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# IMPROVING LEARNING OUTCOMES OF 6TH GRADE STUDENTS AT SDN 2 PALEMBANG ON ECLIPSE AND SOLAR SYSTEM TOPICS ASSISTED BY AUGMENTED REALITY

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## *Abstract*

*This study aims to improve the learning outcomes of 6th-grade students at SD Negeri 2 Palembang on the topics of eclipses and the solar system through the use of Augmented Reality (AR) media. The Classroom Action Research (CAR) was conducted in two cycles, with each cycle encompassing planning, implementation, observation, and reflection stages. The research subjects were 35 students who were guided using AR media to visualize abstract concepts about the solar system and eclipse phenomena. Data were collected through pre-tests, post-tests, student activity observation sheets, and questionnaires regarding students' responses to the use of AR. The results showed a significant improvement in student learning outcomes from Cycle I to Cycle II. The average post-test score increased from 15.46 in Cycle I to 18 in Cycle II, with an overall average improvement of 6.94 points. Additionally, the success indicators were achieved, with 91% of students showing active engagement in the learning process. The use of AR also had a positive impact on students' motivation to learn and their social skills, such as the ability to discuss and collaborate in groups. However, technical challenges like network issues and infrastructure limitations need to be addressed to optimize the use of AR in the classroom. This research concludes that AR-based learning can be an effective solution to enhance students' understanding of solar system and eclipse topics, particularly for the 6A grade students at SDN 2 Palembang.*

***Keywords***: *Augmented Reality, learning outcomes, solar system, eclipse, classroom action research.*

## *Abstrak*

Penelitian ini bertujuan untuk meningkatkan hasil belajar peserta didik kelas 6 SD Negeri 2 Palembang pada materi gerhana dan tata surya melalui pemanfaatan media Augmented Reality (AR). Penelitian Tindakan Kelas (PTK) ini dilaksanakan dalam dua siklus, dengan setiap siklus mencakup tahapan perencanaan, pelaksanaan, pengamatan, dan refleksi. Subjek penelitian adalah 35 peserta didik yang dibimbing menggunakan media AR untuk memvisualisasikan konsep-konsep abstrak tentang tata surya dan fenomena gerhana. Data dikumpulkan melalui pre-test, post-test, lembar observasi keaktifan peserta didik, serta angket respons peserta didik terhadap penggunaan AR. Hasil penelitian menunjukkan peningkatan signifikan dalam hasil belajar peserta didik dari siklus I ke siklus II. Rata-rata skor post-test meningkat dari 15,46 pada siklus I menjadi 18 pada siklus II, dengan rata-rata peningkatan keseluruhan sebesar 6,94 poin. Selain itu, indikator keberhasilan tercapai dengan 91% peserta didik menunjukkan keterlibatan aktif dalam pembelajaran. Penggunaan AR juga memberikan dampak positif terhadap motivasi belajar dan keterampilan sosial peserta didik, seperti kemampuan berdiskusi dan bekerja sama dalam kelompok. Namun, tantangan teknis seperti kendala jaringan dan keterbatasan infrastruktur perlu diperhatikan untuk optimalisasi penggunaan AR di kelas. Penelitian ini memberikan kesimpulan bahwa pembelajaran berbasis AR dapat menjadi solusi efektif untuk

meningkatkan pemahaman peserta didik terhadap materi tata surya dan gerhana, khususnya bagi peserta didik kelas 6A SDN 2 Palembang.

***Kata Kunci**:* Augmented Reality, hasil belajar, tata surya, gerhana, penelitian tindakan kelas.

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## INTRODUCTION

Education plays an essential role in shaping the character and intellectual abilities of students. As a continuous process, education functions to develop individual potential to the fullest through various teaching methods and learning approaches (Utami, 2022). However, in practice, learning often encounters challenges that affect student learning outcomes. One of the subjects that is particularly challenging to understand at the elementary level is the solar system and eclipses. Abstract concepts such as the dynamics of celestial bodies, the distance between planets, and the phenomena of solar and lunar eclipses often pose difficulties for students. (Andriyani et al. 2023).

Empirical data from SDN 2 Palembang indicate that student achievement on the topic of the solar system and eclipses remains below expectations. In Grade 6A, only 4 out of 35 students scored above 70, with the average class score reaching just 55. These results suggest that a significant number of students have not met the minimum mastery criteria. A similar trend was reported by Sari and Pratama (2023), who found that learning outcomes on solar system material using traditional methods were relatively low, with a pretest average of 50.12. Although improvements were observed in the first and second learning cycles, with average scores of 65.47 and 74.32 respectively, several students still failed to achieve the expected competence. One of the underlying causes is the lack of interactive visual media capable of illustrating complex astronomical phenomena such as eclipses, which often require strong spatial and conceptual understanding.

This situation highlights the need for learning approaches that can bridge the gap between abstract concepts and students' real-life experiences (Permadi, 2024). Student engagement in the learning process is a crucial aspect that must not be overlooked. Active learning not only reflects the level of student participation but also serves as an indicator of their comprehension and interest in the subject matter (Listiani, 2022). Therefore, learning strategies must not only focus on content delivery but also promote active participation through engaging and contextual media.

In this context, the use of Augmented Reality (AR) technology emerges as a potential solution to provide a more interactive and meaningful learning experience. AR allows students to interact with three-dimensional objects in the real world through digital devices such as computers or smartphones (Çetin, 2022). Koumpouros (2024) found that the use of AR in learning can enhance interaction, collaboration, and student motivation. Furthermore, Hidayat et al. (2021) stated that AR effectively supports the development of students' literacy skills, including reading, writing, speaking, and listening. With concrete and contextual visualizations, complex subjects like the solar system and eclipses can be delivered in a more engaging and comprehensible manner.

This study aims to improve the learning outcomes of Grade 6 students at SDN 2 Palembang on the topic of the solar system and eclipses through the use of AR-based learning media. In addition, the study also aims to evaluate the effectiveness of AR media in helping students understand abstract concepts, observe their learning engagement during the implementation of AR, and identify any challenges encountered in the process. The novelty of this research lies in the integration of AR technology into elementary-level learning, offering an interactive visualization approach as an alternative to traditional methods. This approach is expected not only to enhance

students understanding but also to contribute to the development of more effective, enjoyable, and technology-driven learning strategies.

## METHODS

The research method used in this study is Classroom Action Research (CAR) based on the Kemmis and McTaggart model. This method is designed to improve the quality of learning through a rational, empirical, and systematic approach. The study was conducted over two cycles from February to April at SDN 2 Palembang, located at Jalan Padang Selasa, Bukit Besar Subdistrict, Ilir Barat 1 District, Palembang City. The subjects of this study were 35 sixth-grade students at SDN 2 Palembang, with details of 17 male students and 18 female students. The data collected consisted of quantitative data, including scores from concept comprehension tests (pre-tests and post-tests), and qualitative data, which involved observations of student and teacher activities, teacher reflections, and student responses gathered through questionnaires. These data sources were obtained directly from classroom learning activities during the implementation of Augmented Reality (AR)-based teaching media.

The research process was carried out in four stages: planning, action, observation, and reflection. In the planning stage, the lesson plan was designed by integrating AR media to support the solar system and eclipse topics. Technologies such as AR applications and supporting devices like smartphones or tablets were prepared. Research instruments, including tests, observation sheets, and questionnaires, were also developed during this stage. The action stage involved implementing AR-based learning in three sessions for each cycle. During this stage, students interacted directly with 3D models of celestial objects and eclipse phenomena using AR and completed relevant quizzes. Observations were conducted to monitor student and teacher activities and to identify challenges faced during the use of AR media. The reflection stage involved evaluating test results and observations to determine the strengths and weaknesses of the implemented learning process and designing improvements for the next cycle. The flowchart of this classroom action research activity is presented in the following figure.

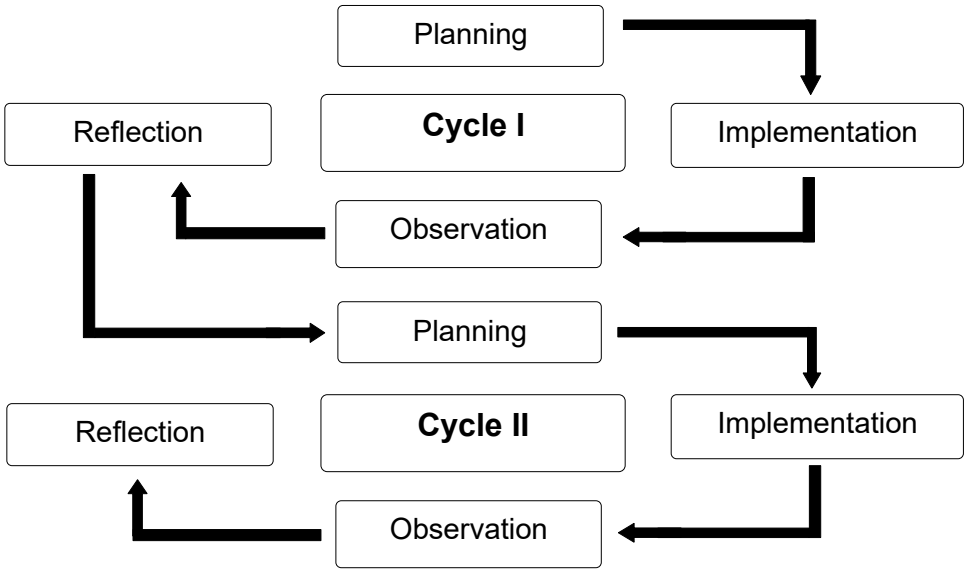



Figure 1. Classroom Action Research Design Based on the Kemmis and McTaggart Model

Data analysis in this study utilized both quantitative and qualitative approaches. Quantitative data were analyzed using descriptive statistics to measure the improvement in students' concept comprehension scores, calculated using the formula:

$$Class\ Average = \frac{\Sigma\ Student\ Scores}{N} \quad (1)$$

N represents the number of students. Qualitative data were analyzed thematically based on observations, teacher reflections, and student responses to identify patterns of student engagement during learning activities. The study was considered successful if at least 70% of students achieved scores above the minimum mastery criterion of 70, the class average score increased by at least 5 points from pre-test to post-test, and 80% of students demonstrated active engagement based on classroom observation results.

The instruments used in this study included observation sheets to record student and teacher activities, concept comprehension test questions for pre-tests and post-tests, teacher reflection sheets, and student response questionnaires to evaluate their acceptance of AR media. With systematic and detailed procedures, this study allows replication by other researchers and provides validation for the effectiveness of AR media in enhancing student learning outcomes.

## RESULTS AND DISCUSSION

This classroom action research aims to improve the learning outcomes of sixth-grade students at SDN 2 Palembang on the topic of eclipses and the solar system through the use of Augmented Reality (AR) media. The study was conducted over two cycles, with each cycle consisting of the stages of planning, implementation, observation, and reflection. Before implementing the first cycle, a preparatory stage was conducted.

In the preparatory stage, a needs analysis and literature review were conducted to emphasize the urgency of implementing classroom action research aimed at improving the learning outcomes of sixth-grade students at SDN 2 Palembang on the solar system topic using augmented reality. This stage also included the development of AR media for solar system and eclipse topics, as well as the preparation of research instruments, including pre-test/post-test questions, observation sheets to monitor student engagement, and student reflection forms.

During the planning stage of Cycle I, an AR-based teaching module and the necessary learning tools and materials were prepared. The teaching module was designed using the discovery learning model, which integrated activities with Augmented Reality. The study then continued to the implementation stage. In this stage, the learning process using AR media was carried out with the topics of the solar system and eclipses. Before the learning session began, students were required to complete a pre-test designed to assess their conceptual understanding of the solar system and eclipse topics. At the beginning of the learning session, students were introduced to how to use AR media. They then explored the available features on the AR media with guidance from the teacher.

The next stage was observation, which was conducted simultaneously with the implementation phase. During this stage, the teacher observed students’ activities throughout the learning session. The observation focused on evaluating the effectiveness of learning activities using AR and monitoring students' engagement during the process. After the learning session was concluded, a post-test was conducted to evaluate the achievement of the research objectives. Students were also asked to complete a questionnaire through Google Forms to provide feedback on their learning experience using AR media.

The final stage of Cycle I was reflection. In this stage, the researcher analyzed the results of the observations and tests conducted during the implementation phase. The analysis aimed to identify the strengths and weaknesses of the intervention involving the use of AR media. The weaknesses identified in Cycle I were then addressed, and the improvements were applied in Cycle II. The observations of student engagement during the learning process in Cycle I are presented in the following table.

**Table 1**. Observation Results of Student Engagement in the Cycle I

| No. | Aspect | Indicator | Percentage | |
|---|---|---|---|---|
| | | | Yes | No |
| 1. | Engagement in Learning | Students appeared enthusiastic while listening to the teacher's explanation. | 80% | 20% |
| | | Students actively participated in discussions and group activities. | 80% | 20% |
| | | Students followed the teacher's instructions in using the learning media | 100% | 0% |
| 2. | Discipline and Cooperation | Students were able to carry out the teacher's instructions without delay. | 91.5% | 8.5% |
| | | Students were able to cooperate with their group members. | 85.8% | 14.2% |
| 3. | Expressing and Responding to Opinions | Students were able to express their opinions effectively. | 80% | 20% |
| | | Students were able to respond to their peers' opinions effectively. | 57.2% | 42.8% |
| 4. | Reflection and Self-Evaluation | Students were able to identify the aspects they have understood and the areas that still need improvement. | 94% | 6% |
| | | Students expressed the aspects they found interesting about the topic studied after the learning activities concluded. | 94% | 6% |

The analysis of the Pre-Test and Post-Test results conducted during the learning process in Cycle I is presented in the following table.

**Table 2**. Pre-Test and Post-Test Results for Cycle I

| No | Students Name | Pre-Test Score | Post-Test Score | Improvement |
|---|---|---|---|---|
| 1 | Respondent 1 | 11 | 16 | 5 |
| 2 | Respondent 2 | 10 | 19 | 9 |
| 3 | Respondent 3 | 14 | 19 | 5 |
| 4 | Respondent 4 | 12 | 14 | 2 |
| 5 | Respondent 5 | 8 | 12 | 4 |
| 6 | Respondent 6 | 12 | 18 | 6 |
| 7 | Respondent 7 | 8 | 17 | 9 |
| 8 | Respondent 8 | 14 | 15 | 1 |
| 9 | Respondent 9 | 12 | 20 | 8 |
| 10 | Respondent 10 | 12 | 12 | 0 |
| 11 | Respondent 11 | 9 | 10 | 1 |
| 12 | Respondent 12 | 9 | 10 | 1 |

| | | | | |
|---|---|---|---|---|
| 13 | Respondent 13 | 12 | 15 | 3 |
| 14 | Respondent 14 | 13 | 17 | 4 |
| 15 | Respondent 15 | 13 | 15 | 2 |
| 16 | Respondent 16 | 12 | 20 | 8 |
| 17 | Respondent 17 | 5 | 11 | 6 |
| 18 | Respondent 18 | 16 | 17 | 1 |
| 19 | Respondent 19 | 11 | 17 | 6 |
| 20 | Respondent 20 | 11 | 14 | 3 |
| 21 | Respondent 21 | 15 | 20 | 5 |
| 22 | Respondent 22 | 9 | 17 | 8 |
| 23 | Respondent 23 | 9 | 12 | 3 |
| 24 | Respondent 24 | 11 | 18 | 7 |
| 25 | Respondent 25 | 7 | 12 | 5 |
| 26 | Respondent 26 | 10 | 14 | 4 |
| 27 | Respondent 27 | 13 | 17 | 4 |
| 28 | Respondent 28 | 6 | 12 | 6 |
| 29 | Respondent 29 | 12 | 16 | 4 |
| 30 | Respondent 30 | 11 | 19 | 8 |
| 31 | Respondent 31 | 11 | 13 | 2 |
| 32 | Respondent 32 | 13 | 19 | 6 |
| 33 | Respondent 33 | 11 | 15 | 4 |
| 34 | Respondent 34 | 12 | 14 | 2 |
| 35 | Respondent 35 | 13 | 15 | 2 |
| | Average | 11.05714286 | 15.45714286 | 4.4 |

Based on the analysis of student engagement observations, the success indicators have been achieved. However, the improvement from pre-test to post-test during the learning process in Cycle I did not meet the success criteria. Therefore, this classroom action research will continue to Cycle II. During the planning stage of Cycle II, adjustments were made to the lesson plans (RPP) based on the reflections from Cycle I. From Cycle I reflections, it was identified that the learning process was ineffective when each student individually accessed the AR media on their own devices. Hence, in the lesson plans for Cycle II, group discussions were emphasized, with each group using only one device to access the AR media.

The research continued to the implementation stage in Cycle II, where learning activities using AR media were conducted again. The focus in Cycle II was on student collaboration, where one device was shared among group members to access the AR media. This approach aimed to encourage more effective group discussions and minimize distractions caused by individual smartphone usage. Additionally, the learning process emphasized concept comprehension, as the teacher simultaneously provided direct explanations to the students in a classical setting while they explored the AR media.

Similar to Cycle I, the observation stage in Cycle II involved monitoring student engagement during learning activities. A post-test was also administered during this stage to evaluate the improvement in student learning outcomes compared to Cycle I. Subsequently, the research moved to the reflection stage of Cycle II. During this stage, the results of observations and tests were analyzed. These results were then compared to those from Cycle I to assess the improvement in student learning

outcomes after using AR media. The observation results of student engagement in Cycle II are presented in the following table.

**Table 3**. Observation Results of Student Engagement in the Cycle II

| No. | Aspect | Indicator | Percentage | |
|---|---|---|---|---|
| | | | Yes | No |
| 1. | Engagement in Learning | Students appeared enthusiastic while listening to the teacher's explanation. | 91% | 9% |
| | | Students actively participated in discussions and group activities. | 91% | 9% |
| | | Students followed the teacher's instructions in using the learning media | 100% | 0% |
| 2. | Discipline and Cooperation | Students were able to carry out the teacher's instructions without delay. | 100% | 0% |
| | | Students were able to cooperate with their group members. | 97% | 3% |
| 3. | Expressing and Responding to Opinions | Students were able to express their opinions effectively. | 91% | 9% |
| | | Students were able to respond to their peers' opinions effectively. | 80% | 20% |
| 4. | Reflection and Self-Evaluation | Students were able to identify the aspects they have understood and the areas that still need improvement. | 100% | 0% |
| | | Students expressed the aspects they found interesting about the topic studied after the learning activities concluded. | 100% | 0% |

The results of the concept comprehension test in Cycle II are presented in the following table.

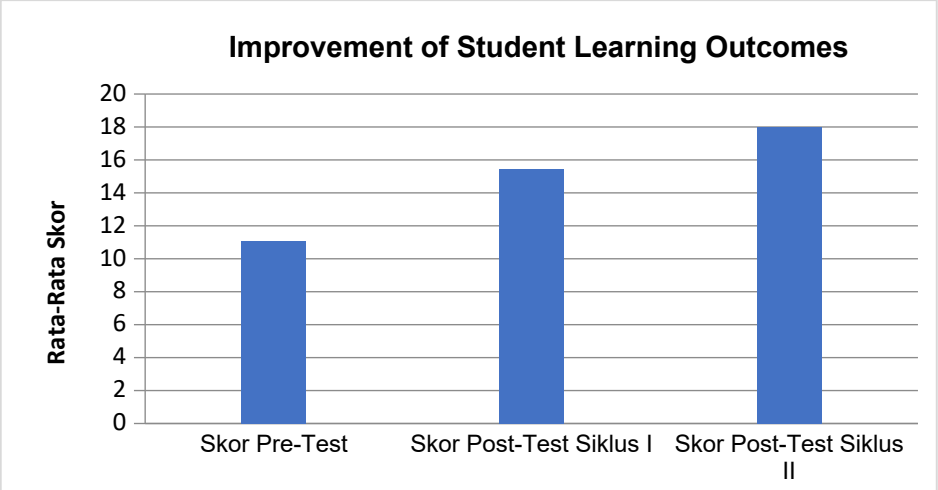
**Tabel 4**. Pre-Test and Post-Test Results for Cycle II

| No | Students Name | Pre-Test Score | Post-Test Score | Improvement |
|---|---|---|---|---|
| 1 | Respondent 1 | 11 | 19 | 8 |
| 2 | Respondent 2 | 10 | 20 | 10 |
| 3 | Respondent 3 | 14 | 20 | 6 |
| 4 | Respondent 4 | 12 | 15 | 3 |
| 5 | Respondent 5 | 8 | 17 | 9 |
| 6 | Respondent 6 | 12 | 19 | 7 |
| 7 | Respondent 7 | 8 | 19 | 11 |
| 8 | Respondent 8 | 14 | 20 | 6 |
| 9 | Respondent 9 | 12 | 20 | 8 |
| 10 | Respondent 10 | 12 | 16 | 4 |
| 11 | Respondent 11 | 9 | 16 | 7 |
| 12 | Respondent 12 | 9 | 15 | 6 |
| 13 | Respondent 13 | 12 | 19 | 7 |
| 14 | Respondent 14 | 13 | 18 | 5 |
| 15 | Respondent 15 | 13 | 19 | 6 |
| 16 | Respondent 16 | 12 | 18 | 6 |

| | | | | |
|---|---|---|---|---|
| 17 | Respondent 17 | 5 | 17 | 12 |
| 18 | Respondent 18 | 16 | 18 | 2 |
| 19 | Respondent 19 | 11 | 19 | 8 |
| 20 | Respondent 20 | 11 | 19 | 8 |
| 21 | Respondent 21 | 15 | 20 | 5 |
| 22 | Respondent 22 | 9 | 20 | 11 |
| 23 | Respondent 23 | 9 | 17 | 8 |
| 24 | Respondent 24 | 11 | 20 | 9 |
| 25 | Respondent 25 | 7 | 15 | 8 |
| 26 | Respondent 26 | 10 | 19 | 9 |
| 27 | Respondent 27 | 13 | 20 | 7 |
| 28 | Respondent 28 | 6 | 11 | 5 |
| 29 | Respondent 29 | 12 | 16 | 4 |
| 30 | Respondent 30 | 11 | 19 | 8 |
| 31 | Respondent 31 | 11 | 16 | 5 |
| 32 | Respondent 32 | 13 | 20 | 7 |
| 33 | Respondent 33 | 11 | 17 | 6 |
| 34 | Respondent 34 | 12 | 19 | 7 |
| 35 | Respondent 35 | 13 | 18 | 5 |
| | Rata-Rata | 11.05714286 | 18 | 6.942857143 |

The post-test results in Cycle II indicate an improvement of 6.9 points, and all students achieved scores above the minimum mastery criterion in the concept comprehension test. Additionally, observation results show that 91% of students demonstrated active engagement during the learning process, indicating that the success criteria have been met, and the cycle can be concluded. The improvement in student learning outcomes on the solar system and eclipse topics assisted by Augmented Reality-based media can be observed in the following graph.

**Graph 1**. The Improvement of Student Learning Outcomes




In Cycle I, AR-based learning was implemented using the discovery learning model. Observations indicated that students were more actively engaged in learning compared to the previous conventional methods. Students showed greater interest in

exploring materials independently with the help of AR; however, several challenges were identified, such as individual device usage that hindered interaction among students. This limitation disrupted group discussions that could have enriched collective conceptual understanding. Based on the results of pre-test and post-test in Cycle I, the average score increased from 11.06 to 15.46, with an average improvement of 4.4 points. Despite this improvement, the results did not meet the predetermined success criteria, and thus the learning process was continued to Cycle II with strategic adjustments.

In Cycle II, strategic adjustments were made by limiting AR usage within group discussions to enhance interaction among students. With this strategy, students no longer focused solely on their individual devices but instead engaged more in discussions and shared their understanding with peers. Furthermore, the teacher provided more direct explanations to ensure better comprehension, especially for students who struggled to interpret information from AR. Observations showed an improvement in group interaction and deeper conceptual understanding compared to the previous cycle. This was also reflected in the pre-test and post-test results, where the average pre-test score of 11.06 increased to 18 in the post-test, with an average improvement of 6.94 points. The improved strategies in Cycle II proved to be more effective in enhancing student learning outcomes. These findings align with the research by Sari and Pratama (2023), which highlighted the positive impact of visual media, such as board games, on students' understanding of solar system concepts. However, this study is more specific as it utilizes AR, which offers a more interactive and immersive learning experience.

In addition to the improvement in learning outcomes, student engagement also showed significant development from Cycle I to Cycle II. In Cycle I, some students were still passive in discussions and lacked confidence in expressing their opinions. However, after strategic adjustments, Cycle II showed improvements in engagement indicators such as active participation in discussions, the courage to answer questions, and the ability to articulate opinions. Students became more enthusiastic about participating in learning activities and demonstrated better critical thinking skills. This indicates that the implemented strategies not only impacted academic comprehension but also developed students' social skills in communication and collaboration. These findings also support research by Koumpouros (2024), which found that AR can enhance interaction, collaboration, and learning enthusiasm among students. However, this study introduces a new dimension by highlighting the importance of collaborative learning strategies to optimize AR usage.

Based on student reflections and observations, the use of AR in learning has shown positive effects in increasing motivation and engagement. Most students felt that the learning process was more enjoyable and interactive. However, technical challenges, such as connectivity issues when using AR, remain obstacles that need to be addressed. Research conducted by Dilmen & Atalay (2021) similarly highlighted such challenges in AR implementation for learning. However, this study offers concrete solutions to address these issues, such as ensuring infrastructure readiness and appropriate classroom management strategies. This provides new insights compared to previous studies that focused more on AR content design without addressing classroom implementation.

Overall, this study demonstrates that AR has great potential to improve learning outcomes, engagement, and students' social skills. However, its implementation must be supported by meticulous planning, adequate infrastructure, and appropriate teaching strategies. Thus, AR can become an effective innovation to enhance the quality of learning in elementary schools.

## CONCLUSION

Based on the results of the classroom action research conducted, it can be concluded that the use of Augmented Reality (AR) media in teaching eclipse and solar system topics successfully improved the learning outcomes and engagement of sixth-grade students at SDN 2 Palembang. This improvement is evident from the significant difference between pre-test and post-test results in Cycle I and Cycle II, where the strategies applied in Cycle II were more effective in enhancing conceptual understanding. Additionally, the use of AR had a positive impact on students' learning motivation, making the learning process more interactive and improving their social skills through group discussions. This demonstrates that AR-based learning combined with group discussion strategies and direct teacher guidance can be an effective solution to enhance students' conceptual comprehension.

As a recommendation, the implementation of AR technology in learning should be supported by adequate infrastructure, such as a stable internet connection and appropriate devices, so that students can access materials without technical issues that hinder understanding. Furthermore, the learning strategies employed should strike a balance between independent exploration and group discussions, ensuring that students not only focus on the technology but also develop critical thinking and collaborative skills. Teachers should also provide optimal assistance to ensure that the use of AR truly aids students in comprehending the material effectively. With proper implementation, AR technology has great potential as an innovative medium to improve the quality of learning in elementary schools.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