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Improvement of Learning Process and Outcomes Using an Open-Ended Approach in Mathematics Education in Elementary Schools

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ABSTRACT

This classroom action research was conducted in grade IV of SDN 04//II Jaya Setia with the background of low mathematics learning outcomes of students. The average daily test score was only 50, still below the school's Target Learning Completion Criteria (KKTP) of 70. This condition prompted the research to be conducted with the aim of improving the learning process and outcomes through the application of the Open Ended approach. The research was conducted in two cycles, each covering the stages of planning, implementation, observation, and reflection. The research subjects consisted of 22 students, while the data collection techniques used observation and learning outcome tests. The research results showed that the application of the Open Ended approach was very effective and significantly improved students' learning outcomes. In Cycle I, learning achievement reached only 59.09%, then increased to 86.36% in Cycle II. This improvement indicates that the Open-Ended approach encourages students' activity, creativity, and understanding, particularly in the material on multiplication and division of decimal numbers. Since the success indicators were achieved, the research was terminated in Cycle II. The implications of this study are that the Open-Ended approach can serve as an alternative strategy for mathematics instruction in elementary schools. Teachers can utilize it not only for decimal number topics but also for other materials that require idea exploration and problem-solving.

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A. INTRODUCTION

Education is a process of behavioral transformation, knowledge enhancement, and accumulation of life experiences aimed at helping students become more mature in their thinking, attitudes, and actions (Mbato, 2024). According to Law Number 20 of 2003 concerning the National Education System, education is a conscious and planned effort to create a learning atmosphere and learning process so that students actively develop their potential, thereby acquiring religious spiritual strength, self-control, personality, intelligence, noble character, and the skills needed by themselves and society. This effort plays a crucial role in producing superior human resources with character who are ready to face the challenges of globalization (Astari et al., 2024). Through education, students not

only acquire theoretical knowledge taught in school, but also learn through meaningful life experiences, which are an integral part of learning to understand and apply knowledge in real life (Noer et al., 2023).

The importance of education is also formally regulated within the Indonesian legal framework. Article 1 point 19 of Law Number 20 of 2003 states that the curriculum is a set of plans and arrangements regarding the objectives, content, and subject matter, as well as the methods used as guidelines for conducting learning activities to achieve specific educational objectives (Noviani, D., & Nafisah, A. 2022). One of the curricula designed by the Ministry of Education and Culture is the 2013 Curriculum, which is an improvement on the 2004 Competency-Based Curriculum (KBK) and the 2006 Education Unit Level Curriculum (KTSP) (Nurholis et al., 2022). This curriculum covers the integrated development of attitudes, knowledge, and skills. Furthermore, the Merdeka Curriculum gives educators the freedom to create quality learning that is appropriate to the needs and learning environment of students (Mulyasa, H. E. 2023). The implementation of the Merdeka Curriculum at the elementary/MI level prioritizes project-based learning as an effort to realize the Pancasila student profile (Inayati, U. 2022, August).

The Implementation of the Merdeka Curriculum at SDN 04/II Jaya Setia has covered all grades and subjects. Merdeka strongly emphasizes project-based learning strategies (Ramadhan, E. H., & Hindun, H. 2023). This approach allows students to implement the material they have learned through projects or case studies, so that conceptual understanding can be achieved optimally (Dly, A. S., & Sulfiani, S. 2024). Projects in the Merdeka Curriculum are known as Pancasila Student Profile Strengthening Projects, which are designed to be cross-curricular. Through this project, students are invited to observe various problems in their classroom environment and provide real solutions to these problems (Tri Rejeki et al., 2024). Project-based learning not only develops academic abilities but also hones students' critical thinking, collaboration, and creativity skills (Sholeh et al., 2024).

Based on observations conducted by researchers on November 20, 2024, in class IV of SDN 04/II Jaya Setia, regarding the mathematics learning process, several issues were found that need attention. In this lesson, the teacher delivered material on division and multiplication of decimal fractions using media such as books, blackboards, and question and answer methods. After providing explanations, the educator gave individual assignments to the students. However, the researcher observed that the students had difficulty understanding the assignment instructions and appeared unmotivated. This resulted in a less than optimal learning process. In a question and answer session with the students, one of the students stated that the learning approach used by the educator was only in the form of explanations in front of the class and the giving of individual assignments, which tended to be monotonous and made the students feel bored (Azhari, F., & Sabir, A. 2023). From these observations, the researchers concluded that students were less motivated during the learning process, so innovations in the learning approach were needed to make the learning atmosphere more interesting and effective.

The researchers also discussed and asked questions to several educators, including Mrs. Inanda Elvina, S.Pd. The researchers asked several questions, one of which was about the development of mathematics learning in schools. Based on the results of the observation, it was found that the learning outcomes of students in mathematics were still less than optimal. This can be seen from the low average mathematics scores. Of the total 22 students, only 8 students managed to achieve the Learning Objective Achievement Criteria (KKTP), while the other 14 students did not achieve the KKTP. This imbalance shows that the majority of students have not met the set standards. Based on the interview results, the results of mathematics learning at SDN 04//II Jaya Setia can be seen from the following scores:

Table 1.1
Summary of Daily Test Results for the Odd Semester of the 2024/2025 Academic Year

No	Initials	KKTP	Value	Description
1	AFS	70	50	**Not Yet Reached KKTP**
2	AFR	70	60	**Not Yet Reached KKTP**
3	AGI	70	50	**Not Yet Reached KKTP**
4	AM	70	60	**Not Yet Reached KKTP**
5	AKW	70	80	**Achieving KKTP**
6	CHR	70	70	**Achieving KKTP**
7	CA	70	70	**Achieving KKTP**
8	IL	70	50	**Not Yet Reached KKTP**
9	KH	70	50	**Not Yet Reached KKTP**
10	MZ	70	60	**Not Yet Reached KKTP**
11	MM	70	50	**Not Yet Reached KKTP**
12	HP	70	80	**Mencapai KKTP**
13	NP	70	50	**Not Yet Reached KKTP**
14	RR	70	50	**Not Yet Reached KKTP**
15	RN	70	70	**Achieving KKTP**
16	RTP	70	50	**Not Yet Reached KKTP**
17	SH	70	80	**Achieving KKTP**
18	SS	70	70	**Achieving KKTP**
19	WJ	70	70	**Achieving KKTP**
20	TM	70	60	**Not Yet Reached KKTP**
21	RS	70	50	**Not Yet Reached KKTP**
22	AYT	70	60	**Not Yet Reached KKTP**
Number		**1.340**		
Rata – rata		**60,91**		
Many students have completed their studies		**8**		
Percentage of completion		**36%**		
Many students did not complete		**14**		
Percentage Incomplete		**63%**		

Source: Fourth Grade Homeroom Teacher, SDN 04//II Jaya Setia

Based on Table 1.1, the data on the final mathematics test scores show that out of 22 students, 8 students (36%) have achieved KKTP, while 14 students (63%) have not achieved KKTP. The low daily test scores are influenced by the mathematics learning process at SDN 04/II Jaya Setia, which is still less than optimal. The learning process tends to use conventional methods that are not very interesting, resulting in low learning outcomes for students (Lokat et al., 2022). Effective mathematics learning can be achieved if students are able to understand the material, master the class, and show creativity in learning mathematics.

As a solution to this problem, the researchers offer the Open-Ended approach. This approach is a learning approach that presents open-ended problems with various possible correct answers (Ariani, A., & Widjajanti, D. B. 2013). In the process, this Open-Ended Approach can provide opportunities for students to gain knowledge or experience in discovering, recognizing, and solving problems using several techniques (Febriani et al., 2021).

The Open Ended approach provides opportunities for students to develop various solutions to mathematical problems without being bound to a single answer (Alviasyah, E. N. 2025). With this approach, students are encouraged to think more critically, increase creativity, and hone problem-solving skills. At SDN 04/II Jaya Setia, the implementation of the Open Ended approach is expected to improve the quality of the learning process and learning outcomes, especially in understanding

more complex mathematical concepts (Trigunawan, I. N. 2020). This approach aims not only to help students master the material, but also to train them to think critically and creatively in solving problems (Sapitri et al., 2022).

This study aims to improve the quality of the mathematics learning process and outcomes through the application of the Open Ended approach to fourth-grade students at SDN 04/II Jaya Setia. The Open Ended approach is a learning strategy that provides space for students to build and achieve learning objectives in an open and flexible manner (Santika et al., 2022). In its implementation, students are given open-ended questions or problems that can be solved in various ways and with different solutions. This approach not only facilitates problem-solving skills but also encourages students to develop creative solutions to more complex situations (Jarnawi, 2022).

Furthermore, the Open Ended approach emphasizes the importance of creating a fun and supportive learning environment, thereby increasing students' motivation, active participation, and confidence in the learning process (Hidayat & Hendra, 2020). In this context, interactions between students become more dynamic because students are encouraged to use various problem-solving strategies and share solutions in class discussions. This approach has also been proven effective in improving students' critical thinking skills when applied optimally and systematically (Hulu et al., 2025; Sari, 2023). By giving them the freedom to explore various alternative solutions, students are encouraged to think more deeply, reflectively, and analytically about the problems they face.

Based on theoretical studies and previous results, the Open Ended approach has the potential to strengthen student learning outcomes through the development of higher-order cognitive skills, such as analysis, evaluation, and creation, which are trained through problem-based learning (Aziz et al., 2025). In this study, the Open Ended approach will be applied through two cycles of action to observe gradual improvements in learning processes and outcomes. This strategy also aims to train students to express their ideas openly and confidently, as well as to get them used to engaging in active discussion and collaboration in the classroom (Payadnya et al., 2022). The implications of this study indicate that the Open Ended approach can be an alternative learning strategy that is relevant in the context of the Merdeka Curriculum, which emphasizes differentiated learning, strengthening the Pancasila student profile, and developing students' character and critical thinking skills. Therefore, teachers need to consider applying this approach as part of learning innovation in the classroom, especially in mathematics subjects that require a balance of logical and creative thinking skills.

B. LITERATURE REVIEW

Open-ended learning is a method that encourages students to think critically, creatively, and actively in solving problems independently or in groups (Novtiar et al., 2017). This approach allows students to come up with various answers or solutions without rigid restrictions, making the learning process more dynamic and involving active student participation (Ritonga et al., 2024). In the context of fourth-grade mathematics learning at SDN 04/II Jaya Setia, the open-ended approach was applied to improve the learning process and outcomes of students through tasks that encouraged open thinking and group discussions (Fatwa et al., 2024). Thus, this approach not only improves students' academic abilities in understanding mathematical concepts but also strengthens social skills such as cooperation and communication among students in heterogeneous groups (Restalia et al., 2025). Based on various studies, cooperative learning that integrates the open-ended approach can improve cooperative behavior and social relationships among students, while encouraging overall academic development. The open-ended approach in mathematics learning is a model that encourages students to actively participate in the learning process, allowing them to exchange ideas and develop critical thinking independently and in groups.

Based on various studies, cooperative learning that integrates an open-ended approach can improve cooperative behavior and social relationships among students, while also encouraging comprehensive academic development. The open-ended approach in mathematics learning is a model that encourages students to actively participate in the learning process, allowing them to exchange ideas and develop critical thinking independently and in groups. This approach differs from simply learning in ordinary groups because it requires the full involvement of students, where students not only receive information from the teacher but also teach and learn from each other within the group. The characteristics of open-ended learning include open-ended problem-based learning that encourages students to explore various possible answers, increases mutual dependence, cooperation, and individual responsibility in completing tasks. Based on various studies, cooperative learning that integrates an open-ended approach can improve cooperative behavior and social relationships among students, while also encouraging comprehensive academic development. The open-ended approach in mathematics learning is a model that encourages students to actively participate in the process. Teachers act as facilitators and motivators who help guide the learning process without being the sole source of information. The steps for implementing the open-ended approach include topic identification, cooperative planning, plan implementation, information analysis and synthesis, presentation of results, and joint evaluation between teachers and students. Through this process, students' active involvement in mathematics learning increases significantly, resulting in a noticeable improvement in the learning process and outcomes. Therefore, the application of the open-ended approach is very effective in achieving mathematics learning objectives that emphasize not only the final results but also the development of students' critical thinking and creativity at SDN 04/II Jaya Setia.

C. METHODS

This study is a Classroom Action Research (CAR) that aims to improve the process and outcomes of mathematics learning through an open-ended approach for fourth-grade students at SDN 04/II Jaya Setia. This research was conducted in the odd semester of the 2023 academic year, specifically from December 21 to 29, 2023. ACT was chosen because it allows teachers and researchers to identify and solve learning problems directly in the classroom. The approach used in this study was participatory and reflective, creating a learning atmosphere that was as natural as possible so that the researcher could interact directly and familiarly with the research subjects (Nurhayati et al., 2024). The research subjects were 27 fourth-grade students. This research was conducted in two cycles, each consisting of planning, implementation of actions, observation, and reflection. Data collection techniques used observation, interviews, and learning outcome tests, while data were analyzed qualitatively and quantitatively to evaluate the improvement in the learning process and outcomes of students after the application of the open-ended approach.

1. DESAIN PENELITIAN

This research design uses a Classroom Action Research (CAR) approach conducted in two cycles (Utomo et al., 2024). Each cycle consists of four stages, namely planning, implementation of actions, observation, and reflection. This study aims to improve the process and outcomes of mathematics learning through the application of an open-ended approach, which provides space for students to explore various ways of solving problems creatively and openly. In its implementation, the Group Investigation model was used as a collaborative strategy to encourage active student involvement in discussions and problem solving. Through the observation and

reflection stages, researchers and teachers analyze the effectiveness of the approach applied and evaluate changes in student learning activities and learning outcomes. The results of each cycle are used as a basis for improvement in the next cycle, so that the learning process becomes more effective, participatory, and oriented towards the development of students' critical thinking. The following is a diagram of the cycle.

2. Participant

This study used a classroom action research (CAR) approach with the aim of improving the learning process and outcomes of students in mathematics learning through an open-ended approach in grade IV of SDN 04/II Jaya Setia. The open-ended approach was chosen because it encourages students to think creatively, exploratively, and more actively in solving mathematical problems (Novtiar, C., & Aripin, U. 2017). The research was conducted in two cycles, each consisting of planning, implementation, observation, and reflection stages. The research subjects consisted of 27 fourth-grade students (16 boys and 11 girls) and social studies teachers at SDN 88/II Sungai Mengkuang. This class was selected based on initial identification results that showed problems in student activity and low mathematics learning outcomes, as well as the support of teachers to collaborate in implementing classroom actions. Data were collected through observation, interviews, field notes, and learning outcome tests. Data validity was obtained through triangulation of techniques and sources, while data analysis was conducted using descriptive qualitative and quantitative methods. Through this design, it is hoped that there will be improvements in both the learning process and student learning outcomes.

3. Intervention

This study used an open-ended approach through the Group Investigation model to improve the process and outcomes of mathematics learning in grade IV at SDN 04//II Jaya Setia. The intervention was carried out over four weeks with two meetings in each cycle. In the first cycle, the first meeting focused on delivering material related to mathematics learning using an open-ended approach in the Group Investigation model, where students were encouraged to actively observe and discuss with the help of observation sheets for students and teachers (Susanti, G., & Adawiah, R. 2020). The second meeting was used to conduct a learning outcome evaluation test for students as a form of assessment of their understanding of the material. In the second cycle, a similar process was applied with more in-depth material and a more intensive application of the Group Investigation method, followed by an evaluation test in the second meeting to measure the improvement in student learning outcomes after the intervention. Observations during the learning process were conducted to monitor student engagement and the effectiveness of the open-ended approach in improving critical thinking and mathematical problem-solving skills.

4. Data Collection

Data collection in this study was conducted using a combination of quantitative and qualitative methods (Waruwu, M. 2023). Quantitative data were obtained through learning outcome tests in the form of pre-tests and post-tests given to fourth-grade students at SDN 04/II Jaya Setia to measure changes in mathematical ability after the application of the open-ended approach in learning. Meanwhile, qualitative data were collected through observations of the learning process that took place in the classroom. These observations focused on the syntax of the group investigation model used by teachers during learning, which was systematically recorded in

teacher and student observation sheets. The observation sheets covered the learning steps that had been designed in the teaching materials and implemented directly, thus providing a comprehensive picture of the implementation of the open-ended approach in improving the mathematics learning process and outcomes.

5. Data Analysis

Data analysis in this study used quantitative and qualitative approaches to obtain a comprehensive picture of the improvement in mathematics learning processes and outcomes through an open-ended approach among fourth-grade students at SDN 04/II Jaya Setia. Quantitative data were analyzed using descriptive statistics through calculating the percentage change in student learning outcomes between cycles, namely from cycle 1 to cycle 2. The results of the analysis showed a significant increase in the average score and level of student learning completeness after the implementation of the open-ended approach. In addition, qualitative data obtained from observations during the learning process were analyzed thematically to identify teachers' teaching patterns, the level of student engagement in learning, and the practices carried out by teachers in implementing this approach (Hilda, E. M. 2023). This thematic analysis found that the open-ended approach was able to increase student activity and creativity in solving mathematical problems, while motivating teachers to apply more varied and interactive learning strategies. Overall, this data analysis shows that the application of the open-ended approach has a positive impact on both the learning process and the mathematics learning outcomes of students in grade IV at SDN 04/II Jaya Setia.

D. RESULT AND DISCUSSION

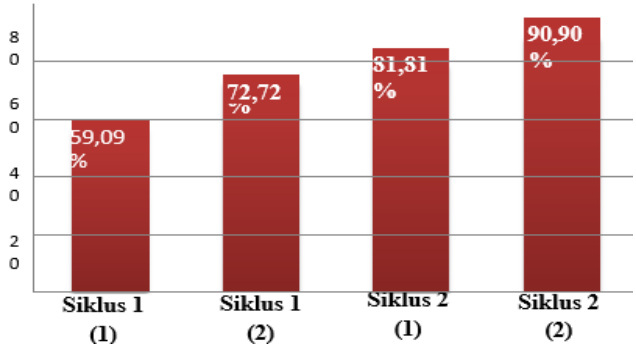
Based on data obtained from observations and mathematics learning outcome tests, it is known that the application of the Open Ended approach can significantly improve the learning process and outcomes of students. This study was conducted in two cycles, each consisting of two meetings. At the beginning of each cycle, the learning process was observed by observers using student and educator observation sheets, while at the end of each cycle, students were given evaluation tests to measure their learning progress. The results of the observation sheets showed an improvement in the quality of learning, as demonstrated by the active involvement of students and the role of educators in directing a more open and exploratory learning process. One of the data analyzed in this study was a recapitulation of the educator observation sheets during the learning process. These observation sheets were used to assess the extent to which educators applied the Open Ended approach in managing the class and guiding participants in solving mathematical problems. The observation data in cycle I and cycle II showed improvements in the implementation of learning, both in terms of teaching strategies, time management, and interaction with students. The data from observations in cycle I and cycle II showed improvements in teaching, both in terms of teaching strategies, time management, and interaction with students.

Table 1. Percentage Increase in Educator Observation Sheets

Cycle	Average Percentage
Cycle I Meeting I	58,33%
Cycle I Meeting II	75,00%,
Cycle II Meeting I	83,33%
Cycle II Meeting II	91,66%

Next, the discussion of the data from the observation sheets for students in cycle I meetings I and II and cycle II meetings I and II can be seen in Figure 4.2 below.

Figure 1. Comparison of Improvement Diagrams
Student Observation Sheets Per Cycle



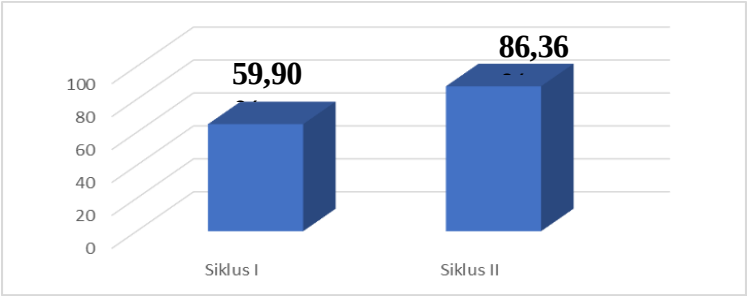
Based on data from the student observation sheets presented in Figure 4.12, there was a significant increase in the learning process at each meeting in each cycle after the implementation of the Open Ended approach in mathematics learning in grade IV at SDN 04/II Jaya Setia. In the first meeting of cycle I, the percentage of student involvement in the learning process was recorded at 59.09%. This percentage increased in the second meeting in the same cycle to 72.72%. A more significant increase was seen in cycle II, where in the first meeting, the percentage of student observation reached 81.81%, and in the second meeting, it increased again to 90.90%. This percentage indicates a "very good" category in student engagement during the learning process. These results indicate that the effective application of the Open Ended approach can increase students' active involvement and enthusiasm in participating in mathematics learning. Thus, it can be concluded that the use of the Open Ended approach in mathematics learning has succeeded in significantly improving the learning process of fourth-grade students at SDN 04/II Jaya Setia.

Table 2. Mathematics Test Results of Students in Cycle I and Cycle II

Implementation of Actions	Completeness		Percentage (%)	
	Completed	Not yet completed	Completed	Not yet completed
Pre-cycle	8	14	36%	63%
Cycle I	13	9	59,09%	40,90%
Cycle II	19	3	86,36%	13,63%

Next, the discussion of the learning test results for students in cycle I and cycle II can be presented in the following bar chart in Figure 2:

Figure 2. Learning Test Results For Students In Cycle I And Cycle Ii



Based on the results of the student learning tests in cycle I, out of 22 students who participated in the learning process, 13 students achieved learning completeness with a percentage of 59.90%, while the other 9 students (40.90%) did not. In cycle II, there was a significant increase, where the number of students who achieved mastery rose to 19 (88.36%) and only 3 students (13.63%) did not achieve mastery. These three students were known to have difficulty understanding the material due to limitations in capturing information and slow thinking processes. Overall, the increase in learning outcomes from cycle I to cycle II reached 26.46%. This finding is in line with the results of previous research by A. (2015), which showed an increase in learning completeness from 58.33% in cycle I to 75% in cycle II after the application of the open-ended approach. This improvement was driven by a pleasant classroom atmosphere through open discussions between teachers and students. This is reinforced by the opinion of Hidayat et al. (2019), who stated that open-ended questions can encourage active interaction between educators and students. In addition, Novikasari's (2010) theory emphasizes that the advantage of the open-ended approach lies in its ability to provide space for students to actively participate, express ideas, and develop mathematical knowledge and skills more deeply and comprehensively. Thus, the open-ended approach has proven to be effective in improving the learning process and outcomes of fourth-grade students at SDN 04/II Jaya Setia.

Reflections from the implementation of cycle I revealed various obstacles faced by teachers and students, including teachers' difficulties in managing a noisy classroom environment, students' low ability to ask and answer questions, and students' lack of courage to present the results of discussions independently. Students also appeared to be less active and less focused during the learning process, which had an impact on suboptimal learning outcomes. After improving the learning strategy in cycle II, most of these obstacles were minimized. Students began to show a more cooperative attitude, confidence in expressing their opinions, and more enthusiasm in participating in mathematics learning using an open-ended approach. Group learning became more enjoyable and effective in helping students understand the material. Although there were still a small number of students who did not achieve mastery, overall there was a significant improvement in both learning activities and student evaluation results in cycle II compared to cycle I, as reflected in the observation sheets and learning evaluation results.

The open-ended approach is expected to continue to be applied and developed in mathematics learning so that all students are able to think critically, creatively, and more actively in the learning process. Teachers are also expected to become more professional in managing classrooms and facilitating students to dare to ask questions, answer, and present ideas. The implication is that the open-ended approach not only improves learning outcomes but also shapes students' characters to be more active, independent, and creative. The results of this study can be used as a reference for teachers in designing learning strategies that emphasize problem solving, collaboration, and the development of higher-order thinking skills, so that the quality of mathematics learning in elementary schools improves overall.

E. CONCLUSION AND SUGGESTIONS

The results of the Classroom Action Research conducted in class IV of SDN 04/II Jaya Setia show that the application of the Open Ended approach has been proven to significantly improve the learning process and outcomes of mathematics students. The improvement in the learning process can be seen from the results of observations of teacher and student activities, which show positive developments in each cycle. Teacher activity increased from 58.44% (Fair category) in cycle I meeting I to 91.66% (Very Good category) in cycle II meeting II, while student activity increased from 59.09% to 90.90%

in the same category. In addition, student learning outcomes also experienced a significant increase, where at the end of cycle I only 13 students (63.36%) achieved the Minimum Completion Criteria (KKTP), and increased to 19 students (86.36%) at the end of cycle II. These findings confirm that the Open Ended approach is not only capable of increasing student engagement in the learning process, but is also effective in improving academic achievement. The implication of this study is that the Open Ended approach can be used as an innovative learning strategy to develop critical thinking, creativity, and problem-solving skills among elementary school students. In the future, further research is expected to expand the application of this approach to other mathematics subjects and different grade levels, as well as explore the integration of this method with digital learning media to improve the quality and effectiveness of learning more broadly.

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