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Improving Students' Mathematics Learning Outcomes Through the Implementation of PAIKEM: A Classroom Action Study in Elementary Schools

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Abstrak

Meningkatkan hasil belajar matematika siswa memerlukan penerapan model pembelajaran yang membuat siswa aktif, inovatif, dan kreatif, serta efektif dan menyenangkan, salah satunya adalah model PAIKEM (Pembelajaran Aktif, Inovatif, Kreatif, Efektif, dan Menyenangkan). Penelitian tindakan kelas ini bertujuan untuk meningkatkan hasil belajar matematika siswa melalui penerapan model PAIKEM. Penelitian ini dilaksanakan di sebuah Sekolah Dasar pada semester ganjil tahun ajaran 2021/2022. Desain penelitian mengikuti model Kemmis dan Taggart, yang terdiri atas perencanaan, tindakan, observasi, dan refleksi dalam dua siklus. Teknik pengumpulan data menggunakan observasi, wawancara, tes, dan dokumentasi, dengan subjek penelitian adalah siswa kelas V. Data dianalisis secara deskriptif kuantitatif dan kualitatif. Hasil penelitian menunjukkan bahwa model PAIKEM berhasil meningkatkan hasil belajar matematika siswa secara signifikan. Hal ini ditunjukkan oleh peningkatan ketuntasan belajar klasikal dari 85% pada Siklus I menjadi 100% pada Siklus II. Dengan demikian, dapat disimpulkan bahwa model PAIKEM efektif dalam meningkatkan hasil belajar matematika di sekolah dasar.

Kata kunci: PAIKEM; Hasil Belajar Matematika; Penelitian Tindakan Kelas; Sekolah Dasar.

Abstract

Improving students' mathematics learning outcomes requires the application of learning models that make students active, innovative, and creative, as well as effective and enjoyable, one of which is the PAIKEM model (Active, Innovative, Creative, Effective, and Enjoyable Learning). This classroom action research aims to improve students' mathematics learning outcomes through the application of the PAIKEM model. This research was conducted in an elementary school in the odd semester of the 2021/2022 academic year. The research design followed the Kemmis and Taggart model, which consists of planning, action, observation, and reflection in two cycles. Data collection techniques used observation, interviews, tests, and documentation, with the research subjects being fifth-grade students. Data were analyzed descriptively quantitatively and qualitatively. The results showed that the PAIKEM model succeeded in significantly improving students' mathematics learning outcomes. This was indicated by an increase in classical learning completeness from 85% in Cycle I to 100% in Cycle II. Thus, it can be concluded that the PAIKEM model is effective in improving mathematics learning outcomes in elementary schools.

Keywords: PAIKEM; Mathematics Learning Outcomes; Classroom Action Research; Elementary School.



1. INTRODUCTION

Mathematics is a fundamental subject in elementary schools that plays a crucial role in shaping students' ways of thinking. It fosters logical, analytical, systematic, and critical reasoning when taught in an engaging and structured manner. However, in many classrooms, mathematics instruction remains dominated by teacher-centered lectures, which often prioritize curriculum completion over meaningful learning experiences (Rahayu & Pratiwi, 2020; Sari & Fitriani, 2021). Such practices tend to result in low achievement, limited participation, and negative perceptions of mathematics as a difficult subject.

In practice, many students continue to struggle with mastering basic mathematical concepts. Average test scores frequently fall below the national minimum mastery criterion, and students often demonstrate low self-confidence in participating in class activities. They are reluctant to present solutions, ask questions, or engage in discussions due to anxiety and fear of making mistakes. This reflects broader issues of mathematics anxiety and reduced motivation, which can significantly hinder long-term academic progress (Fauzi & Widjajanti, 2018; Putra et al., 2020).

Previous studies suggest that innovative pedagogical models, such as PAIKEM (Active, Innovative, Creative, Effective, and Joyful Learning), can help address these challenges. PAIKEM emphasizes student-centered learning, contextual problem-solving, creativity, and collaboration, which make mathematics more engaging and less intimidating for young learners (Wahyudi et al., 2021; Astuti & Nugraheni, 2022). Empirical evidence shows that PAIKEM enhances students' conceptual understanding, problem-solving skills, and classroom engagement more effectively than traditional lecture-based methods (Indrawati & Yulianti, 2020; Yuliani et al., 2021; Kartika et al., 2023).

Despite these findings, there remains a research gap in understanding the comparative advantages of PAIKEM over other innovative models such as Problem-Based Learning (PBL) and inquiry-based learning. While PBL and inquiry are known to foster higher-order thinking, their application in lower elementary grades often faces challenges, such as high preparation demands and the need for advanced learner autonomy (Rahmawati et al., 2021). By contrast, PAIKEM integrates creativity, exploration, and enjoyment into daily lessons, making it more adaptable and contextually relevant for primary school students (Santosa & Setiawan, 2019; Lestari et al., 2022). However, studies explicitly highlighting why PAIKEM may be superior to other models in addressing both achievement and affective factors such as confidence and motivation remain limited.

Moreover, the consequences of persistently low mathematics achievement extend beyond academic scores. Students with repeated difficulties are at risk of decreased self-efficacy, diminished interest in STEM pathways, and heightened levels of mathematics anxiety (Ismail et al., 2019; Firdaus & Wulandari, 2020). These negative outcomes emphasize the urgency of adopting effective, student-centered approaches such as PAIKEM that not only improve learning outcomes but also foster motivation, confidence, and positive attitudes toward mathematics (Pranata et al., 2022; Ningsih & Handayani, 2023).

Based on this background, this study aims to investigate the effectiveness of the PAIKEM model in elementary mathematics instruction, particularly in improving student achievement and addressing issues

of low self-confidence and motivation. By doing so, this research seeks to fill the literature gap and provide empirical evidence on the relevance of PAIKEM compared to conventional methods and other pedagogical models in the context of Indonesian elementary mathematics education.

2. METODE

2.1. Research Design

This study employed a Classroom Action Research (CAR) design, following the Kemmis and McTaggart (2014) model, which consists of four stages: planning, action, observation, and reflection. The research was conducted in two cycles, with each cycle consisting of two meetings. This design was selected to improve mathematics learning outcomes through the implementation of the PAIKEM model.

2.2. Participants and Context

The participants of this study were 20 fifth-grade students (11 boys and 9 girls), aged between 10 and 11 years. The study was carried out during the odd semester of the 2021/2022 academic year. The school is located in an urban area with adequate learning facilities, including classrooms equipped with whiteboards, projectors, and basic mathematics learning media. Based on preliminary observations, the students demonstrated varied initial mathematical ability, with an average score of 66.57 on the topic of two-dimensional shapes, which is below the national minimum mastery criterion (KKM = 75).

2.3. Procedure

The CAR procedure consisted of two cycles as shown in Table 1. Each cycle followed the four steps of the Kemmis and McTaggart (2014) model.

Table 1. Research cycle in Classroom Action Research (CAR)

Cycle	Stage	Description
1	Planning	Designing lesson plans using PAIKEM; preparing learning media and test items
	Action	Implementing PAIKEM in mathematics lessons (topic: properties of 2D shapes)
	Observation	Monitoring teacher and student activities using observation sheets
	Reflection	Analyzing results, identifying weaknesses, revising plans for next cycle
2	Planning–Reflection repeated as in Cycle 1 until improvement achieved	

2.4. Data Collection Instruments

The instruments used in this study consisted of several components. Observation sheets were employed to record teacher and student activities during PAIKEM-based lessons, with indicators including student participation, engagement, and interaction. A mathematics achievement test, consisting of 20 multiple-choice items, was designed to assess students' understanding of two-dimensional shapes. For example, one item asked: "Which of the following quadrilaterals has two pairs of parallel sides?" The validity of the test items was ensured through expert judgment by two mathematics education specialists and one

psychometrician (Creswell & Creswell, 2018). To determine reliability, Cronbach's Alpha was applied, yielding a coefficient of 0.81, which indicates high internal consistency (Fraenkel & Wallen, 2019). Additionally, interviews were conducted informally with selected students to further explore their perceptions of mathematics learning and motivation. Finally, documentation in the form of lesson plans, student worksheets, and photographs was collected to support triangulation.

2.5. Data Analysis

The collected data were analyzed using both quantitative and qualitative approaches. The quantitative analysis involved descriptive statistics, including mean, percentage, and frequency distribution. Learning success was determined based on the criterion that at least 80% of students should achieve a score of 75 or higher (KKM) (Miles et al., 2014). Meanwhile, the qualitative analysis consisted of data reduction, data display, and conclusion drawing from observations and interviews. To enhance validity, triangulation was conducted across different instruments..

2.6. Research Ethics

This study adhered to research ethics principles. Parental consent and verbal student assent were obtained before participation. The anonymity and confidentiality of participants were maintained, and data were used solely for research purposes (BERA, 2018).

3. RESULT AND DISCUSSION

The researcher conducted a preliminary survey before conducting the research. The preliminary survey aimed to determine the real situation in the field or in the fifth grade of Muhammadiyah Degan Elementary School. Therefore, the results of the preliminary survey include: That the learning method used by teachers is dominated by the lecture method. The lectures delivered by teachers are more emphasized on completing the material in the curriculum. Based on the results of the researcher's interviews with fifth grade teachers, it was revealed that teachers have more difficulty providing an understanding of mathematical concepts than other subjects. Teachers only convey formulas and students note the formulas without providing explanations, demonstrations, steps or the origin of obtaining the formulas. This. The researcher found an alternative solution to overcome the low learning outcomes and student self-confidence. This alternative solution uses the PAIKEM model. Through the PAIKEM model, students are encouraged to develop active, critical thinking and are encouraged to think independently. Students can gain learning independence that can influence their thinking process. In addition, students can understand the usefulness of mathematics in everyday life.

3.1. Description of Cycle I Actions

In general, the results of the observation analysis of teacher teaching activities in cycle I showed that meeting I was 68.1%, meeting II was 72%, and meeting III was 86.3%. These results indicate that teacher teaching activities improved at each meeting in cycle 1. After three meetings, an evaluation was conducted on March 7, 2022. The evaluation was conducted to determine the extent to which students had mastered

the subject matter. This evaluation, in this study, is referred to as the cycle 1 learning outcome test.

Table 2. Learning completion cycle I

No.	Learning Completion	Total	Percentage (%)
1	Met Minimum Mastery Criteria	17	85
2	Did Not Meet Minimum Mastery Criteria	2	15
	Total	20	100

Based on Table 2, 17 students (85%) met the Minimum Competency (KKM) with a score of 75, while 3 students (15%) did not. This indicates that student learning outcomes have reached the minimum target set by the school, which is that at least 80% of fifth-grade students have obtained a minimum score of 75 individually. However, the research will continue in Cycle II to see if there is still an increase in student learning outcomes in the next cycle. In addition, in Cycle II, improvements will be made to weaknesses found in Cycle I.

3.2. Description of Cycle II Actions

In general, the results of the observation analysis of teacher teaching activities in cycle II showed that meeting 1 was 95.4%, meeting 2 was 100%, and meeting 3 was 100%. These results indicate that teacher teaching activities improved at each meeting in cycle II. After three meetings, an evaluation was conducted on March 21, 2022. The evaluation was conducted to determine the extent to which students had mastered the subject matter. This evaluation, in this study, is referred to as the cycle II learning outcome test.

Table 3. Learning completion cycle II

No	Learning Completion	Total	Percentage (%)
1	Met Minimum Mastery Criteria	20	100
2	Did Not Meet Minimum Mastery Criteria	0	0
	Total	20	100

Based on table 3, 20 students or 100% met the KKM with a score of 75 and there were no students who did not meet the KKM. This indicates that student learning outcomes have achieved the target set by the school, namely at least 80% of the number of fifth grade students have obtained a minimum score of 76 individually and have met the success criteria set in this study so that the study can be stopped in cycle II.

3.3. Success Percentage

The percentage of success in cycle 1 was 74.2%, which has met the established success criteria. This condition after the research was continued in cycle II, to improve the weaknesses found in cycle 1, the percentage of success of teacher teaching activities became 98.5%. This has shown that teachers teach well and in accordance with the core steps of the PAIKEM Model, namely (a) understanding the contextual problems given, (b) describing and solving contextual problems, (c) comparing and discussing answers and (d) drawing conclusions. Based on the established success criteria, it is categorized as successful if at least

75% of the action implementation process is in accordance with the learning improvement plan (RPP). The increase in teacher teaching activities during cycle I and cycle II can be seen in table 4.

Table 4. Improving teacher activities in learning with the PAIKEM model

Meeting	Cycle I Score Acquisition	Cycle II Score Acquisition
1	15	21
2	16	22
3	18	22
Total number	49	65
Success Percentage (%)	74.2	98.5

The increase in teacher activity in implementing the PAKEM learning model in two cycles is shown in Figure 1.

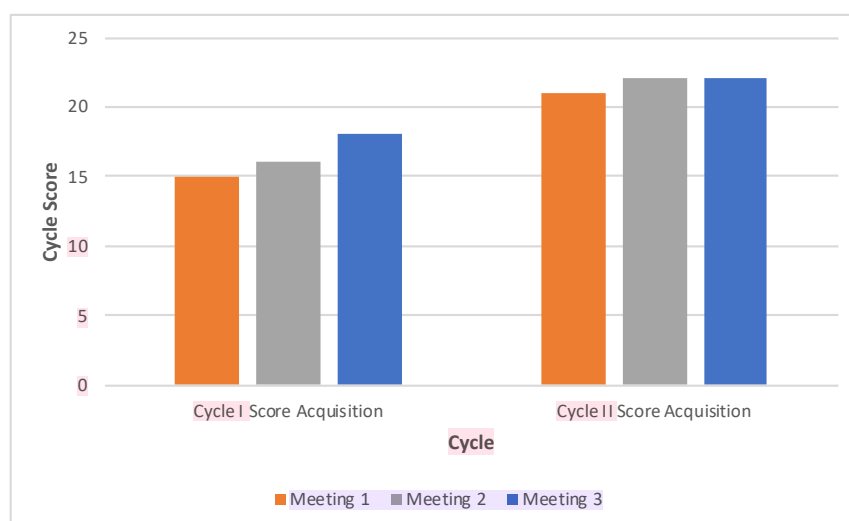


Figure 1. Increasing teacher activities

Based on Figure 1, it is known that the percentage of success in cycle I was 74.2% and the percentage of success in cycle 2 was 98.5%. This shows an increase in cycle II of 24.3% from cycle 1. Based on the established success criteria, it is categorized as successful if at least 75% of the action implementation process is in accordance with the learning implementation plan so that the research was stopped in cycle II because the success criteria had been achieved. The increase in student learning outcomes in the PAIKEM Model learning can be presented in table 5.

Table 5. Improving student learning outcomes in cycles I and II

No.	Learning Outcomes	Cycle I	Cycle II
1	Minimum Value	62	76
2	Maximum Value	92	94
	Average	80.5	83.15
	Standard Deviation	8.90	6.09

Based on Table 5, it is known that student learning outcomes in Cycle I had a minimum score of 62

and a maximum score of 92, with an average score of 80.05 and a standard deviation of 8.90. Meanwhile, student learning outcomes in Cycle II had a minimum score of 76 and a maximum score of 94, with an average score of 83.15 and a standard deviation of 6.09. These results indicate an increase in the average score in Cycle II of 3.1 compared to Cycle I.

The percentage of student learning outcomes completion in the PAIKEM Model is presented in Table 6.

Table 6. Results of learning completeness analysis in cycle II

No.	Learning Outcomes	Cycle I		Cycle II	
		Total	Percentage (%)	Total	Percentage (%)
1	Met Minimum Mastery Criteria (KKM)	17	85	20	100
2	Did Not Meet Minimum Mastery Criteria (KKM)	3	15	0	0
Total		20	100	20	100

Based on the results of the learning completion analysis in Table 6, it is known that in Cycle I, 17 students, or 85%, met the Minimum Competency (KKM), and 3 students, or 15%, did not. After improvements were made to student learning outcomes in Cycle II, students with low scores (not meeting the KKM) experienced improvements. In Cycle II, 20 students, or 100%, met the KKM. The improvement in student learning outcomes in mathematics in both cycles is shown in Figure 2.

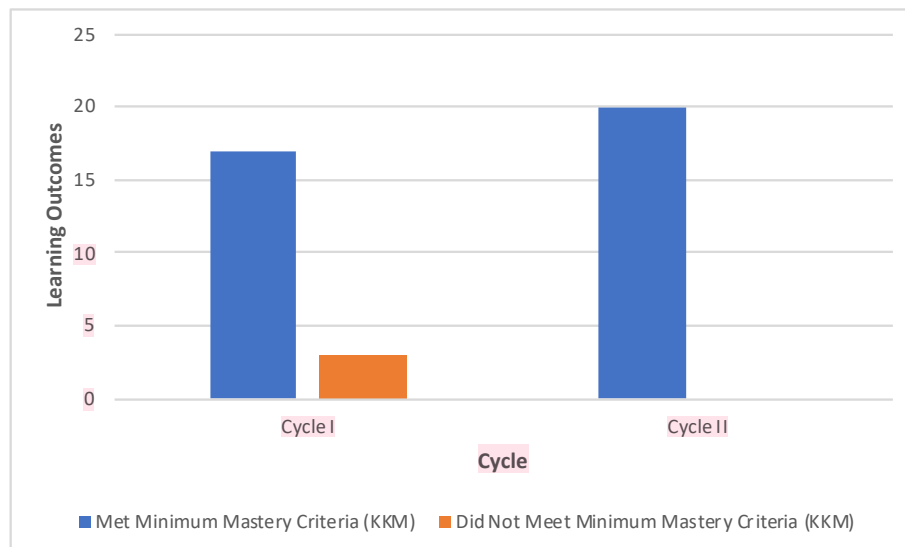


Figure 2. Improving Student Learning Outcomes

Based on Figure 2, it is known that the percentage of completion of learning outcomes in cycle I was 85% and the percentage of completion in cycle II was 100%.

3.4. Discussion

Based on the analyzed data, there was a significant improvement in students' mathematics learning outcomes after the implementation of the PAIKEM model. The adoption of PAIKEM brought renewal

to mathematics instruction by fostering a more engaging and student-centered classroom atmosphere. Students demonstrated enthusiasm, collaboration, and active participation, as evidenced by their willingness to ask questions, exchange information in small groups, and attentively listen to the teacher's explanations. These findings are consistent with Vygotsky's theory of social constructivism, which highlights the importance of social interaction in constructing mathematical concepts. The role of the teacher in guiding students within their zone of proximal development was evident, as teacher facilitation enabled students to reach higher levels of understanding through collaboration with peers and more knowledgeable individuals (Maisarah et al., 2021; Dyah et al., 2019).

The results also emphasize the teacher's role as a facilitator in the learning process. Rather than being the sole source of knowledge, the teacher encouraged active discussions, supported group collaboration, and provided opportunities for students to present and defend their answers. This aligns with Supinah's (2008) view that in PAIKEM-based mathematics learning, the teacher acts as a facilitator, while students take an active role as subjects of learning. Such an approach resonates with Ausubel's theory of meaningful learning, which underscores the importance of students linking new information with prior knowledge to construct deeper understanding (Jamaris, 2013).

Another key factor contributing to improved outcomes was the use of concrete and contextual learning media. By providing real-world objects and relatable contexts, students were able to connect abstract mathematical concepts with everyday experiences. This strategy reflects the principles of realistic mathematics education (RME), as suggested by Gravemeijer and De Lange, emphasizing that students should reinvent mathematical ideas through exposure to real-world problems under appropriate guidance. The findings further support recent studies indicating that the use of concrete and realistic media enhances student focus, engagement, and comprehension in mathematics (Rohmah et al., 2022; Sari & Nugroho, 2021).

The improvement observed between cycle I and cycle II also suggests that iterative reflection and adaptation were crucial. The teacher's continuous efforts to address weaknesses, improve classroom management, and motivate students contributed to a more effective learning environment. Providing positive reinforcement, ensuring equal participation opportunities, and maintaining mobility across the classroom encouraged students to become more confident and motivated. These findings align with recent evidence that teacher facilitation and positive classroom climate significantly influence student engagement and achievement in mathematics (Hidayati et al., 2020; Wulandari & Kurniawan, 2022).

Nevertheless, this study has limitations that must be acknowledged. First, the small sample size (20 students) limits the generalizability of the findings. Future research should involve larger and more diverse populations to strengthen external validity. Second, the study was conducted within a relatively short duration, which may not capture the long-term effects of PAIKEM on mathematical achievement and motivation. Third, while descriptive and qualitative analyses revealed promising improvements, the absence of statistical tests such as t-tests or effect size calculations restricts the strength of causal claims. Future

studies are encouraged to apply inferential statistics and longitudinal designs to provide more robust evidence of PAIKEM's effectiveness.

Comparing these findings with prior studies, Fallarina and Sidiq (2023) similarly reported that PAIKEM improved students' learning outcomes. However, while their study emphasized cognitive achievement, the present research also highlights affective outcomes, such as increased confidence and reduced anxiety. This suggests that PAIKEM may be particularly effective in contexts where student motivation and attitudes toward mathematics are low. On the other hand, its effectiveness may vary in schools with limited resources or where teachers lack sufficient training in student-centered pedagogies. Thus, the success of PAIKEM is highly context-dependent, requiring strong teacher facilitation skills, adequate resources, and student readiness to engage in active learning (Rahman & Supriyadi, 2021; Putri et al., 2022).

In summary, the findings suggest that the PAIKEM model provides an innovative and contextually relevant approach to enhancing mathematics learning at the elementary level. By integrating collaborative, contextual, and engaging activities, PAIKEM not only improves learning outcomes but also fosters motivation and positive attitudes toward mathematics. Despite its limitations, this study contributes to the growing body of evidence that PAIKEM offers a promising alternative to traditional lecture-based instruction, particularly in primary education contexts.

4. CONCLUSION

The findings of this study demonstrate that the implementation of the PAIKEM model can effectively improve students' mathematics learning outcomes in elementary school. The results indicate a clear increase in achievement, with all students meeting the minimum competency standard (KKM) by the end of the second cycle. This improvement was supported by strategies such as providing motivation, encouraging active participation, offering opportunities for students to respond, and giving constructive praise.

Beyond these results, the study highlights several practical implications. For teachers, PAIKEM can serve as an alternative instructional strategy that promotes active and engaging learning, particularly in mathematics, which is often perceived as challenging by students. Therefore, it is recommended that elementary school teachers receive professional development or training focused on the practical application of PAIKEM, including the use of concrete learning media and classroom interaction techniques. For school leaders and policymakers, integrating PAIKEM-based approaches into teacher training programs and curriculum development could strengthen efforts to enhance student learning outcomes at the elementary level.

Finally, further research is needed to test the effectiveness of PAIKEM across different subjects and school contexts, especially in schools with diverse student characteristics. Such studies would provide deeper insights into the adaptability and broader impact of PAIKEM, thereby contributing to the

continuous improvement of teaching practices in elementary education.

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