

The Role of Language in Solving Mathematical Word Problems among Grade 9 Learners

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Abstract

Objectives: The study aimed to explore mathematical word problem solving abilities among Grade 9 learners in Tshwane North District Schools. It highlighted how language plays a pivotal role in learning mathematics and understanding mathematical word problems. Moreover, it showed how language inadequacy and incorrect translation affect Grade 9 learners' solutions to mathematical word problems in schools around Tshwane North District.

Methods: The study used both qualitative and quantitative methods. It also made use of contextual, exploratory, and descriptive statistical data. The study involved 26 ninth-grade learners in Tshwane North District secondary schools in Gauteng Province. Data collection was based on learners' written work (a questionnaire) and analysing the results of the administered test. Data was analysed to detect the language difficulties that learners' face when translating and solving mathematical word problems. The analysis process involved developing initial insights, coding, interpreting, and drawing conclusions to determine whether there is a connection between language proficiency and solving mathematical word problems.

Results: The study showed that learners face difficulties in mathematical processes such as inadequate language comprehension when translating words into mathematical symbols. It also revealed that there is a strong connection between vocabulary knowledge and word problem solving, resulting in learning challenges related to understanding the meaning associated with mathematical word problems.

Conclusions: Evidence from the word problem test for Grade 9 learners revealed that mathematical vocabulary and syntactic features are the main factors causing difficulties in understanding and solving mathematical word problems.

Keywords: English proficiency, Language, Mathematics, problem solving, word problems.

دور اللغة في حل المسائل اللفظية في مادة الرياضيات لدى طلبة الصف التاسع

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ملخص

الأهداف: تبحث الدراسة في مهارات حل المسائل اللفظية في الرياضيات لدى طلبة الصف التاسع في مدارس منطقة شمال تشواني. وتبين الدراسة أن اللغة دور محوري في تعلم الرياضيات وفهم المسائل اللفظية، كما توضح كيف تؤثر الترجمات الخاطئة وعدم الفهم الصحيح للغة في حلول المسائل اللفظية لطلبة الصف التاسع في مدارس منطقة شمال تشواني.

المنهجية: استخدمت الدراسة النهجين النوعي والكمي. كما استخدمت البيانات الإحصائية السياقية، والاستكشافية، والوصفية. شملت الدراسة 26 طالباً من الصف التاسع في مدارس المرحلة الثانوية في منطقة تشواني الشمالية في مقاطعة غوتنغ. جُمعت البيانات باستخدام العمل الكتابي للطلبة (الاستبانة) وجرى تحليل نتائج الاختبار المدار. حُلَّت البيانات لتحديد الصعوبات اللغوية التي يواجهها المتعلمون عند ترجمة وحل المسائل اللفظية. تضمنت عملية التحليل تطوير رؤى أولية، والتميز، والتفسير، واستخلاص النتائج لتحديد ما إذا كانت هنالك علاقة بين إتقان اللغة وحل المسائل اللفظية.

النتائج: أظهرت الدراسة أن الطلبة يواجهون تحديات في حل المسائل الرياضية عند ترجمة المسائل اللفظية لرموز رياضية. كما كشفت عن وجود علاقة قوية بين فهم المفردات وحل المسائل اللفظية، مما أدى إلى تحديات متعلقة بفهم المعنى المرتبط بالمسائل اللفظية. الخلاصة: أظهرت الأدلة المستمدة من اختبار المسائل اللفظية للطلبة أن المفردات الرياضية والخصائص التركيبية هي العوامل الرئيسية التي تسبب صعوبات في فهم وحل المسائل اللفظية.

الكلمات الدالة: إتقان اللغة الإنجليزية، اللغة، الرياضيات، حل المشكلات، المسائل اللفظية.



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1. Introduction

Solving mathematical word problems has become a difficult process in the understanding of a problem posed, decoding and solving the problem. Learners are engaged in solving word problems which have been identified as a challenge in learning mathematics. The study shed light on intervention strategies that will help struggling learners to understand and solve word problems (Reagan, 2003:120). The study also identified how conceptual understanding can be achieved using problem-solving strategies.

Grade 9 learners are faced with language inadequacy in understanding and acquiring mathematical conceptual knowledge (MCK), and constantly struggling to translate statements and solve mathematical word problems. Learners' struggle led to underperformance in mathematics where learners find it difficult to express and interpret the word problems into formal mathematical notation. Teacher needs to possess the skill to explain difficult concepts especially word problems in algebra to learners who experience difficulties and provide means and ways to assist such learners in the class. The learning of mathematics is a daunting task for the learners who have to learn in the language that is not their home language, and to learn and understand the mathematical concepts (Setati, Chitera & Essien, 2009 & Martiniello, 2008).

2. Literature Review

Mathematical assessment provides better understanding of what Grade 9 learners need to be engaged in the learning process of mathematical word problems. The research on the role of language in Grade 9 learners' solutions to word problems which focused on vocabulary and formative assessment. The research questions were:

- To what extent are Grade 9 learners able to translate mathematical word problems into number sentence or formal notation?
- What difficulties do Grade 9 learners experience in translating mathematical words problems into a number sentence or formal notation?
- What elements of language are evident in the way Grade 9 learners solve word problems?

The research was conducted to Grade 9 learners in a public secondary school within Tshwane North District, and the school has the capacity of 800 learners with 280 learners are in Grade 9.

Learners need to have proficiency in reading comprehension when solving mathematical word problems, in which the language effects and linguistic skills are barriers for learners to understand word problems. There is a correlation between reading comprehension and ways of solving word problems, (Nortvedt, 2010, Vukovic & Lesaux, 2013). It appears that learners find it hard to translate certain word problems into number sentences, hence learners engage in calculations regardless of understanding the problem.

1.1. The role of language in learning mathematics

Mathematics is a human activity, a way of thinking about the external world; a category of constructing meaning. Hence, word problems are function of experiences and far more tentative and uncertain than it was previously thought. Language skills are more important in expressing mathematical ideas and strengthening reasoning. Competency in the communicative mathematics language is an important tool for learning Mathematics (Meaney, Trinick & Fairhall, 2011). The researcher concurred with Luneta (2013) when they state that learners should know and understand the language of mathematics and develop skills to apply in solving word problems. Therefore, learners should connect knowledge with mathematical language.

English is regarded as an official language associated with success and progression and used as a language of learning and teaching (Smit, 2010). The role of language as a medium of instruction in promoting effective teaching and learning has become a critical issue that has occupied many educationists all over the world for many years (Orr 1987, 1997 as cited by Deyi, Simon, Ngcobo & Thole, 2007). Many studies have already revealed that the use of home language in the early grades enhances children's ability to learn better compared to the use of a second or foreign language (UNESCO, 2003, as cited by Rai, V., Rai, M., Phyak, Rai, N., 2011). Learners need to have knowledge of mathematical language

in order to gather and understand information on concepts and procedures in mathematics.

Maniruzzaman, (2010) stated that ideas are more easily conveyed through the home language than through English as learners usually understand their home language better. Learning opportunities that encourage learners to use of proper mathematical language and should be emphasised, so that learners are able to understand the concept being taught. The correct use of mathematical vocabulary will have positive impact on understanding the concept and dealing with and removing misconceptions the learners might encounter. Learners do bring informal mathematical language to the classroom which they have acquired outside the classroom and tend to use it to communicate their ideas within the mathematical concept they are dealing with. A philosophical assumption is that learning occurs when learners solve word problems related to those that they encounter every day (Hung, Jonassen & Liu, 2008).

1.2. Language barriers to word problem translation

Language is considered as the useful tool for communication. Marji (2009) supports the idea that language has an important role in the learning of mathematical word problems, where mathematical concepts and procedures are learned. The proficiency in language will help the learner to communicate, interpret and interact with fellow learners and in turn promotes information sharing and transfer of mathematical knowledge and skills to solve word problems easily.

Learners who exhibit understanding and mastery of the English language, are more likely to understand mathematical word problems, which require analysis of ideas (Haag, Heppt, Stanat Kuhl & Pant, 2013). Misconceptions in mathematics led many learners to experience language problems in understanding word problems. Word problems statements need to be translated into simpler terms (mathematical notation). To succeed in translation, learners need to understand the meaning of mathematical vocabulary, such as a number subtracted from two ($2 - x$). If the learner has inadequate grasp of the language of instruction, that will contribute to the underachievement and makes it difficult for the learner to understand Mathematics.

Mathematics require translation of word problem into simpler terms. To succeed in translation, learners need to understand the meaning of mathematical vocabulary. If the learner inadequately grasps the language of instruction, this will contribute to underachievement and makes it difficult for the learner to understand Mathematics. When relating to word problems, one has to take into cognisance that the learners' language level has differential effects on their abilities. Learners need to learn and understand the mathematical language to correctly translate word problems into mathematical notation. Kingsdorf & Krawec, (2014) stated that "The translation phase is related to linguistic and factual knowledge and requires the skill of number selection to solve word problem". Therefore, learners when solving word problems, they first translate the text and create a visual-schematic representation of the situation to be solved, while the paper mapping brings an incorrect solution to the word problem.

Integration of mathematical language proficiency is an important aspect in mathematical word problem solution. Learners require to show their mathematical comprehension by reading the word problem, understand the dynamics of the statement before engaging in problem-solving. The transfer of reading comprehension strategies can assist struggling learners. There is a relationship between reading and literacy skills, which impact mathematical comprehension. According to Kytälä and Björn (2014), "both technical reading and reading comprehension were strongly associated with mathematics word problem skills".

Wright (2012) points out that some African cultures have the characteristic of communities in rural schools, do not want their languages to alter the importance of cultural significance. Parents believe that English is associated with socio-economic benefits hence mathematics should be taught in English. Learner's limited English proficiency has become a problem especially to non-English speaking learners which their primary language is their African home language. Communication among learners makes room for concepts to be shared with the help of language. According to Sfard (2009), "communication goes hand in hand with cognition". Therefore, learning occurs in a social setting which allows learners to communicate to each other using the language.

Learners need to be introduced to a socio-mathematical norm to allow the learner to engage in speaking with meaning

in a professional development for learners in senior phase. This will allow learners to interact among themselves in a social context of learning mathematics to elaborate on mathematical concepts in trying to understand their meaning. Emphasis on the appropriate language usage for communication when learners solve mathematical problems, and this will be done through interaction with fellow learners. Interactions among learners, creates opportunities for learners to comment on their problem-solving methods and reflect on their written solution (Siyepu, 2013).

1.3. Ability to connect with concepts

Mathematical literacy is the ability that enables learners to formulate, interpret and solve real-life problems that are related to mathematical concepts in various context (Maryani & Widjajanti, 2019). Yamat (2011) made recommendation that “fostering a deep understanding by encouraging higher order thinking whereby learners identify and analyse information, pose and solve mathematical problems, make informed decisions, and reflect on the reasonableness of their solutions”. Therefore, it is through reflection and analysis that metacognitive thought processes, become visible through achieving solution of mathematical problems in building a strong mathematical foundation on procedural and conceptual understanding.

According to Setati, cited by Tshabalala (2012), “for the learner to develop mathematical thinking, learners have to be able to communicate mathematically”. Learners should be encouraged to use correct mathematical language to avoid the simplification of everyday language use. Language and mathematics competence are inseparable. Teacher’s translation of English to learner’s home language (code-switching) emerges as the solution to the challenges faced by learners. Verbal translation of activities improves the understanding of the mathematical word problems. The correct use of mathematical vocabulary will have positive impact on understanding of the concept and dealing with and corrections of misconceptions the learners might encounter. Learners acquire informal mathematical language outside the classroom. Learners tend to use the acquired mathematical language to communicate their ideas. Mathematical thinking is closely related to the learning process of mathematical literacy.

Solution of word problems require the application of quantities and text that relates mathematically. Communicating mathematical ideas becomes difficult to accomplish when learners have acute problems in the language of learning. DiCerbo, Anstrom, Baker & Rivera (2014), viewed language as a critical element of teaching and learning of mathematical word problems. Poor performance in mathematics becomes an important issue as Grade 9 learners struggle to grasp important mathematical concepts. Therefore, understanding the language of mathematical instruction is essential to solving word problems successfully.

In a study conducted by Lin, Morgan, Farkas, Hillmeier & Cook, (2013), similar results were found that learners with Mathematics difficulties while in the lower grades tend to have a higher chance of having reading difficulties as they progress in higher grades than those learners who did not have reading difficulties. Learning difficulties tends to coincide with one another, therefore learners struggling with reading also struggle with solving mathematical problems. There should be a connection between reading mathematical problems and understanding ways to the solution. This connection can help the learners to achieve better in mathematics.

When learners are fully engaged in solving mathematical problems, they do think and write in a procedural format that can lead them to the solution of the problem, thus applying conceptual knowledge gained while learning certain concepts. Understanding word problems, visualisation plays an important role in understanding mathematical word problem, (Yilmaz & Argun, 2018). The need for visualisation is one approach to learning and understanding in embracing the sustainable instructional model to support the learner in accessing conceptual understanding of mathematical word problems, (Kim, 2020). Connections are specifically crucial since mathematical concepts are hierarchically ordered and the precise meanings of words need to be established or transformed into mathematical symbols and notation for the problem to be understood and solved (Fang & Schleppegrell, 2010). Therefore, comprehension of grammatical patterns and structures is essential in order to understand mathematical concepts.

1.4. Learners' under-performance in mathematics

Learner's under-performance is blamed on lack the independence in self-practice. Daily assessment tasks practice will benefit the learner and enable them to achieve better. According to Zacharia, Komen, George & George (2012) causes of learners' poor performance is due to insufficient or inadequate instruction to learners. Hence, learners become demotivated and develop a negative attitude towards mathematics as a subject and perform low.

Grade 9 learners during 2019 when the test was administered were unable to relate mathematical problems with a real everyday life situation. Learners lack sufficient mathematical conceptual knowledge and this impact their confidence negatively. This might be that learners are inadequately prepared in lower grades as they lack proper mathematical foundation and conceptual background. It is evident that learners do not know the basics of calculating the Perimeter, Area and Volume as it is done in the Intermediate Phase classes. Learners need to be efficient and accurate in performing basic computations with whole numbers ($39 = 73 + x$) without always having to use the calculator. Conceptual understanding of place value supports the development of number computation fluency. Such understanding will support accurate mental arithmetic and more flexible ways of dealing with numbers and will make learners ultimately achieve.

In solving a word problem, learners are required to attain mathematical skills, concepts, or processes be used to achieve at the intended goal. Learners need to possess mathematical conceptual understanding in order to have clear understanding of knowledge acquired through classroom learning, which is needed to understand connections in mathematics and be able to translate word problem into mathematical statements which will enable the learner to solve the problem mathematically. When relating to word problem, one has to take into cognisance in determining to what extent the learner's language level has differential effects on their abilities is clearly of practical importance, in getting more insight in the broadness of the commonly observed learner performance, where the language used in the Mathematics assessment which is not their first language but additional language. Therefore, learners cannot master the mathematical concept if the language used is not understood.

Studies by Kogelman & Warren, (1978) and Tobias (1978), connects misconceptions and mathematics anxiety as main contributors of misconceptions in word problems, mathematical concepts and operational skills, (Jackson, 2008). Mathematical problems expressed entirely in words can be a barrier to some learners. Word problems also help learners to individually learn, reason and apply their mind critically and analytically, i.e., *Mary is 14 years old. John is one and half times older than Mary. How old is John?* From the scenario, the word "one and half times older..." became a challenge to learners to understand and put it into correct number sentence. Learners experience difficulties in connecting mathematical operations to given life scenarios. Learner's errors are related to conceptual understanding of word problems.

According to Sajadi, Amiripour and Rostamy-Malkhalifeh (2013), "word problem solving is one of the most important elements of mathematical problem solving which incorporates real-life problems and applications". However, word problem solving is not properly taught by many teachers because of language problems. Learning how to solve word problems requires proper use of language (LoLT) and continually exposing learners to apply mathematical language. The approach to word problems should have realistic considerations and be connected with the real-life experience and knowledge. Many learners think that school mathematics has no connection to their real-life experience. When solving word problems, learners often simply apply arithmetical operations with neither realistic consideration nor use of common sense.

Polya (1973) identified the following phases in solving a word problem:

a) Understanding the problem.

Learners should be able to analyse the problem stated in words, visualise the problem, apply appropriate mathematical rules as the connect mathematical symbols and notation with relevant mathematical ideas presented and following the correct calculation procedure to solve mathematical word problem. Hence, learners will understand of the situation.

b) Making a plan.

Visualisations enable learners to create a mental picture of the problem and presenting a mathematical statement by encoding the text. Transformation in thinking from abstract to concrete allow learners to reorganise the mental picture and mathematical knowledge in order to have connection between the word problem and picture. Identifying the key word in gaining insight of the problem and helps the learners to develop a better understanding of the concepts related to the word problem.

c) Carrying out the plan.

The solution of word problem is affected by language use, the comprehension text, mathematical terminology that comprehend the correct operation entrenched in the statement, (Kunene & Sepeng, 2017). The learners may face a challenge with understanding the linguistic aspects of word problems, which might lead to misunderstanding of the problem posed and the plan to be followed may not be proper and lead to incorrect solution of the problem. Applying the mathematical rules and strategies to the problem constructed and find the solution to the problem correctly.

d) Looking back.

Checking if the problem was well understood, the correct procedure was correctly followed and with substitution method, testing the outcomes to the statement expressed when carrying out the plan satisfies the initial statement translated. Finding obstacles that formed barriers to solutions of the problem.

Solving word problems contributes to the learners' mental development of higher order thinking as they apply mathematical conceptual knowledge gained in the classroom. It also helps learners to discover and develop the mathematical knowledge related to the problem they are solving. According to Murchan, Shiel & Vula, (2012), the above phases will help to "direct learners in the learning process and enable them to acquire necessary skills that will be useful to achieve better results". Learners need to be taught how to unfold word problems and learn to identify the key points, phrases or words within the problem that will assist them to understand the underlying problem.

To understand the difficulty of a word problem, is important to process the solution of the problem through those phases (Murchan, Shiel & Vula, 2012). Problem solving requires the ability to recognise the underlying structures in the problem situation, establishing the relationship in symbolic structure and manipulate symbolic expressions containing unknown values to find the answer to the problem. It often happens where some learners resort to working backwards, knowing the answer and working towards establishing the statement to the problem. Learners develop the strategy that will help them find a solution through reorganising the ideas linked to the problem.

Mathematics require translation of word problem into simpler terms to remove the misconceptions and instil mathematical thinking where the learners need to understand the meaning within the mathematical vocabulary. If the learner inadequately grasps the language of instruction, this will contribute to underachievement and makes it difficult for the learner to understand Mathematics. The statement made by the Minister of Basic Education (Motshekga), that Schooling 2025 places emphasis on the role of language in education (DBE, 2011). It is aimed to improve the performance of learners over the 12 years of schooling.

Introducing a mathematical lesson in class, normally starts with two or three examples on the chalkboard depending on the level of understanding of learners on a particular concept. Through the process of learning in class, learners are offered the opportunity to solve one problem and when they succeed is then that they are given a series of questions to work on when engaged in word problems in mathematics, learners develop the ability to interpret and communicate mathematical ideas. Mathematics also provides learners with the opportunity to develop the ability to communicate mathematical ideas clearly and work with others and value their contributions to the problem.

Many learners are unable to express themselves in English and therefore, code-switching to local language is enforced rather than to let the language to become a barrier from understanding the mathematical concept. In the class of learners of the same language, understanding its dynamics will be able to express themselves easily and will understand the mathematical concept better. The learners must, therefore, connect reading of the word problem to encoding it to the mathematical way through writing in the form of variables and constants in an expression or an equation to solve.

Mathematics learning focuses on the idea of encouraging learners to use mathematical discourse to make a conjecture. Learners must be encouraged to use their problem-solving skills, reasoning and communication skills to make conjectures, explore their own ideas and mathematical approaches in order to understand the problem and find the solution to the mathematical problem they are faced with in a mathematical learning. The construction of knowledge socially relates to the construction and transmission of mathematical values, information gathered and ways of understanding through processes of social interaction (Donald, Lazarus & Lolwana, 2010).

There are five (5) mathematical processes which a learner needs to understand and follow when engaged in solving mathematical word problem.

Problem Solving:

- Learners should develop own understanding of mathematical problem and develop solution skills to apply.

Reasoning and proof:

- Learners should conceptualise the problem and engage in process of sense-making.

Communication:

- Sharing strategies through discussion with fellow learners reveal conceptual understanding.

Connections:

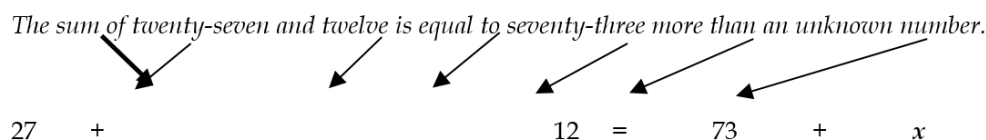
- Apply the conceptual and procedural knowledge to the problem in seeking the solution.

Representation:

- Learners reflect their understanding using symbols, graphs and discourse to represent mathematical understanding.

Using the above-mentioned mathematical processes, learners should convey understanding and create interaction where the teacher is unable to recognise the mathematical errors in content and be able to reinforce the occurrence that will enhance learning. Mathematics language is a challenge, especially in word problems because the text is dense, and concept loaded. For example:

The sum of twenty-seven and twelve is equal to seventy-three more than an unknown number. Find the number. The solution will be that learners must convert word problem into mathematical numbers:



The illustration above shows the translation as it was supposed to be from word statement to mathematical notation.

$$27 + 12 = 73 + x \quad [\text{Statement, where } x \text{ is an unknown number}]$$

$$39 = 73 + x \quad [\text{Adding both 27 and 12 to give 39}]$$

$$39 - 73 = x$$

$$\underline{x = -34}$$

Learners are facing a challenge of understanding seventy-three more than an unknown number. The problem is that numbers can be related as unknown variables such as x and y and being more than or less than, will be either $73 + x$ or $y + 73$. Learners should be aware of mathematical language characters within the said word problem text which forms part of daily mathematical vocabulary. The mathematical academic language is not limited to the acquisition and the use of content vocabulary, but it also encompasses the way of thinking and allow the use of all modes of language. Teachers as curriculum drivers need to consider how learners can be helped to use language correctly to transform knowledge and experience into understanding across the curriculum and become active learners. The vocabulary used in mathematics

is needed to classify mathematical objects, understand mathematical ideas, and to reason mathematically.

Acquisition of cognitive strategies becomes essential and will assist learners to become good problem solvers. The goal of the instructional strategy is to let learners internalise the cognitive processes in order to use them while solving mathematical word problems. According to Montague, Enders & Dietz, (2011), solving word problems involves translating, transforming linguistic and numerical information into verbal, symbolic and quantify representations with the aim to perform appropriate calculations and checking accuracy. Learners should be able to make connections between their understandings and assimilate new concepts within the information provided on the problem. The language used in word problems is recognised as the reason why learners find it difficult to understand and comprehend the problem.

Learners need guidance in order to explore the results of their solutions while engaged in solving the mathematical problems. Therefore, learners will be able to recognise the relationship between decisions and their actions towards the outcome of their decision. It is imperative if we wish to improve teacher pedagogy and make learning more accessible for all learners, in the township community where the language of instruction differs from the home language of different learners in a multi-lingual classroom. Learners lagged behind in Mathematics achievement as assessed on contextual problems due to hidden language problems, because contextual problems are accompanied by language as well as mathematical concepts that need to be well understood and interpreted correctly.

Learning Mathematics in English as First Additional Language (EFAL) becomes a serious challenge to learners as they are supposed to learn English as a language and learning Mathematics as well. Learners should learn to communicate and apply the mathematical language in order to understand the mathematical concepts conveyed through word problems. Appropriate use of mathematical language will alleviate learner's inability to communicate and use mathematical language when learning Mathematics. Learners need to display strategic competency which requires the ability to generate, evaluate and implements problem-solving strategies which forms part of connecting ideas within and outside mathematics by recognising the relationship in the transformational process of word problems to mathematical number sentences.

Learners are expected to demonstrate proficiency in the language of learning in order to have access to the curriculum and to reduce educational inequalities. If learners encounter communication problems, it might lead to the feeling of helplessness resulting from inability to comprehend that language of learning. Hence, translation of word problems will become difficult for learners to translate into mathematical notation. Poor understanding of mathematical instruction by learners' limits their learning abilities of mathematics. Paradis (2009), concluded that "obtaining oral language proficiency in the second language on par with native speakers can take most of the elementary school years". Learners' need to learn and understand the mathematical language and link with mathematical concepts to understand the word problem statement in order to translate it into mathematical notation.

2. Research methods and design

2.1. Research Objectives

The study sought to explore the extent to which the Grade 9 learners are able to translate and solving words problems mathematically. The study also indicates the difficulties that the Grade 9 learners experience in translating mathematical words problems into number sentence or formal notation. The aim was to assess learners' abilities to work with symbols and variables that are critical to efficient functioning in algebra. The objectives of the study focus on:

- Identify the extent to which Grade 9 learners translate mathematical word problems into mathematical notation.
- Identify the difficulties that Grade 9 learners experience in translating mathematical word problems into number sentence.
- Identifying the elements of language difficulty that hinder Grade 9 learners when solving word problems.

1.1. Population and sampling

The study involved one secondary school in Soshanguve within Tshwane North District. The school was selected from schools in Tshwane North District, mainly situated in the disadvantages area. Non-probability sampling which is purposive (Showkat & Parveen, 2017) was used to select the school which was likely to provide the richest and valuable data. The school setting for data collection was convenient, easy and not expensive to access. The technique possesses an inability to generalise the findings of the results because the sample selection might not represent the entire population being studied (McMillan & Schumacher, 2010). The test was administered to twenty-six (26) learners. During this phase, learners were working individually. Each learner translated the question according to his or her understanding as the question was posed and solved the word problem. None of the participants (learners) refused to respond to the test, though some participants opted not to respond to certain questions within the test.

1.1. Data collection and research instrument

The researcher used a structured test as the primary source of collecting data from the Grade 9 learners in a school, in which their age range between 14 years and 16 years. To gather information about the role of language in Grade 9 learners' solutions to word problems, learners had to complete the test, which consisted of eight (8) questions. The test questions were formulated in line with the Senior Phase CAPS (Curriculum and Assessment Policy Statement) document.

Each of the problem items were also related to the mathematics curriculum strands that are outlined in the school curriculum statement. These strands are concerned with number and number relationships, and measurement. These items also required learners to make use of their knowledge of basic ideas related to algebra and functions. The knowledge of algebra that was required here involved the use of symbols and variables. The instrument provided information gathered on learners' efficacy towards understanding the text and translating the problem into mathematical notation and solved the problem. The test was economical to administer, easy to respond to, provide time for learners to think and respond to the questions asked.

1.2. Ethical Considerations

Participants were informed about the purpose of the research and the assurance of their confidentiality. The researcher informed the participants of what research was all about and that participants had the right to decline or withdraw their participation if they chose to do so. The right to privacy is an important consideration in any research project. According to McMillan and Schumacher (2010), dishonesty violates informed consent and confidentiality of the participants, hence, the participants were informed and assured regarding anonymity and all information collected would remain confidential. Participation was voluntary and the participant had the right to withdraw at any stage. Participants were requested to sign a written consent form to confirm their agreement to participate in the research project. The names of the schools and participants were not used in the study, instead codes were used.

2. Data analysis

The analysis was conducted on word problem questions and learners' responses which were coded in a process of summarising the participants' responses to the questions. The learner's responses were then categorised according to the emerging themes and patterns based on the learners' difficulties encountered with role that language plays in Grade 9 learners' solutions to word problems. Data was arranged into logical order to uncover the challenges faced by learners, which need to be discussed in detail and be classified into different dimensional headings that merge into different themes, namely: Translation ability (T), Variable ability (V), Operation ability (O), Answer ability (A).

3. Results and Discussion of results

Results

- **To what extent are Grade 9 learners able to translate mathematical word problems into number sentence or formal notation?**

Most learners do not understand the meaning attached to word problems relayed. The language vocabulary knowledge influences success in solving a word problem. It shows that learners have a lack of English proficiency and lack competency in the application of English as a language of learning and teaching when solving word problems. The lack of language fluency practice makes learners unable to follow the problem-solving procedure. Learners could not have a personal connection and understanding of mathematical concepts embedded within word problems, hence learners encounter a major problem in solving word problems. Learners are unable to connect the coherent system such as rules, procedures and formulas applied in mathematics.

- **What difficulties do Grade 9 learners experience in translating mathematical words problems into a number sentence or formal notation?**

Learners' inability to understand the phrases used makes learners not to perform calculations correctly. Some learners only wrote an answer without translation statement, only shows that they are unable to derive means to follow the procedure in the calculation. Learners' lack the knowledge of the syntax used where additional language is at a greater disadvantage to learners whose home language (spoken language) is not the same as language of teaching and learning. The interrelation between linguistic complexity and numerical factors, which the learner has not fully acquired in the early grades. Linking mathematical concepts across modes becomes difficult where learners use home language rather than language of learning and instruction.

Difficulties which learners experience are language challenges in reading comprehension and vocabulary in the mathematics context, grammatical patterns, the figurative expression and semiotic systems in mathematics, such as "*more than an unknown number*"; "*a number subtracted from ...*" and "*one and half times*". Learners are expected to make connections within the learning situation and will develop way of thinking, reading and expressing the mathematical representation.

Learners are unable to comprehend the problem statement which is influenced by lack of background knowledge of language of learning and teaching (LOLT). It becomes difficult for learners to decode phrases, identify what they are supposed to do even though the language used is simple.

- **What elements of language are evident in the way Grade 9 learners solve word problems?**

Lack of English proficiency and difficulty in the application of English as a language of learning and teaching when solving word problems. The following areas presented the challenges to learners:

- Lack of basic mathematical conceptual knowledge and thinking skills.
- The inability of learners to reflect back, checking the validity of the solution.
- Lack of command constraints related to the mathematical syntax used.
- Difficulty in understanding instructions provided.

The language challenge undermines learners' ability to understand, solve and perform well in mathematical word problems. The inability of language practice fluency made learners not to follow problem solving procedures due to inability to understand the mathematical language. The language challenge undermines learners' ability to understand, solve and perform well in mathematical word problems.

Learners who struggle solving mathematical word problems are those who have difficulty with English as Language of Learning and Teaching (LoLT). These learners are not able to understand the meaning of the word problems being taught. Sepeng and Madzorera (2014) found that vocabulary knowledge influences success in solving word problems. This shows that learners do not have a sufficient command of English and are not able to use English as the language of learning and instruction in solving word problems. The learners could not make a personal connection with the

mathematical concepts embedded in the word problems, so they encountered major problems in solving word problems. The inability of learners to understand the phrases used results in learners not doing the calculations correctly. There are learners who have only written the answer without translation explanation, which shows that they are not able to derive the means to follow the calculation.

The solution of word problems is influenced by the interrelation between linguistic complexity and numerical factors, which the learner has not fully acquired in the early grades. Learners should try to overcome the challenge of dealing with and interpreting different representations of the same concepts. If learners have difficulty doing this, they should integrate concepts across the modes. Linking concepts across modes becomes difficult because learners have to do this in a language that is not their home language, but an additional language. Learners need to use the language frequently and effectively in mathematics to promote cohesion and consistency in understanding literacy and its numerical elements. The language challenges undermine learners' ability to understand, solve and perform well in mathematical word problems.

Skillful reading is essential in understanding the text in word problems and identifying appropriate strategies to solve word problems. There should be a correlation between the language of teaching and the teaching of mathematics. In the teaching of mathematics, learners need to be encouraged to use English as LoLT in the learning of mathematical word problems. The dependency of home language needs to be used only to the extent of understanding and should not hamper learners' understanding of word problem statements as they are translated into mathematical notation. Identification of problematic areas needs to be monitored and learners assisted in resolving language problems so that they understand the mathematical language used in assessment tasks.

Conclusions

Learners lack the ability to integrate common sense knowledge with what is learned in classroom Mathematics. Grady, (2013:5), viewed mathematics "...as a connected coherent system in which there are reasons for such things as rules, procedures and formulas, whether or not the individual yet knows or understand the reasons." The use of LoLT will strengthen the learner's linguistic competence. Incompetence in language proficiency could prevent learners from understanding mathematical word problems when solving tasks alone. Learners who use English as their home language are more advantaged as compare to those who take English as a first additional language.

Home language learners encounter no difficulties in solving word problems. Learners lack positive motivation which contributes negatively to their performance. The findings revealed that learners experience language difficulties, which creates challenges in understanding the word problem narrative statements and translation into mathematical notation. Language challenge undermines learners' ability to understand, solve mathematical word problems and perform well. Mathematical word problems require an understanding of mathematical language and language proficiency such as "learners' ability to use language to make meaning and communicate verbally and in writing during learning process" *cf* Demirsoy (2020:14-17), where most learners lack the appropriate use of language of teaching and learning (LoLT), (Moleko,2021).

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