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Beyond Memorization: Building Problem-Solving Skills in Sequences for Future Math Teachers

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A B S T R A C T

This study looks into how future math teachers solve problems when dealing with sequences. Data show a worrying trend: none of the respondents received a very high score, and more than 60% received a low grade. The biggest obstacle turned out to be harmonic sequences, indicating a critical knowledge gap. Even simple sequences, such as arithmetic sequences, could be challenging, especially when phrased issues and non-consecutive phrases were included. It's interesting to note that students started using online tools like YouTube lessons as part of a self-help movement. This, however, draws attention to a possible over-reliance on outside sources. The study highlights how crucial it is to reinforce fundamental information across a range of sequence types. Future math teachers can approach and solve sequence issues with more confidence if they have a solid grasp of the fundamentals and have conducted purposeful web research. This will ultimately result in more effective teaching methods.

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INTRODUCTION

The ability to solve problems is essential for overcoming obstacles in daily life. The learner can recognize issues and formulate a plan of action for resolving them. It develops analytical abilities, flexibility, and critical thinking (Ütkür Güllühan, N., 2021). Poor math abilities, a lack of comprehension of the topic, and a lack of experience are some of the reasons why problem-solving can be difficult (Szabo, A., et al 2024). When faced with sequence problems, students frequently find it difficult to see the underlying pattern, convert written descriptions into mathematical formulas, switch between particular terms and general rules, and memorize formulas without understanding the underlying ideas. These difficulties can make it challenging to solve new problems (Agustiani, N., 2021).

According to a Mendeley source study by Maysaroh, problem-solving became the main focus of education as the movement spread throughout the United States of America (USA) and the rest of the world in the 1980s (Santos-Trigo, M., 2024). Similarly, mathematics not only helps students become more employable and educated for the future, but it also improves their capacity for problem-solving in the real world (Maysaroh, E., et al., 2023).

However, it is noted that students majoring in mathematics at the University of Eastern Philippines - Laoang Campus are having trouble with problem-solving. They consequently encounter difficulties in comprehending the issue and locating pertinent data when resolving sequences. Additionally, some math majors run into difficulties when trying to solve problems. These challenges may result from interpreting written problems, converting them into mathematical symbols, or understanding the fundamental ideas underlying formulas, which might make it difficult to apply the solutions to new situations (Aisy, N. M. R., Mulyono, et al, 2022).

Furthermore, this study can advance our knowledge of how pupils acquire and resolve sequence-related difficulties. Students' learning results can eventually be improved by using this knowledge to enhance instructional strategies. Additionally, for students to apply their knowledge and skills to solve problems of a foreign nature, problem-solving in mathematics is a critical skill that must be cultivated or modified (Pebrianti, A., et al 2023). To prepare students to acquire relevant 21st-century skills like mathematical reasoning, critical thinking, and mathematical problem-solving, it is necessary to understand the types of mathematical skills needed in today's world and the changes that should be made in both content and pedagogy (Olsson, J., & Granberg, C., 2022).

Based on Hamzah's study using a Mendeley source. According to reports from the Trends in International Mathematics and Science Study (TIMSS), Malaysian respondents performed noticeably worse than other respondents in the cognitive dimension, which focused on critical thinking and problem-solving. This claim demonstrated that children had not fully mastered the mathematical abilities necessary, particularly for problem-solving. Since a large number of individuals are still having difficulties, this finding should not be ignored. Gaining a knowledge of this issue is essential. Better programs may be

developed to help children who struggle with problem-solving if the challenges associated with many of the mathematical abilities that need to be acquired are addressed (Hamzah, A. M., 2023).

According to a study by Maryati and Fadhilah (2021), students at MAN 2 Bandar Lampung had difficulty with the subsequent steps of solving mathematical problems, even if they understood the problems themselves quite well (87.10%). In particular, 'terrible' categories were occupied by preparing the solution (40.32%), carrying out that plan (24.19%), and considering the solution (48.39%). The researchers categorized the resulting overall average of 50% as weak. Because they identify sequences as a particular area of difficulty, their study focuses on enhancing students' problem-solving abilities in this particular area of mathematics (NICHAREE SANGSAMAK et al., 2023).

The researchers considered that it was necessary to carry out this study to ascertain students' problem-solving abilities and challenges when it came to mathematics using mathematical sequences because of the circumstances that were provided. It will specifically aim to respond to the following queries: "What are the levels of problem-solving skills in solving sequence-related problems under mathematics majors? “What challenges do you have while attempting to solve mathematics problems that include sequences?", and "How have the respondents addressed the challenges they have faced?".

THEORETICAL REVIEW

Problem-Solving Stages Theory by Newell and Simon, 1972

According to this idea, there are several steps in the process of addressing an issue, such as defining it, coming up with solutions, assessing them, and choosing the best one. This theory includes concepts, methods, and frameworks designed to improve problem-solving abilities. This offers an organized framework for examining and resolving the challenges students encounter while attempting to solve mathematics problems using sequences. It clarifies how deficiencies in mathematical knowledge and cognitive skills affect students' capacity to resolve sequence-related mathematical issues and contribute to our understanding of the cognitive processes involved in problem-solving (Savinova, A. D., 2023).

Information Processing Theory by George Armitage Miller, 1960s

According to this approach, addressing problems involves receiving, processing, and applying information to come up with solutions. To solve problems successfully, it highlights the importance of working memory, knowledge frameworks, and mental techniques. According to information processing theory, short-term memory can only store a certain number of chunks of information—roughly seven plus or minus two. This may help to explain why kids find it difficult to solve complicated puzzles that need multiple details to be remembered at once. This emphasizes the idea of chunking as well, which is the process of organizing linked bits of data into coherent units. To help students recall and process the knowledge better, teachers can assist them in breaking difficulties down into smaller, more

digestible portions. A student may have trouble encoding the information because of complex phrasing, short-term memory constraints, or difficulties accessing pertinent information from long-term memory if they struggle with a particular kind of problem. Teachers can design learning environments that support students' information processing and problem-solving strategies by grasping the fundamentals of information processing theory. Students may benefit from this in terms of enhanced problem-solving abilities and greater academic achievement (Teglasi, H., Caputo, M. H., & Scott, A. L., 2022).

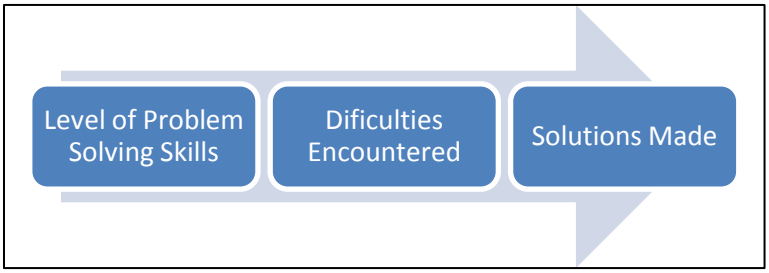

Figure 1. Conceptual Framework

METHODOLOGY

The University of Eastern Philippines Laoang Campus served as the study's location. There are 47 students involved, including BSED Mathematics Majors in their first, second, third, and fourth years of study who are enrolled in the second semester of the school year. 2023–2024. The study employed a hybrid methodology. We will use a quantitative design to analyze the problem-solving skill-level data. The data on the challenges respondents had when solving mathematical sequences will be analyzed using a qualitative design.

The necessary data was gathered via a questionnaire. The items were extracted from Lee, Sun, & Wang's book. January 6, 2024. Regarding Intermediate Algebra. Their degree of proficiency in solving mathematical sequence problems was gauged using the questionnaire. The quantitative data were evaluated to ascertain the problem-solving proficiency level. Conversely, an interview guide questionnaire was employed, which was also based on one presented by Maryati and Fadhilah in their study regarding the challenges faced when completing mathematical sequences. The qualitative data were categorized into topics to interpret the challenges respondents had when completing mathematical sequences. Standard deviation and weighted mean are used in this investigation.

RESULTS

The results of the research presented in this part are the results of the research questions the researchers want to attain.

Levels of Problem-Solving Skills in Solving Problems Involving Sequence

Table 1 presents the level of problem-solving skills of the respondents. The distribution of math majors' problem-solving abilities when it comes to addressing sequence-related problems is displayed in the table. The scores are classified into three categories: Very Low (0–4), Low (5-8), and Moderately High (9–12). Sixty-nine percent of pupils had a Low score, followed by fourteen percent who received a Very Low score and twenty-three percent who received a Moderately High score.

Table 1.
Levels of Problem-Solving Skills

Score	**Frequency**	**Percentage**	**Interpretation**
0-4	7	14.9	Very Low
5-8	30	63.9	Low
9-12	10	21.3	Moderately High
Total	47	100	

The study of Albay (2020) utilized the problem-solving approach as supported by various collaborative strategies as an instructional intervention in teaching mathematics to first-year college students and investigated its effects on the enhancement of their performance in and attitude toward College Algebra.

This study of Enriquez and other researchers has provided valuable insights into the potential of Realistic Mathematics Education (RME) as a pedagogical approach to enhance problem-solving skills in the Philippine educational context. Through a systematic review of existing literature, the researchers have identified several key findings regarding the impact students' problem-solving abilities, engagement, and alignment with constructivist principles (Enriquez, E., et al., 2024).

Difficulties Encountered in Solving Problems Involving Sequences

Table 2 presents the qualitative data collected by the researchers from the respondents. It exhibits the difficulties encountered in solving mathematical problems involving sequences. Table 2 indicates a fundamental deficiency in students' comprehension of sequences. The most difficult sequences were harmonic ones as the idea and particular formulas were unfamiliar to the student. This flaw also impacts simple arithmetic sequences, emphasizing the importance of a deeper understanding of fundamental sequence principles.

Table 2
Difficulties Encountered in Solving Problems Involving Sequences

Respondent	Difficulty	Reason
1	Harmonic Sequence	Unfamiliarity with solving techniques
2	Harmonic Sequence	Unfamiliarity with the concept

3	Harmonic Sequence	Unfamiliarity with the concept
4	Non-whole number sequences (including Harmonic)	Unfamiliarity with the concept
5	All sequences (especially complex)	Weak foundation in sequence concepts
6	All sequences	Weak foundation in sequence concepts
7	Harmonic Sequence	Unfamiliarity with the concept
8	Harmonic Sequence	Lack of knowledge and formulas
9	Arithmetic Sequence (word problems)	Weak foundation in sequence concepts
10	Arithmetic Sequence	Weak foundation in sequence concepts

Rachma & Rosjanuardi (2021) results show that learning obstacles are classified into epistemological, ontogenic, and didactical obstacles. Based on the onto-semiotics approach, the students had difficulties in defining a mathematical idea on sequences and series topics. They could convert a problem into a mathematical model but were confused to use a proper procedure. It can be concluded that students still experience obstacles in learning sequences and series topics.

The solutions made by the respondents to the difficulties they encountered

Table 3 shows the solutions made by the respondents to the difficulties they encountered. Despite their difficulties with sequences, many students showed initiative. Most looked to the internet for answers, especially for harmonic sequences (a typical problem), where they could find instructions on YouTube and Google searches. This "self-help" craze draws attention to the advantages of adding online research to traditional classroom instruction.

Table 3
Solutions made by the respondents

Response	Difficulty	Solution
1	Harmonic Sequence	Research & YouTube tutorials
2	Harmonic Sequence	Google & YouTube searches
3	Harmonic Sequence	Studying the topic
4	Non-whole number sequences (including Harmonic)	Internet search after survey

5	All sequences (especially complex)	Review basic lessons
6	All sequences	YouTube tutorials & reviewing notes
7	Harmonic Sequence	YouTube tutorials
8	Harmonic Sequence	Google & YouTube tutorials
9	Arithmetic Sequence (word problems)	Problem analysis & formula selection
10	Arithmetic Sequence	Online formula search & video tutorials (limited success)

One of the most common problem-solving strategies is trial and error. In other words, you try different solutions until you find one that works. Sometimes, it's more effective to solve a problem based on a formula than to try different solutions blindly (Msw, 2022). Dumigsi and Cabrella (2019) Strategic Intervention Material can help improve the academic achievement of Grade 9 students in Mathematics. Incorporating SIM into the delivery of the lessons with least mastery develops the mathematical skills in solving problems involving quadratic functions. The said intervention material assists students in developing the fundamental knowledge, skills, and understanding of Mathematics and aids them in the transfer of learning. Additionally, parental involvement fosters stronger parent-child relationships, boosts student confidence, and promotes a positive attitude toward mathematics. To create a conducive learning environment, schools, teachers, and parents should collaborate, implementing recommendations such as creating quiet areas, promoting digital detox initiatives, managing workload, offering targeted support, establishing study environments, and setting clear expectations for mathematics practice Nobis and Caparroso (2024). This is consistent with the idea of carefully integrating math apps into the learning process to improve, not replace, critical thinking skills (Deo, 2022). Educators are advised to strategically integrate math applications while taking into account varied learning styles (Cabugwason et al., 2024).

DISCUSSION

The study found that a majority (63.9%) of respondents scored low in problem-solving competency, indicating a need for improvement in this area. This finding appears to contradict Almerino et al. (2020) who reported strong academic performance among students. This discrepancy suggests a potential gap between academic achievement and practical problem-solving skills. The assessment used in this study may have focused on a static problem-solving type, unlike the interactive approach emphasized in PISA 2012 (OECD, 2013). This difference in methodology could explain the variation in results. Future research could investigate specific areas where students struggle with problem-solving, explore

methods to bridge the gap between academic performance and practical skills and assess whether incorporating interactive problem-solving approaches leads to improved learning outcomes. By considering these factors and comparing findings with existing research, a more comprehensive understanding of student problem-solving competencies can be achieved. This knowledge can then be used to develop targeted interventions and further research on effective methods for improving problem-solving skills.

This study found harmonic sequences to be the biggest hurdle for students in sequence problems (80% difficulty in Table 2), likely due to a lack of familiarity with the concept and formulas. Interestingly, some students struggled with worded problems and non-consecutive terms even in familiar sequences like arithmetic progressions. This aligns with Sulistiowati et al. (2019) who found difficulty interpreting problems, but our findings suggest the challenge extends beyond that. Similar to Rachma & Rosjanuardi (2021), some students struggled with solution processes, indicating a gap in procedural fluency even for familiar sequences. By reinforcing foundational knowledge in harmonic sequences and problem-solving strategies across various sequence types, educators can equip students to tackle these challenges with greater confidence. Future research could explore targeted interventions for specific difficulties like interpreting word problems or applying solution procedures.

This study found students tend towards self-help with sequence problems (8/10 using online resources like Google and YouTube per Table 3), aligning with Nobis (2021) on the rise of online learning. However, a crucial point from Respondent #5 highlights a potential gap in foundational knowledge. They emphasize building a strong base in "basic lessons" before using online resources, suggesting they should be supplemental. Reinforcing core knowledge alongside online exploration, as suggested by Dumigsi & Cabrella (2019), could be more effective for building confidence. While current curriculum materials seem adequate, exploring alternative methods might be beneficial. Studies by Lusica (2015) and Barredo (2013) (cited in Guzman Gurat, 2018) showed positive results with Supplemental Instructional Materials (SIM) as a remediation tool, suggesting additional resources could enhance learning. Furthermore, Spangenberg and Pithmajor (2020) identified student problem-solving strategies like direct counting, proportion, recursion, and mental imagery. Understanding these strategies can inform educator methods to better equip students (e.g., focusing on foundational knowledge, exploring alternative instruction, and promoting awareness of strategies). This combined approach can create a more comprehensive learning environment for sequence comprehension.

CONCLUSIONS AND RECOMMENDATIONS

The low problem-solving competency scores found in this study, despite potentially strong academic performance from other research (Almerino et al., 2020), suggest a gap between theoretical knowledge and practical skills. Future research should target specific areas of difficulty and explore methods to bridge this gap. Additionally, investigating the effectiveness of interactive problem-

solving approaches, compared to the potentially static methods used here, could be valuable in improving student outcomes.

While harmonic sequences posed the biggest challenge (80% difficulty), likely due to a lack of foundational knowledge, student struggles extended beyond interpreting problems. Some students even faced difficulties with solution processes in familiar sequences, suggesting a gap in procedural fluency. To address these challenges, educators can equip students with greater confidence by reinforcing core knowledge in harmonic sequences and problem-solving strategies across various sequence types. Future research could explore targeted interventions for specific difficulties, such as interpreting word problems or applying solution procedures.

This study found students favoring online resources for sequence problems (8/10 using Google and YouTube), reflecting the rise of online learning. However, a potential gap in foundational knowledge emerged. To bridge this gap and create a more comprehensive learning environment, educators can: 1) reinforce core knowledge alongside online exploration, 2) explore alternative instructional methods like Supplemental Instructional Materials (SIM), and 3) promote student awareness of problem-solving strategies like direct counting, proportion, recursion, and mental imagery.

FURTHER STUDY

Although some pupils have a moderate understanding of sequences, the data indicates that there is room for development. Additional research could look into the best ways to teach harmonic sequences, how technology can help students learn sequences, how problem-solving and sequence comprehension are related, and how to monitor students' development over time. These studies can help teachers better understand how to help students who are having difficulty, which will help them gain valuable problem-solving skills and a stronger knowledge of sequences.

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