P-ISSN: 2790-6795	Annals of Human and Social Sciences	Jan-Mar 2024,Vol. 5, No. 1
O-ISSN:2790-6809	http://doi.org/10.35484/ahss.2024(5-I)50	[554-562]

Annals of Human and Social Sciences
www.ahss.org.pk

RESEARCH PAPER

Problem Solving Skills through Mathematical Vocabulary and Formative Feedback: Evidence from Grade VII Private Schools

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ABSTRACT

The objective is to understand what teachers should be acquainted with to facilitate the development of problem-solving proficiency in their students. Another objective is to inquire how a teacher is informed by a comprehensive review of the research literature in mathematics education. There has been a significant focus on effective mathematics instruction.This article employs a category-based approach to examine the types of knowledge deemed essential for effective mathematical problem-solving instruction. This paper presents the findings of an action research study conducted by a teacher educator and researcher. This study sought to uncover the intentions of Grade VII school teachers. The research utilized various data sources, including reflective journals, semi-structured interviews, field notes, lesson observations, and reports. A two-stage model was proposed to guide the planning and execution of action research projects in schools. The paper concludes that formative feedback is crucial for the learning of challenging skills like problem-solving in Mathematics. It then observed their actions concerning formative feedback on midterm exams in courses that claim to teach problem-solving. The study found that action research is a highly effective approach for enhancing professional development; however, it also highlighted the challenges associated with implementing this methodology in real-world educational settings. It is essential for teachers to have a deep understanding of mathematical problem-solving, not only for their own proficiency as problem solvers, but also to guide students in developing their problem-solving skills. The study recommends that a mathematics teacher's expertise in teaching problem-solving must extend beyond their general ability to solve problems.

Keywords: Formative Feedback, Grade VII Students, Mathematical Vocabulary

Introduction

Mathematics holds a pivotal role in education, serving as a foundational skill that underpins various academic disciplines. Beyond its immediate applications in subjects like science and engineering, the study of mathematics cultivates critical thinking, logical reasoning, and problem-solving proficiency (Vula & Berdyna 2011). These skills are not only essential for academic success, but also contribute to broader cognitive development. Mathematics is a gateway to technological advancements and innovation, shaping individuals into technologically-literate contributors to the global knowledge economy. Proficiency in Mathematics expands career opportunities, particularly in STEM fields, and fosters quantitative literacy, enabling individuals to make informed decisions in various aspects of life. Its real-world applications, from managing personal finances to interpreting statistical data, emphasize the practical relevance of Mathematical skills in daily life. Furthermore, a mathematically- literate population enhances a nation's global competitiveness by contributing to economic growth and innovation. In summary, the importance of Mathematics in education extends far beyond the classroom, playing a vital

role in shaping well-rounded individuals equipped for success in the modern world. There is a pressing need for a successful and affordable Maths intervention model that is research-based and applicable for schools.

As the researchers observed seventh Grade students struggling with solving word problems, they became increasingly invested in finding ways to help them develop this crucial skill. The investigators realized that there were several barriers preventing them from effectively solving word problems and began to ask myself questions to better understand the root causes of their difficulties. The researchers wondered about the impact of limited Mathematical vocabulary, the challenges they faced in comprehending problem statements, the struggle to identify relevant information, and the absence of effective problem-solving strategies.

Motivated by these concerns, the researchers sought out instructional strategies that could be useful in addressing these barriers. The researchers explored various approaches, such as teaching Mathematical vocabulary explicitly, improving language comprehension, and providing students with explicit problem-solving techniques. The investigators also considered the value of incorporating activities that would engage and empower students in the context of word problem solving. The researchers recognized that developing students' word problem-solving abilities required them to acquire specific skills. These skills encompassed interpreting and comprehending problem statements, extracting key information, translating words into Mathematical expressions or equations, and employing strategic problem-solving approaches. By fostering the development of these skills, the investigators aimed to equip students with the tools they needed to tackle word problems successfully. Given the importance of word-problem solving in both academic and real-life contexts, researchers became determined to conduct further research on this topic. By examining the underlying barriers, exploring effective instructional strategies, and creating meaningful activities, the investigators aimed to provide my seventh grade students with a supportive learning environment. Researchers' ultimate goal was to enable them to overcome these barriers, develop strong problem-solving skills, and approach word problems with confidence and proficiency.

Furthermore, the study explored available resources that provided activities and tasks designed to enhance word-problem solving in seventh grade students. These activities aimed to engage students in real-world scenarios, hands-on experiments, and simulations that fostered critical thinking, logical reasoning, and the application of Mathematical concepts. Throughout this reconnaissance phase, the researchers also aimed to identify the essential skills that students should develop to excel in solving word problems. These skills encompassed the ability to interpret and comprehend problem statements, analyze and extract relevant information, translate words into Mathematical expressions or equations, and utilize problem-solving strategies effectively. By conducting this initial reconnaissance, the study laid the groundwork for the research, ensuring that the investigators are well-informed about the existing knowledge and practices in the field. Armed with this information, the researchers were better equipped to design the study, formulate research questions, and develop effective strategies to enhance word problem-solving abilities in seventh grade students.

Literature Review

A researcher stated that the role of mathematical vocabulary is very important in the modern technological era to interrelate and solve a variety of routine daily life problems. To be successful in understanding mathematics students must know the language of recommended that the teachers should be encouraged to employ problem solving methods in teaching mathematical concepts like set, information handling and geometry etc. Mastering mathematical word problem solving is an important aspect of learning mathematics and mathematical reasoning. It is unfortunate that students are able to

perform other mathematical tasks but find difficulty in solving word statements (Blessman & Myszczak 2001). They are able to easily perform operation such as addition, subtraction, multiplication and division. These students ably identify units of measurement and perform calculation tasks with numbers and equations. However, when faced with word problems, many students find it hard to figure out what to do. Many times students are able to understand part of the questions, but struggle to do the necessary steps and end by doing incorrect working.

As stated by Burns (2007) learning of mathematics is parallel to learning a second language. Sharma (2001) further draws a connection between mathematics and language, stating that mathematics functions as a form of language with its own symbols, letters, vocabulary, and grammar, facilitating communication through these elements (p. 66). In order for a student to be successful it is necessary to know the meaning of mathematical terms. When mathematical terms are clear to a student only then they can better understand the concepts. This is applicable to all subjects as when students grasp the fundamental vocabulary they will understand the content effectively.

According to Kranda (2008) to achieve success in learning mathematics, students must effectively engage in the language of mathematics. An essential component of this linguistic proficiency is the skill of solving word problems, which plays a crucial role in fostering mathematical thinking. Modern educational research emphasizes the significance of mathematical vocabulary for students in formal conditions (Van de Walle 2007). In the context of mathematics education, this highlights the crucial role of mathematical vocabulary in shaping students' conceptual understanding. Educational standards and frameworks, such as the Common Core State Standards in the United States, explicitly recognize the centrality of mathematical vocabulary. National Council of Teachers of Mathematics (NCTM). (2000) says that these standards guide educators in integrating vocabulary instruction into their teaching practices, acknowledging that a strong command of mathematical language is integral to mathematical proficiency (Common Core State Standards Initiative, 2010). Formative feedback aligns with the idea that assessment should be an ongoing, formative process that guides learners toward higher-order thinking. The shift is informed by theories such as assessment for learning which posits that assessment should be a tool for enhancing learning rather than merely measuring it (Black & Wiliam, 2006). These tools allow educators to provide immediate feedback and tailor instruction based on real-time data, aligning with the principles of formative assessment.

The primary aim of incorporating mathematical vocabulary in education is to deepen students' conceptual understanding of mathematical principles (Siena 2009). Clear and precise language enables students to articulate, comprehend, and communicate mathematical concepts effectively. Mathematical vocabulary aims to facilitate communication within the mathematical community. Standardized terms and symbols provide a common language for mathematicians, educators, and students, fostering a shared understanding of mathematical concepts and promoting effective communication in mathematical discourse. Proficiency in mathematical vocabulary correlates with improved problem-solving skills. When students can accurately interpret and express mathematical ideas, they are better equipped to analyze and solve complex problems, enhancing their overall mathematical competence. Mathematical vocabulary aims to prepare students for higher education and future careers in fields requiring mathematical expertise. A strong command of the language of mathematics is essential for success in academic pursuits and professions that demand mathematical proficiency. The central aim of formative feedback is to support continuous improvement in student learning. By providing timely and specific information about strengths and areas for growth, formative feedback empowers students to make adjustments and progress toward mastery of learning objectives.

Material and Methods

Action research followed by various sages was employed. The research comprised content analysis and a survey to analyze h to what extent the teachers and the students practiced mathematical vocabulary.it comprised phases for implementation. The first phase of the research involved implementing various strategies to clarify everyday mathematical terms and create a student dictionary. During Phase II of the research, the focus shifted towards implementing formative assessment feedback strategies. The central intervention during this phase involved conducting formative assessments and providing feedback to students. The feedback was primarily given by the teacher, but students also had the opportunity to provide feedback to each other. The feedback was predominantly provided in written form, although there were instances where verbal feedback was also utilized. The purpose of the feedback was to enhance students' performance and guide them towards the appropriate procedures in solving word problems. It aimed to highlight potential errors, clarify steps in problem-solving, and provide guidance for improvement. As part of this phase, students actively engaged in solving word problems, and for each problem solved, feedback was given to enhance their performance and provide further clarification and guidance for future work.

The study was guided by an experimental design employed to investigate the impact of teaching mathematical vocabulary and providing formative feedback on the problem-solving skills of students. The target population included teachers instructing in mathematics across various educational levels, and a stratified random sampling was utilized to ensure representation from respective organizations. The independent variables consisted of different teaching strategies for mathematical vocabulary and various types of formative feedback, while the dependent variable was the problem-solving skills of students. Data collection methods included surveys to gather teachers' opinions and practices, observations to assess teaching practices, and student assessments to evaluate problem-solving skills. The study incorporated both experimental and control groups, with randomization to control biases. Interventions involved training sessions and instructional materials. Ethical considerations, such as obtaining informed consent and protecting participant confidentiality were integral to the research design.

Procedures

Data collection encompassed surveys, observations, and student assessments, aiming for a comprehensive understanding of teacher practices and student outcomes. Ethical considerations, including informed consent and participant confidentiality, were integral to the study. The research unfolded over a defined timeline, from intervention implementation to data analysis, with the ultimate goal of contributing insights into effective teaching strategies and their impact on students' problem-solving skills. Acknowledging potential limitations, the study incorporated pilot testing to refine instruments and procedures. The findings were gathered as required in the research protocol. The researcher obtained an introductory letter from the university's head, outlining the study's purpose. This document served as a formal introduction when liaising with school principals. Subsequently, the researchers secured approval from school principals to proceed with data collection. Agreements were established with both principals and teachers regarding the timeline for the distribution and collection of the questionnaires. To mitigate potential issues related to collusion among students during the questionnaire completion process, the researchers took a hands-on approach by personally administering and supervising the students as they filled out their questionnaires. Interviews with school principals and coordinators were scheduled on mutually agreed-upon dates, and detailed notes were recorded during these interactions. Rigorous document analysis followed, involving the meticulous ticking of checklists and the addition of pertinent comments.

Sampling and Population

The target population for this study comprised educators who specialize in teaching mathematics across various private educational levels. This included teachers from elementary, middle, and high schools, as well as instructors at the colleges teaching mathematical vocabulary and providing formative feedback on problem-solving skills across the spectrum of mathematical education. The sample for this study consisted. The sample size comprised students and teachers. The study employed a stratified random sampling technique to ensure proportional representation from each educational institution. This involved dividing the population of teachers into strata based on their educational level (elementary, middle), and then randomly selecting participants from each stratum. This method helped to ensure that each educational level was adequately represented in the sample, allowing for meaningful comparisons and generalizability of findings across different stages of mathematical education. Within each stratum, random assignment was used to allocate teachers to either the experimental or control group. This randomization helped control for potential biases, ensuring that both groups was are comparable at the outset of the study. Random assignment enhanced the internal validity of the study by reducing the likelihood of pre-existing differences between the groups that could confound the results. The combination of stratified random sampling and random assignment contributed to the robustness and generalizability of the study, allowing for insights that were applicable across various educational levels within the field of mathematics education.

Research Instruments

The researcher utilized three distinct research instruments—questionnaires, interview guides, and focus group discussions based on a careful consideration of various factors. This selection was informed by the type of data intended for collection, the available time constraints, and the specific research questions guiding the study. The choice of questionnaires was driven by their appropriateness for efficiently gathering quantitative data related to participants' opinions, practices, and perceptions on teaching mathematical vocabulary, formative feedback, and problem-solving skills. The use of interview guides was motivated by the need to delve deeply into individual experiences, allowing for a qualitative exploration of educators' perspectives and practices. Focus group discussions were incorporated to capture collective insights and observe group dynamics, offering an efficient way to explore shared experiences among participants. This combination of research instruments was tailored to align with the research objectives and the diverse nature of the data sought in the study. Questionnaire, interviews and observations were primary instruments in the study. For instance, to interviews vary in number of ways. They may be unstructured, semi-structured or structured.

Pilot Study

A pilot study is a small-scale, preliminary research investigation conducted to test and refine research methods, instruments, and procedures before implementing them on a larger scale in the main study. It serves as a valuable tool for identifying potential issues, refining research protocols, and ensuring the feasibility and effectiveness of the study design. In the pilot study, researchers typically selected a smaller sample size and conducted a trial run of data collection and analysis procedures. This allowed them to assess the clarity of survey questions, the appropriateness of interview guides, and the overall feasibility of the study design. Researchers often make adjustments based on the insights gained during the pilot phase to enhance the reliability and validity of the main study. In conclusion, a pilot study is an essential step in the research process, providing researchers with valuable information to refine their methods and ensure the successful execution of the main study.

Reliability of the Instrument

Table 1
Summary of Reliability Tests Results

Respondents	No of Cases	No of Items	Alpha
Students	21	23	0.72
Class Teachers	10	28	0.66
Coordinators	1	13	0.71
Principals	1	12	0.65

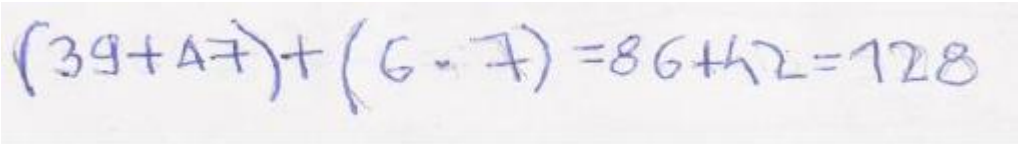
Results and Discussion

Data Analysis

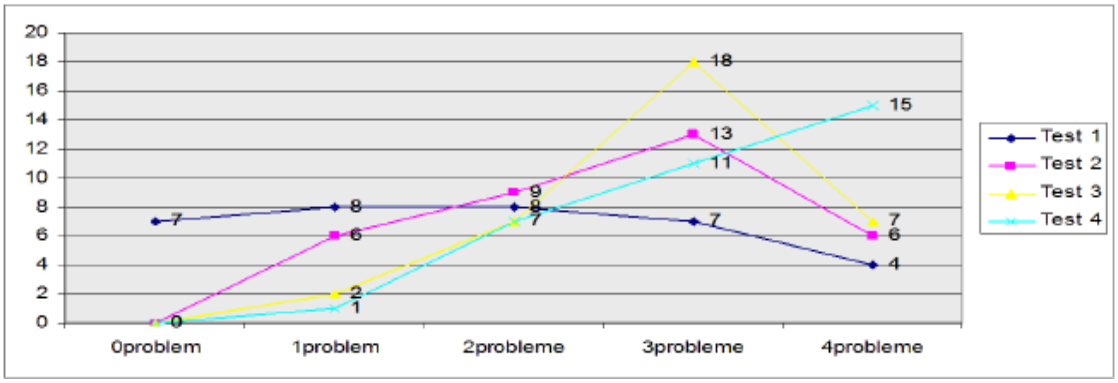
Results of the Test

The first test clearly pictured that most of the students were having difficulty in interpreting word statements. 67% of the students gained average scores. After analyzing the result, it showed that students were not able to comprehend the mathematical terms written in the questions.

Reduce the sum of numbers 39 and 47 with the product of the numbers 6 and 7.



Students were not able to understand the meaning of the word 'reduce' and because of this they were not able to solve the problem correctly. One of the students, instead of subtracting and then dividing, did the opposite and added the amounts (39+47) and then multiplied them. This mistake clearly stated that this particular student was not able to identify the keywords given in the question or was not attentive in ready the question and therefore solved it incorrectly. The researchers from this example identified that students were continuously making this mistake in understanding the words: increase, decrease, double, *x* times more, *y* times less, and so on. They were confused by the terms: less than or x times less, or more than, y times more, which in turn makes the working incorrect. These inaccurate explanations arise from the deficiency in comprehending mathematical terms. Confusion over mathematical terminology prompted students to propose inappropriate strategies when solving problems. When students were given a clear understanding of vocabulary, they were able to understand the keywords and were giving appropriate explanation. The initial plan which basically focused on enhancing student's mathematical vocabulary contributed in developing students thinking skills. The students who had difficulty at the beginning in comprehending the keywords, improved their vocabulary and demonstrated a clear understanding of specific terms. After analyzing student's individual work these results were collected. While the initial intervention resulted in enhancements in students' problem-solving skills, some individuals still encountered challenges when tackling word problems.



After performing four tests, a positive change was revealed in student's performance. Students exhibited an uplift in the number of problems solved correctly which eventually resulted in an increase in their average score. Action plans revealed a positive effect on student's performance. After each plan, improvement was observed, leading to an increase in the number of students who solved the questions correctly. The measures taken in this research proved to be beneficial in developing students' conceptual skills in solving problems. Acosta-Tello (2010).

Findings

When executing the first action plan, different other activities were implemented in order to further enhance mathematical vocabulary of the students. Games were played by students in pairs to boost peer interaction. Students were to identify the keywords from the given word problems and explain them. Words were selected from daily routine list. (Solomon, 2009). Another activity was the explanation of mathematical words using artistic presentation. Students explained the words: addition, subtraction, multiplication and division through word explanations, presenting examples and illustrated with drawings using a worksheet called: *What does it mean?*

After completing this phase, a test was administered to explain the same words. (Amen, 2006). In October 2023, the researchers executed a second action plan focusing on formative assessment feedback strategies, covering the period from September to November 2023. The focus of this research was to assess students at every stage and then give them constructive feedback so that they could rectify their mistakes. Teachers were the main person in giving feedback, but students were also learning from their peers. Written and verbal both type of feedback was given to students. Feedback resulted in improvement of students performance, guided them in following proper steps to solve the word statements. It also highlighted their mistakes and made them rectify them to reach the final solution. Feedback to pupils about their progress was important in contributing to motivation and further progress.

The study found that it is essential for a study in Mathematics to see how the skills nd potential of a learner can be tapped and enhanced. Students who fail Mathematics test often find it difficult to understand the languae of a test in mathematics. Teaching mathematical vocabulary in the early primary schooling is also beneficial to students in secondary classes. Students of Grade Vii found it convenient to solve problems in mathematics by resolving the issuesand complication in the problem translating the language into their own first language. This allowed a fairy connection between the stages to solve a problem and the affinity with the subects. Discussion to resolve the key issues was found to be highly effective and beneficial. A game –based problem-solving was aso found to be effective.

Conclusion

Solving word problem plays a crucial role in shaping students' mathematical content knowledge and ability in mathematics so it should be considered as an important part of teaching and learning in mathematics. By proper guidance and training, students reluctant in solving word problems can be motivated. By applying different strategies and activities, students feel confident in solving word problems. This collaborative action research resulted fruitful in developing students' mathematical vocabulary skills to solve problems and guided the teachers in changing their strategies. By employing action research cycles, the purpose of conducting the research was achieved and answered the research questions. Findings of the research showed that there is a direct connection between problem solving and comprehension of the vocabulary. (Amen, 2006; Burns, 2007; Brethower, 2008; Georgius, 2006; McConnell, 2008). Following a work out on mathematical vocabulary students demonstrated an uplift in their test scores. (Amen, 2006, p. 23). As stated by Amen (2006), students should continuously write, visualize and act about mathematical vocabulary. Our research supported Amen's findings. Research from Brethouer (2008) indicated that by having a clear concept of vocabulary in learning mathematical concepts is directly related to a deeper understanding of them. Research has demonstrated that when students understand the mathematical keywords they are able to solve the problems accurately and it also fosters their conceptual mathematical knowledge.

Recommendations

Student's communication and expression in mathematics also enhanced by the learning of vocabulary in problems which as a result polishes their reasoning skills. The word wall used and remembering vocabulary must be used as an effective tool in aiding students to use them appropriately. The result of feedback must also be a very useful technique. Students should also be taught to find such vocabulary feedback useful not only in clearing their queries and correcting their mistakes, but also taking it as reference for future assignments. The two-way communication between the teacher and the students must supply information for identifying the challenges faced by students. (Murchan, Shiel, & Vula, 2012). Feedback must be productive, as it enables the student to better assess themselves and how the task can be approached in many different ways. Implementing an action research methodology must prove to be an effective way to develop students' skills in solving word problem and to create a conducive classroom environment.

More opportunities should be given to students for solving word problems as it is not only important in mathematics, but it will train them to connect mathematical concepts with real life scenarios. By developing these skills, it must help students to understand mathematical terms, build confidence in doing word statements and communicate whole heartedly about mathematics. Problem solving should be considered as one of the 21st century skill which our students need to acquire in order to compete with the modern world. One to one facilitation is needed by the students in their work and feedback strategy proved must be beneficial in this regard. By following this cycle of identifying the students who were having difficulties in learning, creating activities according to the diverse needs of students, implementing and reflecting on action plans, a more quality education can be provided to our students.

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