ogbonnaya (2023). Their research findings reveal that less than 10% of learners who participated in their study exhibited an ability to comprehend word problems and formulate a strategic approach, with nearly only 5% demonstrating the capability to successfully resolve such mathematical word problems. Apart from learners, Kleopas' (2020) study revealed that the majority of Namibian teachers encountered challenges in the application of effective instructional techniques for imparting mathematical problem-solving skills to young

learners. Most mathematical word problems challenges are linked to poor teaching and learning resources, learners' poor reading ability, lack of support from the Education Regional Office, and lack of pedagogical knowledge (Chirimbana et al., 2022; Kleopas, 2020) and curriculum issues (Iilonga & Ogbonnaya, 2023). It remains a valid contention that the text comprehension discussed by Pongsakdi et al. (2020) and the verbal skills elucidated by Strohmaier et al. (2022) are constituent elements of language and its influence on learners' comprehension of mathematical word problems, as posited by Maluleke (2019). Therefore, based on the reviewed literature, the absence of tangible common findings in research concerning word problems underscores the imperative to disseminate this research, despite the data having been gathered over a decade ago. Moreover, the connection between contemporary investigations and their predecessors concerning this subject continues to reveal research gaps. Thus, emphasising the enduring presence of word problems within primary school mathematics.

The principal aim of this research was to provide an in-depth understanding of learners' perspectives regarding the factors that contribute to challenges in comprehending and resolving mathematical word problems. Additionally, the study sought to unveil any disparities that might exist in the instructional methods and the acquisition of problem-solving skills specific to mathematical word problems. This research aimed to provide insights to the relevant educational authorities such as regional directorates of education, school boards and policymakers, thereby facilitating informed actions in response to the ongoing challenge. It is noteworthy to acknowledge that educational research is inherently pragmatic in nature; it aspires not solely to acquire knowledge and comprehend relationships for the sake of knowledge, but also to harness this knowledge for the purpose of improving future educational practices. The study sought to answer the following research questions:

1. What are the learners' perceptions concerning the underlying factors contributing to challenges in solving mathematical word problems at Ovikange primary school?
2. What factors influence learners' ability to generate accurate mathematical procedural solutions in word problem solving?

Methodology
This study follows an exploratory mixed-methods assessment approach or sequential mixed-methods study design, see Figure 1. In this approach we combined both quantitative and qualitative data collection methods (Rustam et al., 2019) to gain a comprehensive understanding of the learners' performance of word problem assessment and their subjective perspectives or explanations per question. Learners wrote a test as a word problem assessment tool. The test was designed as a qualitative assessment whereby learners generated their open-ended responses, written narratives, or descriptive information. Qualitative assessments were used to capture in-depth, narratives, or subjective data that might not be easily quantified but could provide rich insights into participants' experiences and perceptions (Bleiker et al., 2019).

Instruments and procedure
The researchers with the help of the two mathematics teachers at the school developed a word problem test assessment task as an evaluative instrument for the grade 7 learners. In addition to the assessment test, learners were presented with a mixed method survey that featured inquiries prompting them to categorise their assessment test responses according to their perceived difficulty based on their experience during the assessment test.

In the final part of the survey, participants were asked to clarify their answers with an explanation by stating the challenges they encountered while attempting the test questions. The survey was divided into two sections. Section A gathered quantitative data generated from the learners' ratings of the test questions. The test questions were rated as 1=Easy, 2 = Moderate and 3 = Difficult. An assessment test consisting of 8-word problems was administered to 63 Grade 7 learners of Ovikange Primary School, see Appendix 1. The assessment test was aimed at capturing how learners understood and solved mathematical word problems. The gender and age of the participants were not recorded. The data collection procedure is shown in Figure1. The seventh grade represented the pinnacle of academic achievement at the school, and learners were selected from grade 7 for the research study. This decision was predicated upon the researchers' judgment that learners within Grade 7 possessed the requisite cognitive capacity to articulate their cognitive reasoning processes effectively, and further, their communication skills were deemed sufficiently advanced to participate in this research. Data were collected through paper and pencil methods. The learners were from two class groups and the data collection tools were administered by the researchers and the mathematics teachers to make sure that the learners participated in the study at the same time. Participants were given 30 minutes to complete the test and 15 minutes for the survey.

The participants were informed in advance that the data collected would be kept confidential and their identities would not be revealed to the public at any stage. Thus, the participants were not required to fill in their names on the assessment test and survey papers. This was to insure the anonymity of all participants. The participants were fully informed in advance about the purpose of the research study. The participants were also informed that they reserved the full right to withdraw from the study at any time of the process. Since all participants were underage pupils, their parents provided consents through the school in writing to allow their children to participate in the study. Section B of the survey gathered open-ended qualitative data of the explanations supporting the performance per assessment question and the rating of each question.
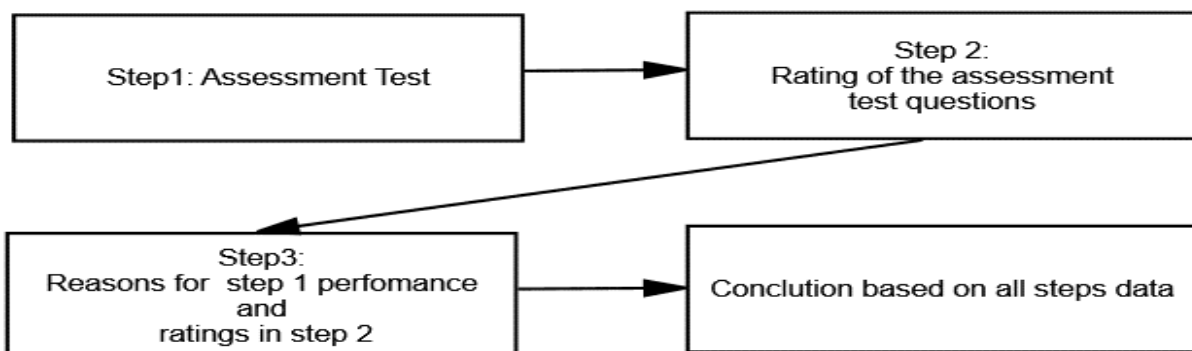

Figure 1: Data collection procedure

Data analysis

We used the basic mathematical statistics, the mean and frequencies to understand the data and to answer the research questions. The assessment test for mathematical word problem solving were graded by two mathematics teachers and overseen by one of the researchers as a moderator. They all adhered to a collectively devised marking scheme throughout the grading process. Following this process, the researchers conducted a detailed analysis of the individual question-level performance of the learners on a mathematical word problems assessment test, see Table 1. Additionally, we examined the learners' perceptions and evaluations of each of the questions on the assessment test. During the final phase, we assessed the quantity of learners who successfully answered each of the assessment test question.

Results

This section provides the answers to the research questions. It reports results on the assessment test performance, learners' mathematics word problems perceptions and the identified difficulties related to word problem solving.

Learners' scores and perceived factors contributing to challenges in solving mathematical word problems

In response to the first research question, we analysed the individual question-level performance of the learners. Table 1 provides an overview of the learners' assessment test results. The first column displays test scores achieved by the learners in the test out of 15 marks. The second column indicates the number of learners (out of 63) associated with each respective score in the first column. The

findings revealed that most participants achieved a score of only two marks out of 15 in the word problem solving assessment test. This score constitutes 30% of the total number of participating learners, representing the largest cohort of participants in the assessment test. The second-highest percentage of learners, totalling 23% of the total participants, obtained a score of three marks out of 15 on the word problem solving assessment test. The third most frequently achieved score was one out of 15, accounting for 22% of the participating learners. This indicates a difference of a learner between the second and third categories of the assessment test-takers. Nevertheless, seven marks and four marks out of 15, were attained by five learners each. These results constituted 16% of the overall number of learners who took part in the assessment test.

The second-lowest score achieved was zero out of 15 marks, and it was obtained by three learners. This score represented 5% of the total participants in the assessment test. The highest score, which was eight out of 15 marks, was the least frequently attained, and this was similarly the case for six out of 15 marks. Each of these scores accounted for only 2% of the participants, indicating that only one learner achieved each of these scores. The data analysis revealed that no learner obtained a score of five out of 15 marks. Furthermore, among the 63 learners who took part in the test, none of them achieved a score within the range of nine to 15 out of 15 marks. Consequently, this indicated that many of the learners, constituting 98% of the participants, attained scores below 50% on the test. Only one participant managed to secure a score of 53%. This overall trend signified a failure to meet the passing threshold for most of the learners.

Table 1: Learners' performances for each question on a mathematics word problems solving assessment test

Test Scores	Frequency of Learners
0	3
1	14
2	19
3	15
4	5
5	0
6	1

7	5
8	1
9	0
10	0
11	0
12	0
13	0
14	0
15	0
Total	**63**

To gain insight into the learners' perceptions of mathematical word problems, a comprehensive analysis of their individual assessments of each question featured in the assessment test was undertaken. Table 2 encapsulates the classification of the test questions into distinct categories based on the participants' rating of their perceived difficulty levels. For the first question, the largest proportion, constituting 44% of participants, regarded it as easy, while 41% deemed it to be of moderate difficulty, signifying a perception of neither easy nor difficult. Results shows that 15% of the participants encountered challenges with question one, thus designating it as difficult. In the case of the second question, the majority (43%) of the participants categorized it as moderate, with 37% perceiving it as moderately challenging and 20% finding it easy to comprehend. Question three was predominantly perceived as easy by the majority, amounting to 65% of the participants, and only appeared difficult to 16% of the participants. On the other hand, 14% rated this question as moderate. Concerning the fourth question, a significant majority (51% of participants) classified it as difficult, while 11% found it easy, and 38% considered it to be of moderate difficulty. Question five appeared to pose some ambiguity for a substantial proportion of participants. Specifically, 49% rated it as moderately challenging, 48% deemed it difficult, and only 3% perceived it as easy. In the context of question six, the ratings were distributed almost evenly across the categories, with 35% considering it easy, 33% marking it as of moderate difficulty, and 32 participants characterising it as difficult. For the seventh question, the majority, comprising 41% of the participants, perceived it as moderate, with 38% regarding it as difficult, and 21% finding it easy to handle. Lastly, the final question showed a similar rating distribution, with 16% rating it as both moderate and difficult. However, the majority, 68%, perceived it as easy.

Table 2: Perceptions of learners on each word problem question

Question	Easy	Moderate	Difficult	Total per Question
1	28	26	9	63
2	13	27	23	63
3	41	13	9	63
4	7	24	32	63
5	2	31	30	63
6	22	21	20	63
7	13	26	24	63
8	43	10	10	63
Mean	2.68	2.83	2.49	2.67
Total %	35	34	31	100

Table 3 provides a comprehensive representation of the participants who successfully answered each of the eight questions in the assessment test. Notably, questions three and eight emerged as the most adeptly answered, with an identical attainment

rate of 84% correct responses. Followed by question one and seven achieving 30% and 19% correct responses respectively. Question two witnessed a success rate of 14%, while question five had a success rate of 10%. Question four, in contrast, was not solved correctly by any of the learners, resulting in a zero achievement rate. Question six registered a lower success rate, of 5% of the total respondents.

Table 3: Number of learners who passed per question

Question	Number of learners
1	19
2	9
3	53
4	0
5	6
6	3
7	12
8	53

Challenges influencing learners' ability to generate correct solutions to mathematical word problems

This question was answered in the concluding segment of the survey. Participants were requested to identify and elaborate upon three specific challenges encountered while solving the assessment test questions. Regrettably, this section of the survey received a notably low response rate. Only 10% of the participants provided written responses. Most of the participants drew lines in the part where they were supposed to answer this question. Some used it for calculation purposes. Among the 10% of the participants who answered this question, 6% of them indicated that they had problems with understanding or ascertaining what the questions were asking them to calculate. Fewer learners (4%) indicated that they did not know what method to use when calculating.

Discussions

The results from this study painted a mixed picture, in some instances learners indicated that a question was moderate in terms of difficulty but had a higher number of learners who passed it. Likewise, some questions were rated as easy e.g., question 1 (54 of the participants indicated that it was easy to moderate) but, only 19 out of 63 got it correct. Firstly, the learners performed poorly in the assessment test which acknowledges an existing challenge in word problem comprehension. Secondly, the learners' perception of each test question did not correspond with their overall performance and the total number of learners who passed each question. For example, only nine participants in our study acknowledged to have experienced challenges with solving question one. However, the learners rating of this question did not correspond with their actual performance, only 19 learners solved this question correctly. Yet the majority (28) perceived it as easy. This can be because of participants' misinterpreting the question, thinking it was simple to solve and ending up getting it wrong. Our findings align with that of Yunus et al. (2019), who observed that learners often make errors in solving word problems due to misunderstandings, mistakes in transforming the problem, and processing skills that lead to incorrect final answers. Furthermore, Yunus et al. (2019) found that misunderstanding the questions was caused by the learners forgetting the procedures and rushing to solve the question. Moreover, Al-Mutawah et al. (2019) found that word problem-solving skills (procedural knowledge) was positively correlated to learners' conceptual understanding. Meaning that learners who cannot use their procedural knowledge to understand the questions will struggle to interpret word problems into proper mathematical statements thus, generating incorrect answers (Al-Mutawah et al., 2019).

The results indicate that learners were challenged in solving the mathematics word problems due to poor or lack of understanding the mathematical language from the texts. This poor or lack of understanding could have stemmed from learners' anxiety when doing mathematics schoolwork. Mathematics anxiety has the potential to cause learners to produce unpleasant emotions which interfere with the solving of mathematical problems and affect their progress (Wani, 2020). This finding can also be a language proficiency issue. Prediger

and Neugebauer (2023) found that language proficiency did not affect instructional approaches intended to enhance the mathematics learning of learners. Thus, providing a dissimilar result than ours. However, our findings echo those of Pongsakdi et al. (2020) that word problem solving performance is strongly related to learners' text comprehension and arithmetic skills. Consequently, mathematical communication which can be classified into two principal categories: written communication and verbal communication has a direct/indirect impact on the learners' ability to solve word problems.

Conversely, our findings found a gap between learners' verbal and written mathematical communication errors in solving word problem. Our participants appeared to have both the verbal (the qualitative expressions) and written (assessment test) mathematical communication error in solving word problems. This finding contrasts those by Maulyda et al. (2020) who found that learners' mathematical verbal communication skills were better than their written communication skills. We argue that learners can also be better or worse in both.

Limitation and future research
The word problems used in this study were not characterised based on difficulty levels. Characterising word problem difficulty levels could have helped with a deeper understanding of the learners' challenges. Future studies should characterise their word problems in line with difficulty levels of Ayala-Altamirano and Molina (2020) to better understand learners' performance of different word problem levels. The word problems used in the assessment test contained questions from different mathematics topics. We acknowledge that word problems appear in all chapters or topics in mathematics. However, it is advisable for a single study to focus on a specific topic of mathematics to avoid generalisation and enable results to be linked to the mathematics topic of study. Future studies may assess word problem difficulties in relation to chapters like measurements, money and finance or algebra. This will lead to better conclusions in determining if word problems are linked to a specific chapter in mathematics or it is across the mathematics curriculum. In addition, this study assessed the learners' mathematical communication difficulties using a survey tool. Future studies may employ interviews to enable learners to verbally express the challenges they experience when solving word problems. This study was limited to a sample of 63 primary school learners. Thus, the results cannot be generalised to represent all grade seven learners in Namibia. Future studies may include participants from different regions and grades to produce diverse voices of learners. This study was limited to challenges perceived by learners in solving mathematics word problems. Future studies should explore the challenges perceived by teachers in teaching word problems or even compare the teachers' and learners' perceptions. The test and survey tools used in this study were not piloted, which might have contributed to the ambiguity of the responses to question five.

Conclusion
Solving mathematics word problems can be particularly challenging for learners due to various cognitive, linguistic, and instructional factors. The importance of prioritising word problem-solving within the realm of mathematics education is underscored by its ubiquitous presence across various chapters within the mathematics curriculum. Thus, it merits a dedicated focus and recognition corresponding to its pervasive relevance. If learners continue to struggle with word problems, which are a component of every mathematics topic, their overall performance in mathematics could be significantly affected.

Recommendations
Based on the findings from our study, we recommend enhancing learners' comprehension skills for mathematical vocabulary. Learners should practice explicit reading that focuses on improving their reading comprehension, as difficulties in understanding the text of word problems often impede mathematics problem-solving abilities. Moreover, learners should practice vocabulary building that targets specific mathematical vocabulary and phrases commonly found in word problems to help them understand the context and requirements of the word problems methods. Additionally, learners should practice active reading strategies such as annotating the text, summarising, and questioning to improve their word problem solving comprehension. Learners should also consider developing their mathematical reasoning skills such as conceptual understanding and logical reasoning. Conceptual understanding will help them develop a deep understanding of mathematical concepts while logical reasoning will foster their critical thinking through problem-solving

exercises that require them to justify their solutions and explain their thought processes. We encourage learners to engage in word problems exercises that use visual representations such as diagrams, models and graphic organisers. Diagrams and models use visual aids like diagrams, charts, and models to represent the information in word problems. Such exercises can help learners to visualise relationships and better understand the word problem. On the other hand, graphic organisers such as problem-solving mats or flowcharts might help learners organise their thoughts and break down the problem into manageable parts. Finally, learners should practice contextual and relevant word problems. Here, learners practice real-world connections by using word problems that are relevant to their lives and interests to increase engagement and motivation. Moreover, learners should incorporate culturally relevant contexts in their mathematics word problems studies to make word problems more relatable, culturally responsive and inclusive.

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