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Efforts to improve mathematical communication and collaboration skills through the Problem-Based Learning (PBL) model

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Abstract

This classroom action research aims to improve students' collaborative attitudes and mathematical communication skills in learning mathematics by utilizing the Problem-Based Learning (PBL) model. Conducted in accordance with the Kemmis & McTaggart model, this study consisted of three cycles, with each cycle involving one lesson. The research subjects were eighth-grade students of SMP in Surakarta in the 2023/2024 academic year. Data collection was conducted using interviews, observations, and tests, which were analyzed descriptively. The results showed that the use of the PBL model succeeded in improving both the collaborative attitude and mathematical communication skills of the students. Therefore, it can be concluded that the application of the PBL learning model is effective in improving both aspects.

Keywords: *Communication, Collaboration, Problem Based Learning*

Abstrak

Penelitian tindakan kelas ini bertujuan untuk meningkatkan sikap kolaborasi dan kemampuan komunikasi matematis siswa dalam pembelajaran matematika, dengan memanfaatkan metode *Problem Based Learning* (PBL). Dilaksanakan sesuai dengan model Kemmis & Mc Targart, penelitian ini terdiri dari tiga siklus dengan setiap siklus melibatkan satu kali pembelajaran. Subyek penelitian adalah siswa kelas delapan SMP di Surakarta pada tahun pelajaran 2023/2024. Teknik pengumpulan data menggunakan teknik wawancara, observasi dan tes dianalisis secara deskriptif. Hasil penelitian menunjukkan bahwa penggunaan model PBL berhasil meningkatkan baik sikap kolaborasi maupun kemampuan komunikasi matematis siswa. Oleh karena itu, dapat disimpulkan bahwa penerapan model pembelajaran PBL efektif dalam meningkatkan kedua aspek tersebut.

Kata kunci: Komunikasi, Kolaborasi, Problem Based Learning

INTRODUCTION

Education has a significant potential to influence the development of a country. Advanced and progressive education can create a quality young generation, especially in the 21st century (Ichsan, 2022). Students need to possess certain skills, such as critical thinking and problem-solving abilities, the capacity to think critically, laterally, and systematically, as well as communication and collaboration skills, enabling them to communicate and collaborate effectively with various parties (Hafely et al., 2018). In the 21st century, mathematical communication and collaboration skills are essential for students. Mathematical communication skills can assist students in solving mathematical problems.

Communication is the interaction between individuals to convey information multidirectionally (Siswadi et al., 2023). In the context of mathematics education, communication is crucial as it involves teachers and students in the learning process (Muslimahayati, 2019). Mathematical communication is an important aspect that students need to enhance, in line with the goals of mathematics education in Indonesia (Mariani, 2024). In implementing mathematics education, UNESCO emphasizes the four pillars of education and the 21st-century learning framework competencies, known as the 4Cs: communication, collaboration, critical thinking, and creativity.

Collaboration is a group learning process involving discussion, exchange of ideas, and cooperation among students to achieve common goals in problem-solving. However, many students still lack adequate collaboration skills due to insufficient practice and teaching methods that do not support active and collaborative interaction (Octaviana et al., 2022). Communication and collaboration play a vital role in mathematics education. Communication, as a multidirectional interaction between teachers and students, plays a key role in the transformation of messages, materials, and learning media. On the other hand, collaboration encourages group learning processes involving discussion, idea exchange, and cooperation to achieve common goals (Anjani & Jailani, 2023). However, despite their importance, many students still lack adequate communication and collaboration skills due to insufficient practice and teaching methods that do not support active and collaborative interaction (Auliya & Firansyah, 2024). Therefore, it is crucial for the education system to pay more attention to developing these skills so that students can optimize their potential in the mathematics learning process (Hodiyanto, 2017).

From the explanation provided, a learning model is needed that can motivate students to hone their collaboration and mathematical communication skills to achieve the desired learning objectives. The researcher considers the Problem-Based Learning (PBL)

model to be appropriate. PBL is a learning method that involves students in solving relevant problems. As an effective learning method, PBL can enhance students' abilities in communication, problem-solving, and teamwork by presenting challenges relevant to real-life situations, encouraging critical thinking and effective communication (Melinda & Zainil, 2020).

This research is similar to observations conducted by (Widayanti, 2020), which explained the improvement of mathematical communication skills through the PBL learning method. This learning model can enhance mathematical communication skills. The research is also similar to observations by (Andriyanti & Noviani, 2023) , which explained the improvement of collaboration skills through the PBL learning method. This learning model showed an increase in collaboration skills through PBL.

Unlike previous studies, this research observes both collaborative attitudes and mathematical communication skills simultaneously. These attitudes and skills were chosen because they are considered fundamental for students in developing other skills. The purpose of this research is to examine the improvement of collaborative attitudes and mathematical communication skills using the problem-based learning model.

METHODS

This research uses the Classroom Action Research (CAR) method as its methodological framework (Sutama, 2019). PBL is a practice commonly adopted in classroom settings, and the CAR approach is used to address these challenges (Salafiah et al, 2023). First, the problem to be addressed is identified, which may include challenges in teaching methods, students' understanding of the material, or classroom performance. Once the problem is identified, an action plan is developed to address it, involving changes in teaching methods or learning strategies (Haryati et al, 2022).

Next, this action is implemented in the classroom environment, and relevant data is collected during the implementation process (Pratiwi et al, 2023). This data is then evaluated to assess whether the changes were effective in solving the problem. If necessary, further improvement steps are planned based on the evaluation results. The CAR method is a continuous cycle that allows for ongoing improvement in the quality of learning through observation, evaluation, and refinement.

This research follows the Classroom Action Research (CAR) methodological framework with the primary goal of enhancing students' abilities in solving systems of linear equations in two variables through the PBL model and using PowerPoint, comics, and educational videos. The research applies the CAR method based on the stages

proposed by Kemmis & McTaggart, which include 1) planning, 2) implementation, 3) observation, and 4) reflection (Sanjaya, 2011).

In this study, the researcher conducted three cycles according to the CAR procedure outlined by Kemmis & McTaggart. The research subjects were 14 eighth-grade students from SMP Muhammadiyah 5 Surakarta, conducted during the first semester of the 2023/2024 academic year. The research focused on mathematics material related to systems of linear equations in two variables. Data collection methods used in this study included interviews, observations, and tests, with data analysis conducted descriptively. Interviews were directed at peer teachers as a discussion for selecting the learning model used in CAR based on the researcher's reflection on the initial conditions of students regarding mathematical communication and collaboration. Observations were used to monitor the level of collaboration in the classroom. Meanwhile, tests were conducted at the end of each cycle to evaluate students' mathematical communication skills.

RESULT AND DISCUSSION

Before conducting the cycles, the researcher carried out preliminary activities to assess the initial state of the eighth-grade students at SMP in Surakarta. These preliminary activities included interviews with peer teachers, observations during face-to-face learning, and administering questions to evaluate the students' initial abilities. After these activities, the researcher found that the collaboration and mathematical communication skills of the students were relatively low. Subsequently, the researcher prepared teaching materials, including teaching modules, student worksheets, lesson content, and evaluation questions for all stages of the learning cycle.

The first cycle was conducted by following four procedures in accordance with the established research framework, utilizing PowerPoint presentation media. In this cycle, the researcher conducted one lesson, and at the end of the lesson, an evaluation of the students' mathematical communication skills was performed. The learning was conducted face-to-face in the classroom using the PBL model. The researcher acted as a facilitator during each lesson, while a research partner observed the students' collaboration skills and the learning process. The level of student engagement had not yet reached its peak, with only 6 out of 14 students demonstrating positive interdependence during group discussions. Eight students out of 14 had not interacted positively in the learning process, failing to respect others' ideas and suggestions. Additionally, 8 out of 14 students did not show individual responsibility, and 5 out of 14 did not demonstrate teamwork skills. Furthermore, mathematical communication skills were not yet evident at this stage. Challenges that arose during the first stage of learning included delays in conducting

learning activities, caused by the scheduled time after group prayers followed by break time.

The next cycle, *cycle two* was conducted according to the established research model, utilizing comic media. In this cycle, one meeting was held, and at the end of the lesson, an evaluation of the students' mathematical communication skills was conducted. The learning was carried out face-to-face in the classroom using the PBL model. The researcher acted as a facilitator during each lesson, while a research partner observed the students' collaboration skills and the learning process. Students' attitudes towards positive interdependence began to show improvement; initially, there were 6 students, which decreased to 4 out of 14 who demonstrated positive interdependence in group discussions. Four students out of 14 had not interacted positively in the learning process, and 6 out of 14 did not show individual responsibility, while 4 out of 14 did not demonstrate teamwork skills. However, mathematical communication skills began to emerge in this cycle.

Cycle III was conducted following the planned research model, utilizing conversation video media. In this activity, the researcher held one meeting, and at the end of the lesson, an evaluation was conducted to test the students' mathematical communication skills. The learning was conducted face-to-face in the classroom using the PBL model. The researcher acted as a facilitator during each lesson, while a research partner observed the students' collaboration skills and the learning process. Collaborative attitudes began to emerge in this cycle, with only two students not demonstrating positive interdependence, three students not interacting during the learning process, and two students not working productively in groups during the lesson. The remaining students exhibited good collaborative attitudes in this third cycle. The students' mathematical communication skills also showed improvement in this cycle, although not significantly. In this third cycle, the researcher made improvements based on the weaknesses identified in the previous cycles.

The monitoring results of interactions among the eighth-grade students at SMP in Surakarta during the first, second, and third rounds, after being reorganized with the initial data, indicated an increase in each round. All 14 students showed improvement in their participation in learning using the PBL model. The results of the observations of collaboration among the eighth-grade students at SMP in Surakarta in each cycle showed that there was an increase in collaboration. It can be concluded that all 14 students demonstrated improvement in learning using the PBL model. The average results of the increase in student collaboration can be seen in the following table.

Table 1. Results of collaboration skills observation

Collaboration Ability Indicator	Cycle I	Cycle II	Cycle III
Positive Interdependence	63%	73%	88%
Interaction in Learning	59%	75%	84%
Individual Responsibility	64%	73%	80%
Group Work Skills	66%	73%	75%
Average	63%	74%	82%

Based on **Table 1**, it is evident that there has been an increase in student collaboration, starting from 63% in cycle 1, 74% in cycle II, and reaching 82% in cycle III. The findings from the evaluations conducted by the researcher are supported by the implementation of activities that organize students within the PBL learning model. This allows for a greater emphasis on achieving the desired goals, encouraging students to avoid falling behind their classmates. These activities require students to actively collaborate in completing tasks within the set time limits while effectively communicating and discussing with both their peers and teachers.

Eighth-grade students at SMP in Surakarta have shown improvement in their mathematical communication skills in each cycle. The measurement of students' mathematical communication skills was conducted using worksheet questions in each cycle. The results of the improvement in mathematical communication skills among the eighth-grade students at SMP in Surakarta can be seen in the **Table 2**.

Tabel 2. Results of observation of mathematical communication ability

Indicator of Mathematical Communication Ability	Cycle 1	Cycle 2	Cycle 3
Ability to understand, interpret and evaluate mathematical ideas both in writing and in other visual forms	64%	86%	86%
Ability to use mathematical terms, notations and structures to present ideas, illustrate relationships and situations	29%	29%	50%
Writing ability	36%	50%	57%
Mathematical expression ability	21%	36%	75%
Average	38%	50%	67%

Based on the table above, there is an increase in students' mathematical communication skills, starting from 38% in cycle one, 50% in cycle two, and 67% in cycle three. This is considered to meet the success indicators planned by the researcher. The implementation of the PBL learning model also enhances the mathematical

communication skills of eighth-grade students at SMP in Surakarta, particularly in understanding, interpreting, and evaluating mathematical ideas both in writing and in other visual forms, as well as in their writing skills, where students are able to express their ideas and thoughts in their own words. Students improve their mathematical communication skills through activities guided by this research, either individually or in groups. In this study, students play a crucial role in finding appropriate solutions to mathematical problems. The researcher encourages students to seek relevant information, conduct experiments, and discover explanations and solutions that promote mathematical communication. This improvement occurs because the PBL model places students in situations that require critical thinking and problem-solving.

From the explanation above, applying the PBL model to eighth-grade students in the first semester at SMP in Surakarta aligns with the results obtained by Yanti in 2017, where the mathematical communication skills of students improved through the application of the PBL model in their learning. It is clearly evident that there is an increase in this study, as seen from cycle one with a rate of 38%, cycle two increasing to 50%, and cycle three further increasing to 67%. Participation in collaborative learning also influences students' mathematical communication skills. Research conducted by Kumalaretna & Mulyono (2017) aligns with this study, stating that the improvement in mathematical communication skills develops alongside collaboration skills. In addition to the enhancement of mathematical communication skills, this study also observed an increase in student collaboration from 63% in cycle one, to 74% in cycle two, and further increasing to 83% in cycle three. A significant improvement was noted in the relationship between the two variables during each research cycle. The results of the research indicate that the objectives of the study have been achieved. The findings show that the implementation of the PBL model successfully enhances students' mathematical communication and collaboration skills in the classroom.

CONCLUSION

From the research findings, it can be concluded that there is a consistent pattern identified in the CAR, specifically regarding the use of the PBL model in enhancing collaboration among eighth-grade students at SMP in Surakarta. This is evidenced by the improvement observed in each cycle. Additionally, the use of the PBL model also enhances the mathematical communication skills of eighth-grade students at SMP in 5 Surakarta, as demonstrated by the improvements noted in each cycle. From these two perspectives, it can be concluded that the implementation of the PBL method can enhance

collaboration and mathematical communication skills among eighth-grade students at SMP in Surakarta in mathematics learning.

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