Exploration of Students' Problem Solving Ability on Arithmetic Material in a Constructivist Philosophy Perspective Review

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Abstract. This study aims to explore the mathematical problem-solving abilities of male and female students on arithmetic sequence and series material from a constructivist philosophical perspective. The research was motivated by the generally low problem-solving performance of Indonesian students, as reflected in international assessments such as PISA and TIMSS. Employing a qualitative case study design, the research involved two eighth-grade students from SMP Negeri 3 Satu Atap Tawangharjo, each representing a high-achieving male and female student. Data were collected through written tests, interviews, observations, and documentation, and analyzed using an interactive model. Findings reveal that both male and female students achieved all mathematical problem-solving indicators, yet exhibited distinct cognitive patterns. Male students demonstrated logical and spatial strategies but tended to overlook the rechecking stage, while female students showed more verbal, organized, and reflective problem-solving behaviors. From a constructivist perspective, these differences highlight the importance of meaningful, experience-based learning that supports individual knowledge construction.The study suggests that mathematics instruction should integrate varied contextual problems, promote reflective habits, and adopt gender-responsive strategies to enhance students' problem-solving competence. Future research is encouraged to broaden the scope across different topics and student populations.

Keywords: mathematical problem-solving, arithmetic sequences, constructivism, gender differences, qualitative research

INTRODUCTION

In the era of revolution 4.0, problem-solving is one of the abilities and indispensable skills. Problem-solving is an essential skill in overcoming various problems in life that can be overcome appropriately [1]. Problem-solving is the main focus in learning mathematics at school and is an important skill needed in solving problems in everyday life related to non-routine problems [2]. Therefore, every student is required to have good problem-solving skills. Students are said to have good problem-solving skills if they can understand problems, design mathematical models, solve models, and interpret the results obtained [3]. Improving mathematical problem-solving skills in students can also enhance student learning outcomes to advance mathematics and the quality of education in our country [4].

In the framework of developing crucial problem-solving skills in the 4.0 era, Arithmetic Number Pattern material at the 8th grade level plays a fundamental role. This material, which involves identifying regularities in number sequences, determining the next term, to formulating the formula for the nth term and the sum of the first n terms, inherently trains students in logical thinking, identifying patterns, and making generalizations. These abilities are the core of problem solving, not only in mathematics but also in various disciplines and life situations. Therefore, learning Arithmetic Number Patterns that emphasizes pattern observation, formulating general rules, systematic calculations, and interpreting results, will directly improve students' problem-solving skills.

Problem-solving skills can help students to gain more profound experience. The experience gained makes it easier for students to apply their knowledge in everyday life [5]. However, the facts at school show that Indonesian students' ability to solve math problems is still relatively low [6]. Therefore, important principles are needed in the learning reform movement. Constructivism is relevant and a key principle in mathematics learning.

Mathematics learning from a constructivist perspective no longer views students as passive subjects, but rather, students construct knowledge up to the Zone of Proximal Development (ZPD) [7]. In this context, teachers act as facilitators, guides, or moderators, ultimately leading students to a strong and independent understanding of mathematics [8]. According to the constructivist view Prastowo in his research [10], knowledge cannot be transferred directly from teacher to student but must be constructed independently through experience, interaction, and reflection. This process can be observed through several important indicators. First, assimilation, which is the student's ability to connect a problem to prior knowledge or experience. Second, accommodation, when students are able to change or adjust a strategy if the initial strategy proves inappropriate. Third, reflection, which is the effort to review the results and thought process to ensure the accuracy of the solution. Finally, social interaction and scaffolding, where students utilize discussions with peers or teacher assistance to broaden their understanding.

Research on mathematics from a constructivist perspective shows a wide range of applications across educational and cultural contexts. Gultom (2024) applied a constructivist-based contextual learning model to improve student abilities, showing a significant increase with 97% of students achieving the minimum score in cycle II compared to 78.1% in cycle I. In contrast to the results of the Program for International Student Assessment (PISA) in 2018, Indonesia's score did not experience significant progress, which was always below 400 [11]. Meanwhile, data from the Trends in International Mathematics and Science Study (TIMSS) inspection results in 2015 showed that Indonesia was ranked 44 out of 49 countries that participated in TIMSS with an average score of 397 from the international average score of 500 [12]. The data aligns with the results of interviews with mathematics teachers of grade VIII SMP Negeri 3 Satu Atap Tawangharjo, who stated that the mathematical problem-solving ability of their students consisting of two classes is classified as low to medium. This shows that Indonesia needs to reorganize its education system, especially in mathematics learning in the aspect of mathematical problem-solving.

Several things cause low student math problem-solving. Students have low mathematical problem solving because they find it difficult to solve everyday problem solving problems [13]. That is because teachers do not provide direct direction for students in discussing everyday issues [14]. The learning process only focuses on the teacher's target without paying attention to the student's mathematical problem-solving ability. Implementing mathematics learning in the classroom only focuses on achieving the target material in the textbook rather than on the material that students learn [15]. It causes students only to memorize concepts and not understand the content. In addition, another factor is that teachers are unable to use varied learning models. Most teachers only explain the material conventionally with the lecture method, then proceed to give exercise questions contained in the textbook and provide motivation to students [16]. Those thing causes student motivation in learning mathematics to decrease.

Rom a constructivist perspective, the low mathematical problem-solving ability of 8th grade students in arithmetic material, which is characterized by their difficulty in solving contextual problems and tending to only memorize concepts, is a direct consequence of the learning process that does not facilitate active knowledge construction. Teachers who do not provide explicit direction in discussing everyday problems, as well as a rigid learning focus on textbook targets without paying attention to students' needs and learning methods, hinder students from integrating mathematical schemes with reality, causing them to fail to assimilate new information into meaningful cognitive structures or accommodate existing schemes. Furthermore, the lack of variation in learning models that encourage exploration and discovery hinders students from independently building a relational understanding of arithmetic, so that their knowledge tends to be instrumental and fragile, rather than solid and applicable in various problem situations.

The ability to solve mathematical problems certainly differs between male and female students. Differences in mathematical problem-solving are influenced by gender differences, experience gained, and differences in education [17]. The results of previous research related to mathematical problem-solving ability have been widely conducted. The results of research's Özpınar & Arslan [18] in Turkey, showed that female students' problem-solving skills were higher than male students on all three dimensions of the Problem Solving Skill Scale (PSSS). According to Lavasani & Khandan [19] in Oman, stated that male students' mathematical problem-solving skills are superior to female students. Meanwhile, according to Mailani [20] in Southeast America, showed that female students are outstanding in mathematical reasoning and able to visualize objects compared to male students. Based on some of the research above, it can be concluded that male and female students have differences in mathematical problem-solving skills and abilities to achieve learning achievement.

Based on these problems, it is necessary to improve students' mathematical problem-solving skills. Because problem-solving ability is included in one of the objectives of mathematics learning, teachers need to know the extent of the problem-solving stage carried out by students [21]. A teacher should know how to overcome these problems and is obliged to facilitate students in improving their problem-solving skills. One of them is by implementing learning that triggers students to be enthusiastic and motivated in learning. Learning motivation is the driving force to do something to achieve learning goals [22]. Teachers must also be careful and thorough in class management [23]. In addition, teachers must try to determine the right learning strategy for students. Students will feel happy to learn math and easily understand the material if the teacher can create fun learning [24]. Before learning, teachers can provide apperceptions and stimuli to lead students into the material slowly so that they can easily understand concepts and not just memorize formulas.

Referring to some of the research results that have been discussed, the researcher conducted this study with the aim of 1) Outlining the mathematical problem-solving ability of male students in class VIII SMP Negeri 3 Satu Atap Tawangharjo, 2) Describing the mathematical problem-solving ability of female students in class VIII SMP Negeri 3 Satu Atap Tawangharjo. The material used by researchers in this study is arithmetic rows and series because the material is closely related to everyday life, such as problems involving patterns or sequences of numbers.

METHODS

This research is a qualitative research with a case study approach. Qualitative research is a research method used to understand events about what is experienced by research subjects that are natural in nature, then the facts obtained are described in a descriptive manner in the form of word and sentence descriptions [25]. The case study design is appropriate for use in this research because the researcher will explore students' problem-solving abilities focusing on their gender differences from a constructivist philosophical perspective.

This research was conducted at SMP Negeri 3 Satu Atap Tawangharjo. The study was conducted for approximately two weeks, starting from tanggal 8 Juni sampai dengan 15 Juni 2025. The research subjects were students of class VIII. Respondents in this study were 21 students from class VIII B, consisting of 9 male students and 12 female students. All respondents were given math problems, which were mathematical problem-solving ability test instruments in the form of two essay questions on arithmetic rows and series. After that, the students' work results were corrected to obtain students who met the problem-solving indicators and constructivist perspectives. There are four indicators of problem-solving, namely understanding the problem, making a problem-solving plan/strategy, solving the problem by implementing the problem-solving plan, and rechecking and concluding the results obtained. Constructivist philosophy emphasizes several important indicators in the context of acquiring knowledge, especially in solving problems, namely Assimilation, Accommodation, Reflection, social interaction and scaffolding. Then, 1 student was selected from each high category. Thus, the subjects in this study were 2 people consisting of 1 male student and 1 female student.

Data collection techniques in this study used interviews, observations, and documentation of test results. Interviews were conducted to obtain in-depth information directly from the research subjects of the principal, grade VIII math teachers, and students of class VIII B. Observations were made to observe the phenomena that occurred in the research subjects. Documentation is needed to support information obtained from interviews and observations. The documents required are test instruments, student test results, and other relevant documentation. In obtaining the truth, this study uses triangulation of sources [26].

The data analysis technique in this study used an interactive flow method. The process of analyzing data is through collecting data from sources, namely students, and supporting documentation. Data reduction is done by correcting and assessing the results of student test work, where the test results will be used as a consideration for determining subjects and interview guidelines. Furthermore, data presentation is done by presenting data in the form of the results of students' math problem-solving ability tests and in-depth interviews with students. Data verification is done to explain in depth the data presented, and conclusion drawing is done by drawing the core of factual findings linked to the underlying theory.

RESULTS AND DISCUSSION

The results of the problem-solving ability test were assessed using mathematical problem-solving indicators. The mathematical problem-solving indicators consist of four stages, namely understanding the problem (I_1), making a plan/strategizing problem-solving (I_2), solving the problem by executing the problem-solving plan (I_3), and conducting a recheck while concluding the results obtained (I_4). It is in line with the indicators of mathematical problem solving according to Polya in [3].

The results of the mathematical problem-solving ability test on arithmetic sequence and row material were grouped into three parts, namely groups with high, medium, and low mathematical problem-solving abilities. The achievement of mathematical problem-solving ability is a conversion of the scores of students who have taken the test and by the Minimum Completion Criteria (MCC) at the school, which is 70.

TABLE 1. Categories of students' mathematical problem-solving ability

Value	**Category**
$x \geq 80$	High
$65 < x < 80$	Medium
$x \leq 65$	Low

[27]

Furthermore, the results of the problem-solving ability test for the high mathematics category on the arithmetic number pattern material will be presented in TABLE 2 and TABLE 3.

TABLE 2. Test results of male students' mathematical problem-solving ability after sorting

No	**Code**	**Score**		**Total Score**	**Max. Score**	**Value**	**Category**
		1	**2**				
1	LK4	10	8	18	20	90	High
2	LK8	8	10	18	20	90	High
3	LK7	10	7	17	20	85	High

TABLE 3. Test results of female students' mathematical problem-solving ability after sorting

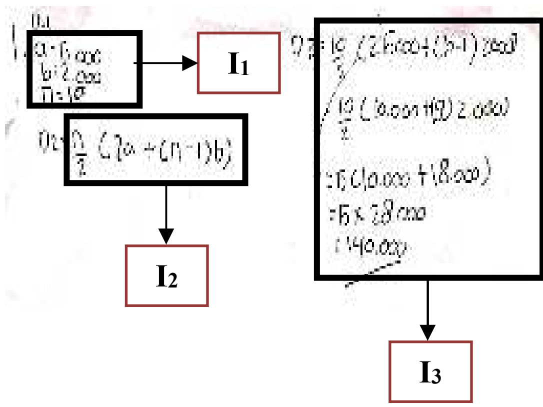
No	**Code**	**Score**		**Total Score**	**Max. Score**	**Value**	**Category**
		1	**2**				
1	PR8	10	10	20	20	100	High
2	PR5	10	10	20	20	100	High
3	PR6	10	9	19	20	95	High
4	PR1	10	8	18	20	90	High
5	PR10	10	8	18	20	90	High
6	PR9	10	8	18	20	90	High

Based on the results of the test of students' mathematical problem-solving ability in solving two description questions on arithmetic rows and series material, the results obtained include the group of male students who have high mathematical problem-solving ability totaling three students. Whereas the group of female students with high mathematical problem-solving ability totaled six students.

Then a semi-structured interview was conducted to find the problem more openly, where the interviewed subjects conveyed their opinions and ideas regarding problem solving in arithmetic problems. The interview was conducted on two students consisting of one male student, who has high mathematical problem solving ability and one female student with high mathematical problem solving ability.

1. **Mathematical Problem-Solving Ability of Male Students**

The group that has a high mathematical problem-solving ability category, on average, has achieved the measured mathematical problem-solving indicators. It can be seen from the results of their work that they can solve both items correctly even though there are still a few mistakes and fulfill each indicator of mathematical problem-solving ability. The following is one of the answer sheets of subject LK4 in working on problem number 1.



Direct Translation:

D_1 (Is Known): a = 5.000
b = 2.000
n = 10

D_2 (Asked): write the arithmetic sequence formula

Formula: $\frac{n}{2}(2a + (n-1)b)$

D_3 (Answered):

$= \frac{10}{2}(2 \times 5.000 + (10-1)2.000)$

$= \frac{10}{2}(10.000 + (9)2.000)$

$= 5(10.000 + 18.000)$

$= 5(28.000)$

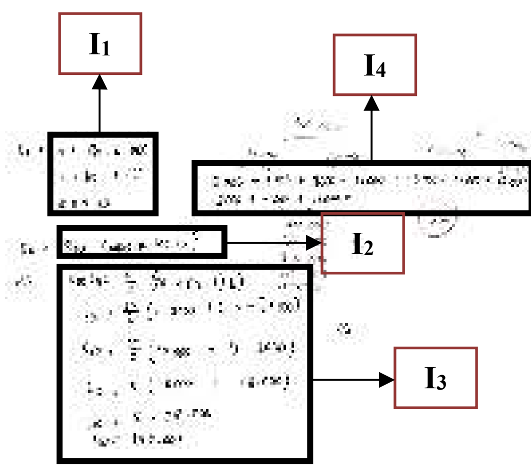
$= 140.000$

FIGURE 1. The answer number 1 of subject LK4

From Figure 1, LK4 has understood the problem correctly and can execute the problem-solving plan correctly on both items. Overall, students with high mathematical problem-solving ability have been able to work on all the problems given. This is supported by the results of student interviews that are able to explain what is known, determine the formula used, and solve problems.

2. **Mathematical Problem-Solving Ability of Femaale Students**

The group that has a high mathematical problem-solving ability category, on average, has achieved the measured mathematical problem-solving indicators. It can be seen from the results of their work that they can solve both items correctly without any errors and fulfill all indicators of mathematical problem-solving ability. Here is one of the answer sheets of subject PR8 in working on problem number 1.



Direct Translation:

D_1 (Is Known): a = Rp 5.000
b = Rp 2.000
n = 10

D_2 (Asked): S_{10}/10th week?

D_3 (Answered):

$S_n = \frac{n}{2}(2a + (n-1)b)$

$S_{10} = \frac{10}{2}(2 \times 5.000 + (10-1)2.000)$

$S_{10} = \frac{10}{2}(10.000 + 9 \times 2.000)$

$S_{10} = 5(10.000 + 18.000)$

$S_{10} = 5 \times 28.000$

$S_{10} = 140.000$

5.000 + 7.000 + 9.000 + 11.000 + 13.000 + 15.000 + 17.000 + 19.000 + 21.000 + 23.000

FIGURE 2. The answer number 1 of subject PR8

From Figure 2, PR8 could understand the problem correctly and fulfilled every indicator of mathematical problem-solving in all the problems given. Based on the results of the interview with subject PR8, the subject was able to understand the meaning of each problem and explain the steps to solve it correctly until he could conclude the problem correctly. From the answer sheet above, subject PR8 could write down what was known and what was asked in the problem. The subject was able to solve the problem using the appropriate formula and managed to find the correct answer. On the answer sheet, the subjects remembered to do the indicators of re-examining the solutions obtained to draw the right conclusions. Overall, subject PR8 was able to answer all questions correctly using steps that were easy to understand. That aligns with the opinion of Yustitia [28] that groups with high mathematical problem-solving ability can solve mathematical problems from the beginning to the end.

In terms of gender, the mathematical problem-solving of male students and female students is good enough. Basically, male students and female students have differences in processing mathematical problem-solving skills and abilities [29]. At the stage of understanding the problem, male students can understand the problem well. It can be seen that they can write what is known and asked in the problem, but there are still a few mistakes. Male students generally have a mindset based on logic, so in understanding problems, they always rely on existing facts without thinking about other things. At the problem understanding stage, male students showed good ability in assimilating new information from the problem into their existing cognitive schemes. Logical thinking patterns based on facts support the process of constructing mental representations of the problem [30]. Students actively construct meaning from the problem text by identifying key elements, a fundamental process in Piaget's constructivism theory that continues to be relevant in contemporary mathematical cognition studies [31]. This suggests that their mental schemes for interpreting and organizing initial information in a problem have been sufficiently developed, allowing them to pass through this stage efficiently [32]. From a constructivist perspective, teachers have a crucial role as facilitators who provide a rich and interactive learning environment [33]. Therefore, constructivist teachers need to provide a variety of problem types, including non-routine and contextual problems, to enrich students' understanding schemes, encourage accommodation when necessary, and facilitate the development of deeper conceptual connections.

At the stage of developing problem-solving strategies, a small proportion of male students have been unable to plan problem-solving well. It happens because male students immediately do problem-solving because they want to finish working on the problem quickly. This could mean that male students' schemas tend to be more instrumental [34]– – knowing how to get the answer – rather than relational – knowing why a strategy is right and how it is structured. In a constructivist context, it is important for teachers to encourage students to discuss, share strategies, and reflect on their planning choices, so that they can construct an understanding of the importance and benefits of careful planning [35]. At the stage of carrying out problem-solving, male students are mostly able to carry out appropriate problem-solving strategies even though, in the process, there are still a few mistakes, such as calculation errors. Computational errors, from a constructivist perspective, may not be conceptual failures, but rather operational errors in the application of existing schemas [36]. Constructivist teachers need to provide formative feedback that helps students identify and correct their own errors, encouraging them to be more thorough in the process of constructing solutions [37]. At the stage of re-examining the problem-solving results obtained, male students only tried to check their answers by asking friends and teachers. Usually, male students tend to immediately work on the following problem because they are sure of the results of their work without checking the results obtained. When answering math problems, male students use spatial strategies, prioritize argumentation, and use logic in solving problems [38]. Constructivist philosophy emphasizes the importance of reflection as a means of identifying misconceptions and strengthening understanding [39]. If students do not reflect on their process, they miss the opportunity to accommodate their possibly flawed schemas or consolidate correct schemas. Therefore, in answering math problems, male students tend to rush and do not make it too much of a burden.

Overall, female students have good mathematical problem-solving skills. At the stage of understanding the problem, female students have fulfilled this indicator quite well. In understanding the problem, female students use feelings rather than logic to find out more about the problem so that it can be solved properly. Female students showed good ability in understanding problems, relying more on feelings than logic. In the context of constructivism, understanding problems that involve emotions and personal experiences can enrich the learning process, because students construct meaning from their experiences [40]. Research shows that emotional engagement in learning can increase student motivation and understanding [41]. At the stage of developing problem-solving strategies, most female students could solve the problem by making a problem-solving plan first. Female students are able to formulate a problem-solving plan before solving it. In the constructivist perspective, planning and organizing strategies are an important part of the learning process, where students are expected to construct their own knowledge through reflection and planning [42]. Research shows that students who engage in strategic planning tend to be more successful in solving problems [43]. At the problem-solving stage, some students have not fulfilled this indicator. In solving the problem, there are still errors and solutions that are not in accordance with the problem presented. That is because they are in a hurry to finish working on the problem quickly so that mistakes occur, are less careful, and forget the formula that must be used. Although some female students have not met this indicator, the mistakes that occur can be seen as part of the learning process. Constructivism emphasizes that mistakes are opportunities to learn and improve understanding. [44]. Research shows that students who are given the opportunity to reflect on their mistakes can develop better understanding and stronger problem-solving skills. [35]. At the stage of re-examining the results obtained, not all female students fulfill this indicator because they are not accustomed to doing a re-examination, and it is not necessary because they feel the problem has been resolved. The female students' unfamiliarity in re-checking their results indicates a lack of reflective habits. In the context of constructivism, reflection is key to internalizing learning and correcting mistakes. [45]. Research shows that students who are accustomed to double-checking tend to have a deeper understanding and can better identify errors. [36]. Female students tend to answer math problems using verbal strategies, so they are pretty good at accuracy in solving problems, completeness, and accuracy in argumentation [46]. Therefore, female students always prioritize accuracy and neatness in solving problems in math problems.

CONCLUSION

This study concludes that both male and female students with high mathematical problem-solving abilities demonstrate achievement across all problem-solving indicators. However, there are notable differences in their approaches and cognitive tendencies. Male students tend to rely on logical and spatial strategies, with a tendency to proceed quickly through problem-solving steps without thoroughly rechecking their answers. In contrast, female students show a preference for verbal reasoning and meticulousness, especially in planning and executing solutions, although some still lack the habit of reflecting on their results.

From a constructivist philosophy perspective, these differences are shaped by the nature of students' individual learning experiences and how they construct knowledge. The findings affirm that mathematical problem-solving ability is not solely determined by cognitive capacity but also by the extent to which students engage in meaningful, reflective, and contextualized learning processes. Teachers, therefore, play a pivotal role as facilitators by designing learning environments that promote exploration, reflection, and dialogue, enabling students to construct robust mathematical understanding.

This research suggests that mathematics instruction should integrate varied and contextual problem types, consider gender-responsive strategies, and emphasize the development of reflective habits to foster comprehensive problem-solving competence. Further studies are recommended to expand the sample size and explore these gender-based patterns across different mathematical topics and educational settings.

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