Interval: Indonesian Journal of Mathematical Education
Vol. 4, No.1, April 2026, pp. 7~13
ISSN: 3021-7857, DOI: 10.37251/ijome.v4i1.3212

An Exploratory Study of Students' Mathematical Problem-Solving Ability Based on Wankat and Oreovocz Theory

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Article Info

Article history:

Received Marc 9, 2026
Revised Apr 4, 2026
Accepted Apr 23, 2026
Online First May 13, 2026

Keywords:

Exploratory Study
Mathematical Problem-Solving Ability
Wankat and Oreovocz Theory

ABSTRACT

Purpose of the study: This study aims to explore students' mathematical problem-solving ability based on the Wankat and Oreovocz theory by identifying how students perform across each stage of the problem-solving process in order to provide a comprehensive description of their abilities.

Methodology: This study employed a qualitative descriptive approach using purposive sampling, involving six students from class VII E at SMP Negeri 19 Bandar Lampung. Data were systematically collected through observation, written essay tests, and semi-structured interviews, and analyzed using data reduction, data display, and conclusion drawing with triangulation techniques for validation purposes.

Main Findings: The results show that most students achieved high problem-solving ability, with 59.26% in the excellent category and 25.93% in the good category. Students performed best at the motivation stage ("I Can") but showed lower performance in planning, evaluation, and generalization stages. High-performing students completed all stages systematically, while lower-performing students experienced difficulties beyond initial stages, especially in selecting appropriate strategies and verifying solutions.

Novelty/Originality of this study: This study offers a detailed stage-based analysis of students' mathematical problem-solving ability using the Wankat and Oreovocz framework, focusing on students' actual performance rather than instructional strategies. It provides new insights into specific difficulties at each stage, particularly in planning, and contributes to advancing knowledge on how structured problem-solving frameworks can be applied to analyze students' cognitive processes.

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1. INTRODUCTION

Education plays a crucial role in developing human potential and shaping intellectual as well as personal capacities. Within formal education, mathematics is recognized as a fundamental subject that supports logical reasoning and critical thinking skills [1]. Learning mathematics is not only directed at mastering concepts but also at applying them to solve real-life problems. For this reason, developing students' mathematical problem-solving ability becomes a primary objective in mathematics education [2]. Such ability is essential in preparing students to face both academic challenges and everyday situations.

In practice, many students still encounter difficulties in solving mathematical problems effectively. Greater emphasis is often placed on obtaining correct answers rather than understanding the processes involved. This condition indicates that students' problem-solving abilities have not yet developed optimally. Observations in classroom settings show that students frequently struggle to interpret problems, plan solution strategies, and evaluate their results [3], [4]. As a result, students' mathematics achievement tends to remain below expected standards.

Numerous studies have highlighted the importance of problem-solving skills in mathematics learning. Structured approaches to problem solving are widely recognized as effective in improving students' understanding and learning outcomes [5], [6]. One of the frameworks that offers a systematic process is the theory proposed by Wankat and Oreovocz, which includes stages such as motivation, exploration, planning, implementation, and generalization [7]. These stages are designed to guide students in solving problems in a structured and reflective manner. However, previous studies have generally focused more on instructional strategies rather than deeply analyzing students' actual abilities.

Limited attention has been given to examining students' problem-solving abilities based on specific theoretical frameworks. Many existing studies do not comprehensively explore how students perform at each stage of the problem-solving process [8]. In particular, research that analyzes students' difficulties in relation to the stages of Wankat and Oreovocz theory remains scarce [9]. This lack of detailed investigation leads to an incomplete understanding of students' competencies [10]. Consequently, further analysis is needed to provide a clearer and more comprehensive picture of students' abilities.

Understanding students' mathematical problem-solving ability is essential for improving the quality of learning. Insights into students' strengths and weaknesses can help teachers design more effective and targeted instructional strategies. In addition, such understanding enables students to become more aware of their own thinking processes [11], [12]. Findings from this study are expected to contribute to the improvement of mathematics learning practices. Strengthening problem-solving ability is therefore crucial for enhancing both academic performance and essential life skills.

A distinctive contribution of this study lies in its focus on exploring students' mathematical problem-solving ability through the framework of Wankat and Oreovocz theory using a qualitative descriptive approach [13]. Unlike previous research that emphasizes teaching strategies, this study provides an in-depth analysis of students' abilities at each stage of the problem-solving process. Attention is given to how students engage in stages such as motivation, exploration, planning, implementation, evaluation, and generalization [14]. This approach allows for a more comprehensive understanding of students' problem-solving behavior. Such findings are expected to enrich the discourse in mathematics education research.

2. RESEARCH METHOD

2.1 Research Design

This study employed a qualitative descriptive approach to explore students' mathematical problem-solving ability based on Wankat and Oreovocz theory [15]. A qualitative approach was chosen to obtain an in-depth understanding of students' thinking processes in solving mathematical problems [16]. The study aimed to describe students' abilities systematically based on observed phenomena. Theoretical frameworks were used to guide the analysis and maintain alignment with the research focus. This design enabled a comprehensive interpretation of students' problem-solving behavior.

2.2 Research Setting and Subjects

The study was conducted at SMP Negeri 19 Bandar Lampung during the second semester of the 2015/2016 academic year. The research setting included both classroom and non-classroom environments. The subjects were selected using purposive sampling based on their mathematical problem-solving ability. Six students from class VII E were chosen to represent different levels of ability. This selection emphasized the richness of information rather than the number of participants.

2.3 Research Instruments

The instruments used in this study included the researcher, a written test, and interviews. The researcher acted as the primary instrument responsible for data collection and analysis. A written test in the form of essay questions was used to assess students' problem-solving abilities. The test items were developed based on the stages of Wankat and Oreovocz theory and had been validated prior to use. Semi-structured interviews were also conducted to explore students' reasoning in more depth.

2.4 Data Collection Techniques

Data were collected through observation, written tests, and in-depth interviews [17]. Observation was conducted to examine students' activities during mathematics learning. The written test aimed to identify students' ability to organize and apply knowledge in solving problems. Interviews were used to validate and deepen the data obtained from the test results. These techniques ensured that the collected data were comprehensive and relevant.

2.5 Data Analysis and Validity

Data analysis was carried out through three stages: data reduction, data display, and conclusion drawing [18], [19]. Data reduction involved selecting and simplifying raw data into meaningful categories. Data were then presented systematically to facilitate interpretation. Conclusions were drawn based on the analyzed data supported by relevant evidence. To ensure data credibility, triangulation techniques were applied by comparing data from observation, tests, and interviews. A summary of the research methodology is presented in Table 1.

Table 1. Summary of Research Methodology

Aspect	Description
Research Design	Qualitative descriptive approach
Research Focus	Students' mathematical problem-solving ability based on Wankat and Oreovocz theory
Research Setting	SMP Negeri 19 Bandar Lampung (Second semester, 2015/2016)
Subjects	Six students of class VII E selected through purposive sampling
Instruments	Researcher, written test (essay), and semi-structured interviews
Data Collection	Observation, written test, and in-depth interviews
Data Analysis	Data reduction, data display, and conclusion drawing
Data Validity	Triangulation (observation, test, and interview)

The research procedure is illustrated in Figure 1.

Figure 1. Research Procedure

3. RESULTS AND DISCUSSION

This section presents the findings of the study on students' mathematical problem-solving ability based on Wankat and Oreovocz theory. The data were obtained through written tests and in-depth interviews and were validated using triangulation techniques. The analysis focuses on students' performance across the stages of problem-solving, including motivation, understanding, planning, execution, evaluation, and generalization. The results are presented in the form of overall performance, stage-based analysis, and individual subject profiles. These findings provide a comprehensive overview of students' problem-solving abilities.

3.1 Overall Students' Performance

A written test consisting of three problems on quadrilateral topics was administered to 27 students of class VII. The results were categorized into four levels based on students' scores. The distribution of students' performance is presented in Table 1.

Table 1. Overall Students' Performance (N = 27)

Performance Level	Score Range	Frequency	Percentage (%)
Excellent	85–100	16	59.26
Good	70–84	7	25.93
Fair	55–69	3	11.11
Poor	≤ 54	1	3.70
Total		27	100

As shown in Table 1, the majority of students (59.26%) achieved an excellent level of problem-solving ability. Meanwhile, 25.93% of students were categorized as good, followed by 11.11% in the fair category and only 3.70% in the poor category. These findings indicate that most students have developed relatively strong

problem-solving skills. However, a small proportion of students still experience difficulties in solving mathematical problems.

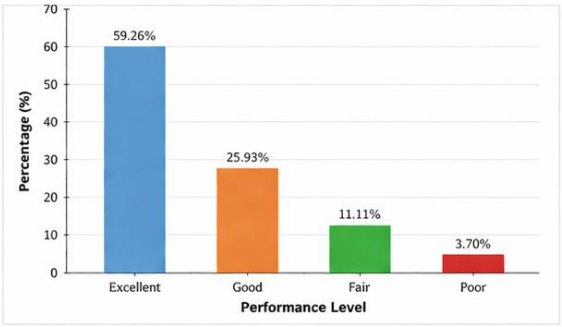

Figure 2. Distribution of Students' Performance Levels

3.2 Students' Performance at Each Stage

Students' abilities were further analyzed based on the stages of Wankat and Oreovocz theory. The results show variations in students' performance across different stages of problem-solving. The detailed results are presented in Table 2.

Table 2. Students' Performance at Each Stage of Wankat and Oreovocz Theory

Stage	Description	Percentage (%)	Interpretation
I Can	Motivation and confidence	92.59	Very High
Define	Understanding the problem	81.48	High
Explore	Identifying strategies	77.78	High
Plan	Selecting appropriate formula	62.96	Moderate
Act	Implementing solution	74.07	High
Review	Checking the result	68.52	Moderate
Generalize	Drawing conclusion	72.22	High

Table 2 shows that the highest achievement was found in the "I Can" stage, indicating that most students had strong motivation and confidence in solving problems. On the other hand, the lowest performance was observed in the planning stage, suggesting that students experienced difficulties in selecting appropriate formulas or strategies. This indicates that although students are motivated, they still face challenges in strategic thinking.

3.3 Profile of Selected Subjects

To obtain deeper insights, four students representing different performance levels were selected as research subjects. Their abilities were analyzed based on each stage of problem-solving. The summary is presented in Table 3.

Table 3. Summary of Students' Problem-Solving Ability

Subject	Level	I Can	Define	Explore	Plan	Act	Review	Generalize	Description
S1	Excellent	✓	✓	✓	✓	✓	✓	✓	Strong in all stages, slight weakness in planning
S2	Good	✓	✓	✓	~	✓	~	~	Good understanding, inconsistent in final stages
S3	Fair	✓	~	~	~	~	~	~	Only strong in motivation, weak in process
S4	Poor	✓	×	×	×	×	×	×	Only motivated but lacks understanding

Note: ✓ = achieved, ~ = partially achieved, × = not achieved

The results indicate that students with higher performance levels tend to complete all stages systematically. In contrast, lower-performing students are only able to demonstrate initial motivation without successfully

completing subsequent stages. This suggests that problem-solving ability is strongly influenced by students' understanding and strategic planning skills.

3.4 Key Findings

Based on the triangulation of test and interview data, several important findings were identified. First, most students showed strong motivation at the beginning stage of problem-solving. Second, the planning stage was the most difficult stage for students, particularly in determining appropriate formulas. Third, students with high ability were more consistent across all stages compared to those with lower ability. Finally, the ability to generalize results was still not optimal for some students.

The findings of this study indicate that students generally demonstrate a relatively high level of mathematical problem-solving ability. Most students achieved the excellent and good categories, suggesting that they have developed adequate skills in solving mathematical problems. However, a small proportion of students still fall into the fair and poor categories, indicating the presence of learning gaps. These results show that while students are capable of solving problems, not all students can perform consistently across different tasks. Therefore, students' problem-solving ability can be considered unevenly distributed.

Further analysis based on the stages of Wankat and Oreovocz theory reveals that students perform differently at each stage. The highest performance is found in the "I Can" stage, indicating strong motivation and confidence among students. In contrast, the planning stage shows the lowest performance, highlighting students' difficulties in selecting appropriate strategies and formulas. Students also experience moderate challenges in reviewing their answers and generalizing results. This suggests that cognitive processes such as strategic thinking and evaluation are still not fully developed.

These findings are consistent with previous studies that emphasize the importance of structured problem-solving processes in mathematics learning. Prior research has shown that students often struggle with higher-order thinking stages such as planning and evaluation [20], [21]. While many studies focus on improving teaching strategies, fewer studies deeply analyze students' actual performance at each stage of problem solving [22]. This study supports the idea that motivation alone is not sufficient to ensure successful problem solving. Instead, students need guidance in developing systematic and reflective thinking skills.

The novelty of this study lies in its detailed exploration of students' problem-solving abilities using the Wankat and Oreovocz framework. Unlike previous research that tends to focus on instructional approaches, this study provides a comprehensive analysis of students' performance at each stage [23], [24]. It highlights specific areas where students experience the most difficulty, particularly in the planning stage. This stage becomes a critical point that differentiates high-performing students from lower-performing ones [25], [26]. Therefore, this study contributes new insights into how problem-solving ability can be analyzed more deeply.

The implications of this study are significant for mathematics teaching and learning. Teachers need to pay more attention to developing students' abilities in planning and evaluating problem-solving strategies [27]. Instructional practices should not only focus on final answers but also emphasize the process of solving problems systematically. In addition, teachers can use the stages of Wankat and Oreovocz theory as a guide to structure learning activities [28]. By doing so, students can develop a more comprehensive understanding of problem-solving processes.

Despite its contributions, this study has several limitations that should be acknowledged. The research was conducted with a limited number of subjects, which may affect the generalizability of the findings [29], [30]. In addition, the study focused only on one school and one mathematical topic, namely quadrilaterals. The qualitative approach also relies heavily on the interpretation of the researcher, which may introduce subjectivity. Therefore, future studies are recommended to involve larger samples and diverse contexts [31], [32]. Expanding the scope of research may provide a more comprehensive understanding of students' mathematical problem-solving abilities.

4. CONCLUSION

This study aimed to explore students' mathematical problem-solving ability based on the Wankat and Oreovocz theory through a qualitative descriptive approach. The findings indicate that most students demonstrate relatively high problem-solving ability, particularly in the motivation stage ("I Can"), which reflects strong confidence in initiating problem-solving processes. However, students still experience notable difficulties in the planning stage, especially in selecting appropriate formulas and strategies, as well as in evaluating and generalizing their solutions. These results confirm that students' problem-solving ability is not only influenced by motivation but also by their capacity for strategic and reflective thinking across all stages. Furthermore, differences in students' performance levels reveal that higher-achieving students tend to complete all stages systematically, while lower-achieving students struggle beyond the initial stages. Therefore, this study highlights the importance of emphasizing structured problem-solving processes in mathematics instruction and suggests that future research

should expand the sample and develop instructional strategies based on the Wankat and Oreovocz framework to enhance students' problem-solving abilities more effectively.

ACKNOWLEDGEMENTS

The author would like to express sincere gratitude to the principal, teachers, and students of SMP Negeri 19 Bandar Lampung for their support and participation in this study, as well as to academic supervisors and all parties who have provided guidance, assistance, and valuable contributions to the completion of this research.

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