Augmented Reality-Based Learning Media to Improve Student Motivation and Learning Outcomes

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ABSTRACT

With the rapid advancement of information technology, it does not necessarily correlate with an equally swift increase in students' interest in the learning experience. Students need proper guidance in the use of information technology to enhance their learning interest, and one type of technology that can be utilized is Augmented Reality (AR). By employing Augmented Reality, it is possible to boost students' interest in the learning experience. In this study, the Action Research (PTK) method is employed to assess students' learning interest using AR technology.The research reveals an improvement in students' scores in the first cycle, with the initial cumulative score of 35% increasing to 40%. Chemistry is chosen as the subject for this study because students tend to achieve lower scores when working on assignments or exams without the integration of information technology in the instructional media.The study emphasizes the significance of incorporating technology, particularly Augmented Reality, to elevate students' learning experiences. In an era marked by the swift evolution of information technology, this research aims to bridge the gap between technological progress and the enhancement of students' learning interests.

1. INTRODUCTION

Currently, the use of information technology has developed rapidly. One study (Marryono Jamun, 2018; Subagio and Limbong, 2023) states that the integration of technology into education involves incorporating technological elements into classroom activities. There are several important points in enhancing learning motivation (Marlina et al., 2021), one of which is the selection of appropriate learning media by teachers, which is consistent with this research. However, the implementation of technology does not always have a positive impact. There are also other effects of technology implementation such as changes in student behavior. Therefore, teachers still need to control the use of technology (Maritsa et al., 2021; Pratama and Rahman, 2023; Sofyan and Hidayat, 2022).This research explores one of the creations in information technology that can be used in the field of education, one of which is Augmented Reality (AR). AR is a technology that displays objects in three-dimensional or two-dimensional form using a medium called a marker and presents the appearance of objects through a mobile phone. Thus, students can see the appearance of objects directly through their mobile phones, which is not only more practical but also safer for students to observe potentially dangerous objects in the real world.The characteristics of augmented reality media itself are suitable for application in chemistry lessons (Awalia Lesmana et al., 2021; Hikmah et al., 2022; Sagita Nurillah and Kharisma Purwanto, 2023), especially in the topics of elements, compounds, and mixtures. Since these topics may not be clear when not portrayed visually,

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augmented reality makes elements, compounds, and mixtures appear real and clear when depicted, thus making it more engaging for students in the classroom. With the use of augmented reality media, students are expected to be more active and interested in chemistry lessons both in the classroom and at home, and the material explained will be delivered effectively.

In several previous studies, the implementation of learning using Augmented Reality has been widely conducted in public schools (Negara and Huda, 2021; Setyawan et al., 2019). However, only a few studies have applied learning using Augmented Reality media to enhance students' understanding of a subject (Mar'atullatifah and Ratnasari, 2023; Sugiharto et al., 2019; Wibowo and Murinto, 2023). Most implementations are only for students with specific special needs. As a result, the learning outcomes, i.e., students' understanding of a subject, tend to be low. This is caused by the lack of teacher creativity in using learning media and the scarcity of references in improving student learning outcomes.The learning outcomes of the students show that 2 students have met the Minimum Mastery Criteria (KKM) and 3 students have not met the KKM. The predetermined KKM is 75. The teacher then seeks the causes of the low learning outcomes of the students. From the teacher's reflection, it is found that the reasons for the low learning outcomes of the students include: the teaching and learning process is still teacher-centered, learning activities are still conducted conventionally, with the teacher mostly using lecture methods and students only playing the role of listeners, causing students to feel bored and become passive.Therefore, the teacher needs to take corrective action to improve students' learning outcomes in chemistry lessons, especially regarding the concepts of chemistry.

This research is inspired by the urgent need to introduce innovative learning approaches to address the challenges of teaching chemistry in secondary schools. The rapid development of information technology has provided new opportunities to enhance teaching quality, and the use of Augmented Reality (AR) is considered as one potential solution. The proliferation of research on the application of AR in various educational contexts indicates that this is not just a trend but also a real potential to improve learning effectiveness.The main objective of this research is to assess the extent to which the use of AR can motivate students, increase their active participation in learning, and ultimately improve their learning outcomes in chemistry. Through the implementation of AR technology, it is expected that students can become more engaged in the learning process, strengthen their understanding of key concepts, and develop critical skills. The results of this research can provide valuable insights for teachers and education policymakers to improve teaching methods and adapt curricula to technological advancements.In this context, it is important to understand that the use of AR is not only to enhance the attractiveness of learning but also to create a dynamic and interactive learning environment. The understanding of chemistry concepts, especially those that are abstract, can be enhanced through the three-dimensional visualization offered by AR technology. For example, subjects such as elements, compounds, and mixtures, which are often difficult to understand through static images, can be explained more clearly and realistically through the use of AR.Also opens up opportunities to detail the characteristics of AR media that are suitable for chemistry learning. By combining technology elements and chemistry learning materials, this research can contribute new knowledge on how to optimally utilize AR technology to enhance students' understanding of complex chemistry concepts. The findings of this research can provide practical guidelines for the development of technology-based curricula and learning at the secondary education level.In pursuing this objective, this research refers to previous studies conducted on the use of AR in learning in public schools. However, the specific focus on enhancing students' success in understanding a subject, particularly in the context of chemistry, makes this research unique. Thus, this research not only contributes to academic literature on the application of AR in education but also provides a specific and relevant contribution to improving student learning outcomes in the context of chemistry education.This research highlights the urgency of using Augmented Reality (AR) in the context of chemistry learning, especially when applied in special needs schools or SLBs. Most previous studies have only focused on the application of AR in public schools, making this research an innovative step that expands the scope of technology use. In facing the unique learning challenges encountered by special needs students, the use of AR can be a more inclusive solution and ensure that all students, regardless of their abilities or special needs, can access and understand

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chemistry materials better.The success of this research also makes a significant contribution to the development of learning methods that are more suitable for the characteristics of students in SLBs. In this context, the research shows that the use of AR can be adapted to present more engaging and relevant materials, even for heavy subjects. Therefore, this research expands our understanding of the potential of AR in supporting the learning of students with special needs, ensuring that this technology is not only widely applied but also provides real benefits across the spectrum of learners.

Additionally, this research also underscores the urgency of exploring further the application of AR in heavy-class materials in chemistry learning in public schools. Subjects considered difficult or complex are often avoided in the implementation of innovative learning technologies. However, this research demonstrates that AR can be an effective tool even for challenging subjects, such as elements, compounds, and mixtures. Therefore, this research not only provides new insights into the use of AR in SLBs but also opens up potential to enhance students' understanding and interest in chemistry materials often deemed difficult in the general education environment.

2. METHOD

This research utilizes the Classroom Action Research (CAR) method with Kurt Lewin's model (Syaifudin, 2021). In this study, the sample used consists of seventh-grade students from SMPLB Bondowoso. These students were chosen because they are the group that will be the subject of the research in implementing the Classroom Action Research (CAR) method with Kurt Lewin's model. The sample was deliberately selected (purposive sampling) because their presence in the class is relevant to the research objectives. In this Figure 1, the integration of tablet devices with augmented reality technology is evident. Students utilize the tablets to engage with educational content in an interactive and immersive manner. The markers or indicators serve as triggers for the augmented reality elements, allowing students to visualize and interact with digital overlays superimposed on physical objects or scenes. This setup facilitates a dynamic and engaging learning experience, where students can explore abstract concepts with the aid of digital simulations and visualizations. Additionally, the use of tablets offers flexibility and mobility, enabling students to access educational content from various locations within the classroom or learning environment. Overall, this integration of technology enhances the learning process by providing students with hands-on experiences and opportunities for active participation in their education.

Figure 1. Using Tablet with Marker for Chemical Augmented Reality

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Figure 2 showcases the implementation of Augmented Reality (AR) in the educational setting, highlighting the use of AR technology as a tool to enhance the learning experience. In this study, the instruments utilized encompass several key elements. Firstly, the teacher develops a learning scenario based on identified issues, employing the CAR Method (Collaborative Action Research) supported by Augmented Reality media. This approach allows for collaborative problem-solving and active participation among students, fostering a dynamic learning environment.Subsequently, the teacher designs the Learning Implementation Plan (RPP) for cycles I and II, which encompass strategies, materials, and media to be utilized throughout the learning process. The integration of Augmented Reality into the RPP enhances engagement and comprehension by providing interactive digital content that supplements traditional teaching methods.Data analysis techniques in this research are conducted through four main steps. Firstly, in the planning stage, the teacher prepares learning scenarios and RPP for each cycle, with a focus on incorporating Augmented Reality media. Secondly, during the action implementation stage, the teacher conducts simulations according to the prepared plan, facilitating hands-on learning experiences for students.Thirdly, in the observation stage, assessments of students' understanding of the material and their skills are conducted during discussions, with a particular focus on monitoring improvements resulting from the use of methods supported by Augmented Reality media. This iterative process allows for real-time adjustments and improvements to teaching strategies.Lastly, in the reflection stage, after the learning session is completed, the teacher evaluates the strengths and weaknesses of the teaching methods, identifying positive and negative aspects of the implementation of each cycle. These reflections serve as the basis for redesigning cycle II, with an emphasis on enhancing teaching effectiveness based on experiences gained from the previous cycle.Overall, the systematic integration of Augmented Reality into the action research process enhances student engagement, comprehension, and retention of educational content, ultimately leading to more effective teaching and learning outcomes.

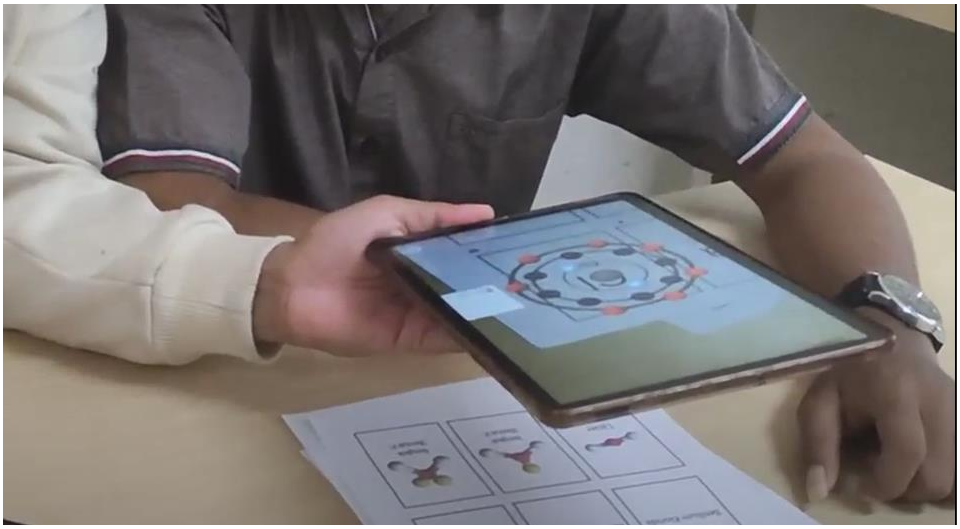

Figure 2. Augmented Reality Implementation on Learning

Figures 3 and 4 visualize Kurt Lewin's model in Cycles I and II, aiding in understanding the research process graphically. In this research model, several actions will be taken as indicated in the diagram below. It will be divided into two cycles, with the first cycle completed before proceeding to the second cycle.

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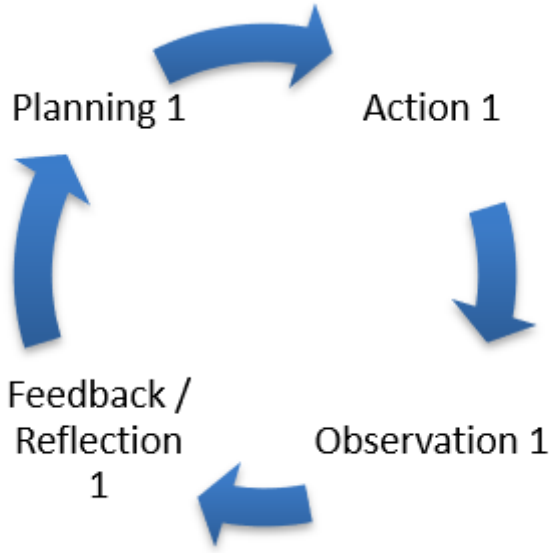

Figure 3. Kurt Lewin's Model in Cycle I

In Figure 3, the model used in this research is depicted. The first step undertaken is the planning process. Educators initiate the initial phase by drafting learning scenarios planned to be executed based on identified issues, utilizing the Discovery Learning Method supported by Augmented Reality media. Additionally, teachers formulate classroom action plans and design the Learning Implementation Plan (RPP) for Cycle I. The second step is the implementation process. On Monday, November 6, 2023, action implementation took place in the seventh-grade class of SMPLB Bondowoso using the Discovery Learning Method supported by Augmented Reality and delivering content on Elements, Compounds, and Mixtures. Also, media such as PowerPoint slides and evaluations through quiz tests were utilized. The teacher conducted activities according to the syntax, with the following sequence: introduction, core, and closing activities. The third step is observation, where assessment of students involves evaluating their understanding of the material and their skills during discussions. The fourth step is reflection. After the learning process is completed, the teacher conducts reflection to evaluate the strengths and weaknesses during the implementation of the teaching method. The reflection results from Cycle I serve as the basis for redesigning Cycle II. Analysis is performed on student activities, teacher performance, and learning outcomes from Cycle I, which then identify the strengths and weaknesses of that cycle. These findings serve as valuable experiences and crucial considerations in the planning and implementation of Cycle II. The implementation of Cycle II is illustrated in Figure 4.

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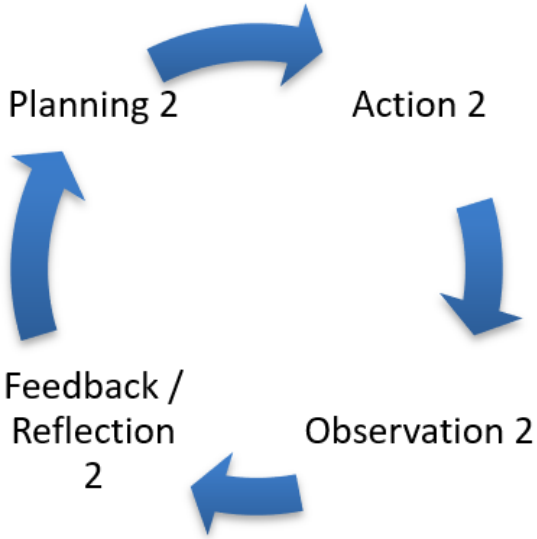

Figure 4. The Kurt Lewin Model in Cycle 2

In the implementation of Cycle II, while still adhering to the Kurt Lewin model, a further research process is conducted. The first step is planning. Activities at this stage begin with the planning of learning scenarios by the teacher, which will be executed based on the encountered issues. Supported by Augmented Reality media, and the formulation of classroom action plans in the form of the Learning Implementation Plan (RPP), are the main focus in the simulation of Cycle II's learning. Preparation of instructional media, such as printed books, laptops, projectors, and worksheets, is also arranged. During the observation in Cycle II, the researcher will oversee improvements arising from the use of methods supported by Augmented Reality media. In Cycle II, the emphasis on improving teaching will be focused based on the experiences gained from Cycle I. The second step is action implementation. In the execution of action, the teacher conducts the learning implementation phase by running simulations according to the detailed activities outlined in the learning implementation plan. The third step is observation, which involves assessing students' understanding of the material and their skills during discussions. The fourth step is reflection. After the learning session is completed, the teacher reflects on the activities to evaluate the strengths and weaknesses during the implementation of the teaching method. After analyzing student activities, teacher performance, and learning outcomes from Cycle II, the next step is to identify the positive and negative aspects of the implementation of that cycle.

3. RESULTS AND ANALYSIS

In this research, there are several references that refer to the use of Augmented Reality, as shown in Table 1. There are two fundamental differences between these references: the type of user target and the different research methods. Based on these previous research references, there is a gap between the studies, namely that the research was not conducted by teachers directly involved in the existing classroom. Therefore, the assessment process was based only on a few trials and was not conducted over one semester of teaching.

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Table 1. The Differences Among Several Studies

Indikator	(Wibowo and Murinto, 2023)	(Setyawan et al., 2019)	Penelitian Saat Ini
Type of media	Augmented Reality	Augmented Reality	Augmented Reality
Target users	Students of SLBN B	Student of Elementary School	Students of SMPLBN
Research method	Multimedia Development Life Cycle	Borg and Gall	Classroom Action Research model Kurt Lewin
Subject used for the study	Not specified	Natural Science	Chemistry

3.1. Pre-cycle Student Learning Outcomes

During the pre-cycle phase of the learning process, it was identified that a total of 3 students obtained scores below the Minimum Completion Criteria (KKM), which is 75 as indicated in Table 2. Out of a total of 5 students, 2 students met the KKM, while the remaining 3 students did not meet the KKM. Based on these findings, the teacher deemed it important to make improvements in the learning process through the implementation of Cycle I and Cycle II in the science subject, focusing on the topics of elements, compounds, and mixtures. During the pre-cycle phase, the teacher tended to apply lecture-based methods more frequently as a teaching approach and did not sufficiently activate student participation in the learning process, which was teacher-centered.

Table 2. Pre-Cycle Student Learning Outcomes

No	Student Name	Pre-Cycle Learning Outcome	Remarks
1	AAC	75	Passed / met KKM
2	SDY	83	Passed / above KKM
3	RZ	55	Not Passed / below KKM
4	SNS	62	Not Passed / below KKM
5	NNS	67	Not Passed / below KKM

Figure 5 is a bar chart representing the learning outcomes of students before the implementation of the Classroom Action Research method with the Kurt Lewin model using two cycles supported by Augmented Reality media. Out of a total of 5 students, only 35% of students obtained scores above the Minimum Completion Criteria (KKM).

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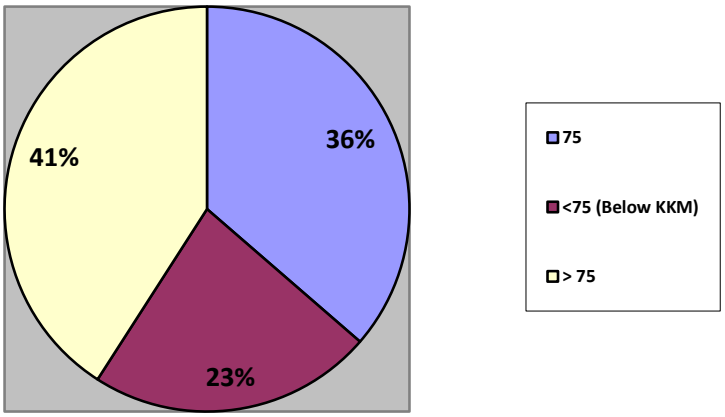

Figure 5. Pre-cycle Student Learning Outcomes

3.2. Student Learning Outcomes Cycle 1

In the first cycle, or the initial cycle with the support of Augmented Reality media, it is important for the teacher to have a good understanding and skills in implementing the learning model correctly. Then, the results obtained in the first cycle after the teacher provided understanding using Augmented Reality media, there was a change in student learning outcomes as shown in Figure 6.

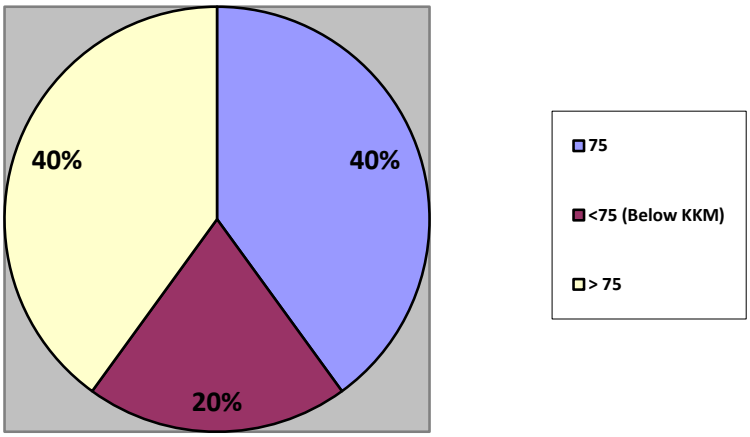

Figure 6. Student Learning Outcomes Cycle 1

The percentage of students who obtained scores above the Minimum Completion Criteria (KKM) increased to 40%. Table 3 shows the students' scores, and there was also a significant increase in the number of students who obtained scores below KKM. Only 2 students remained with scores below KKM, while the other 3 students achieved scores above KKM. Thus, there is a significant progress in the number of students who obtained scores above KKM.

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Table 3. Student Learning Outcomes Cycle 1

No	Student Name	Cycle 1 Learning Outcome	Remarks
1	AAC	78	Passed / above KKM
2	SDY	85	Passed / above KKM
3	RZ	60	Not Passed / below KKM
4	SNS	67	Not Passed / below KKM
5	NNS	75	Passed / above KKM

3.3. Student Learning Outcomes Cycle 2

After the successful completion of Cycle I, as indicated by the changes in students' scores both below and above the KKM, the process continues to Cycle II. This cycle shares similarities in the implementation of Augmented Reality, but it is emphasized more on students who are already familiar with Augmented Reality technology. The learning process becomes faster and easier because the teacher does not need to reintroduce the technology used. The results of the assessment for Cycle 2 are shown in Figure 7.

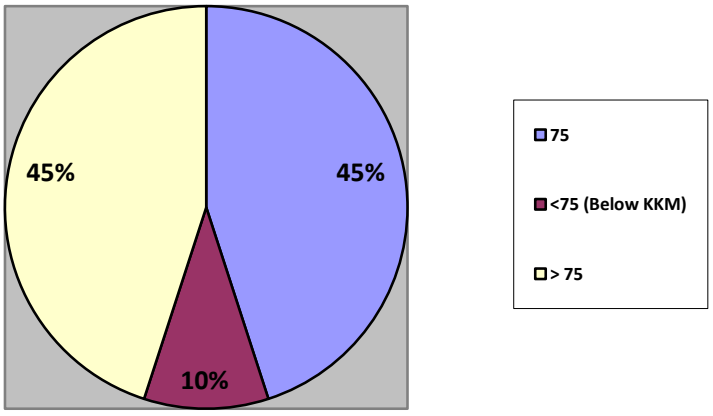

Figure 7. Student Learning Outcomes Cycle 2

Based on Figure 7, the breakdown is provided in Table 4. Where the number of students who obtained scores below KKM decreased by 10% or a total of 1 person, and students who obtained scores above KKM became 45% or two people, but there are two other students who obtained scores at KKM.

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Table 4. Student Learning Outcomes Cycle 2

No	Student Name	Cycle 2 Learning Outcome	Remarks
1	AAC	80	Passed / above KKM
2	SDY	90	Passed / above KKM
3	RZ	65	Not Passed / below KKM
4	SNS	75	Passed / at KKM
5	NNS	75	Passed / at KKM

Some previous studies, such as (Trihartoto, 2020), which used image media, the level of success achieved was not as rapid as in the use of augmented reality media. In this study, there was a significant improvement in learning chemistry subjects. Besides, the object of study was different because this research emphasized more on children with special needs. It required different time and techniques for assessment. However, the use of augmented reality media can improve the scores of children with special needs in learning chemical compounds.

4. CONCLUSION.

The use of the PTK model by Kurt Lewin combined with augmented reality media can enhance students' understanding of chemical compounds, especially in this study conducted on children with special needs who require different delivery methods and teaching processes. However, the results show an improvement in students' capacity, where at the beginning of the pre-cycle, it was 25%, reduced to only 10% in the assessment results in Cycle II. Thus, the conclusion of this study suggests that not only the selection of methods and models but also the learning media play a significant role in determining students' learning outcomes.

5. DECLARATION OF COMPETING INTEREST

We declare that we have no conflict of interest.

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