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The Influence of Augmented Reality (Ar) Media on The Learning Outcomes of SMP Negeri 2 Woha Students in Ict Subjects

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A B S T R A C T

The advancement of digital technology in education demands innovative approaches that not only assess learning outcomes but also enhance students' motivation. At the junior high school level, ICT subjects are often perceived as challenging, with many students performing below the minimum standard, particularly in practical skills, and showing low interest in conventional methods. This study aimed to investigate the effect of Augmented Reality (AR) media on students' learning outcomes and motivation in ICT at SMP Negeri 2 Woha. A quantitative approach with a quasi-experimental Non-Equivalent Control Group Design was applied, involving two classes of 30 students each. The experimental class received learning with AR media, while the control class continued with conventional methods. Data were collected through pretests, posttests, questionnaires, and observations, then analyzed using SPSS and JAMOVI. The findings showed that the experimental class achieved an average posttest score of 85.4 with a medium N-Gain of 0.54, while the control class only reached 75.2 with a low N-Gain of 0.22. Moreover, motivation in the AR class was higher (average 4.38) than in the control class (3.15). In conclusion, AR media effectively supported ICT learning and can serve as an innovative tool for fostering 21st-century skills.

1. Introduction

ICT learning at the junior high school (SMP) level faces a major challenge related to how teaching materials can be effectively absorbed by students who are now living in the digital era. The urgency of this research arises from the rapid development of technology and the demands of 21st century competencies, including technological literacy, creativity, and problem-solving, which demand more interactive and contextual learning methods (Huang, 2024; M. S. Ramadhan et al., 2024). Traditional learning media such as slides, textbooks, and lectures are increasingly less able to accommodate the needs of students with visual, kinesthetic, and auditory learning styles, especially in subjects that contain many abstract concepts or practicums such as ICT. Augmented Reality (AR) offers a potential solution by combining the real world and virtual elements to enhance the student learning experience (Candido, 2025; Gandolfi, 2025; Taufik Hidayat & Jayasri, 2024) Thus, the study on the influence of the use of AR media on student learning outcomes in ICT is not only relevant but urgently implemented in the junior high school environment as an effort to improve the quality of education.

Specific research problems arise from preliminary reports and data that show that the average learning outcomes of SMP Negeri 2 Woha students in the subject of Information and Communication Technology are still below the minimum learning completeness standards set by the school/curriculum. For example, based on the last mid-semester evaluation, as many as 60% of students have not achieved a score of ≥ 75 (KKM), the average grade of the class is 68.2, and the practical skills aspect shows a lower score than the theoretical aspect (for example, practice: average 65, theory: average 70). This problem is exacerbated by students' low motivation towards the use of passive media, as well as the lack of student interaction with practicum ICT materials. National data shows that the adoption of digital media for learning in junior high schools in areas outside large cities is still limited, both in terms of infrastructure and teacher competence (Center for Data and Information Technology, 2025) for example, the percentage of junior high schools that have AR/VR-enabled devices and a stable internet network for digital learning media is still below 40%. The results of initial observations at SMP Negeri 2 Woha show the following.

Based on the results of the analysis, the theoretical aspect (ICT material) showed an average score of 70.5% with 45% of students having not reached the KKM, which indicates that the understanding of basic concepts is still lacking, especially in the aspect of software and hardware operation. In the practicum aspect, the average score only reached 62.3% with 65% of students not meeting the KKM, so it can be seen that students have difficulty following the practicum procedure without the help of interactive visual media. Meanwhile, from the results of the questionnaire, it is known that around 55% of students feel bored or lack interest in the learning media currently used, which indicates low motivation to learn. The interpretation of the data shows that although some students already understand the basic theory, the application/practicum aspect and learning motivation are the main obstacles. The imbalance between theory and practice, as well as the low interest in conventional learning media, signals the need for innovative interventions that support active learning and conceptual visualization.

The problem-solving model proposed in this study is the use of Augmented Reality media as a learning medium in ICT classrooms. AR allows for the integration of three-dimensional virtual objects and real interaction in the student learning process, so that students can visually see practicum demonstrations, perform simulations, and engage directly in previously abstract concepts. The learning model used as a reference is the Experiential Learning Model combined with Multimedia Learning Theory and the Constructivist approach, which supports that students learn better when they actively build understanding through observation, experimentation, and reflection. This model is also adapted to the Blended Learning and Immersive Learning approaches, which have recently been widely researched as an effective framework in the use of AR/VR in the classroom (R. Ramadhan et al., 2025; Sukmandhani et al., 2023).

Recent state of the art research shows that AR has been applied to various contexts and learning materials in junior high and upper secondary education in recent years with positive results. For example, the study "The impact of augmented reality in learning media at the higher education level" shows that AR can improve student understanding and stimulate students' critical mindset (Promise, 2024). Another study at SMP Negeri 1 Mojokerto City shows that the development of AR media in ICT subjects makes learning more interactive, increases students' attention, and increases interest (Sources, 2025; Sofyan & Dewantari, 2023). On the other hand, a literature study on the use of AR-based LKPD in science materials in junior high school/MTs classes shows that AR media is able to improve concept retention and reduce thermodynamic misconceptions (Winda et al., 2024)(Simpson & colleagues, 2024). However, there have not been many studies that have specifically tested the effect of AR on learning outcomes in ICT subjects at SMP Negeri-2 in the Woha area, with the control of motivation variables and practical aspects.

The novelty of this research lies in the use of AR media with a marker-based tracking approach combined with multifaceted measurement, namely theory, practicum, and learning motivation, which are rarely examined simultaneously. This study applies a quasi-experimental pretest–posttest control group design in the local context of SMP Negeri 2 Woha, supported by recalibrated motivational questionnaires and direct observation of student activities. Based on this, the research problems are: (1) Can AR media improve theoretical learning outcomes in ICT? (2) Can AR media enhance practicum results? (3) Does motivation moderate the effect of AR on learning outcomes? Accordingly, the objectives are to determine the effect of AR media on theory, practicum, and the moderating role of motivation.

2. Methodology

Research Type and Design

This research uses a quantitative approach with a quasi-experimental research method. The design chosen was the Non-Equivalent Control Group Design, which involved two groups of participants, namely the experimental class that was treated using Augmented Reality (AR)-based learning media and the control class that used conventional learning media. The selection of this design was based on the consideration that the researcher did not have complete control in randomizing subjects into groups, but it was still possible to make inferential comparisons regarding the effects of the treatment given (Creswell & Creswell, 2023). The research design used in this study followed the Non-Equivalent Control Group pattern, as shown in Table 1.

Table 1. Research Design (Non-Equivalent Control Group)

Group	Pretest	Treatment	Posttest
Experimental Classes	O_1	X (Learning using AR)	O_2
Control Class	O_3	– (Conventional learning)	O_4

Information:
O_1 and O_3 = Pretest
O_2 and O_4 = Final test
X = Treatment of using AR media in ICT learning

Research Procedure

The research procedure is carried out through six main stages that are systematically arranged to facilitate variable control and validation of research results. The research procedure is carried out through six main stages that are systematically designed to ensure the validity and reliability of the results. At the planning stage, an analysis of ICT learning needs at SMP Negeri 2 Woha was carried out, the preparation of research instruments in the form of learning outcome tests, motivational questionnaires, and activity observation sheets was carried out, then validated by experts and revised according to input. Furthermore, the instruments were tested in small groups outside the experimental and control classes, with validity, reliability, difficulty, and differentiating power analysis using SPSS and the MINISTEP Rasch Model. After that, both research groups were given a pretest to find out the initial ability of equivalent. The next stage is the delivery of treatment, where the experimental class uses the Assemblr EDU app-based AR media, while the control class remains with conventional methods based on lectures and textbooks. After learning, both groups were again given a posttest with the same instrument to measure the improvement in learning outcomes. The last stage is data analysis and reporting using SPSS, JAMOVI, and SmartPLS 4 to assess the influence of treatment and effectiveness of AR media on student learning outcomes.

Subject or Research Participant

The research participants are grade VIII students of SMP Negeri 2 Woha for the 2024/2025 school year. The selection of participants was carried out by purposive sampling technique, based on the consideration that both classes had a relatively similar number of students, were taught by the same teacher, and had comparable academic characteristics.

The criteria for participants in this study were determined through inclusion and exclusion requirements to ensure student involvement in accordance with the needs of the research. The inclusion criteria include active students who are registered in grade VIII of SMP Negeri 2 Woha, have an attendance rate of at least 80% during the learning process, and are willing to participate in the entire series of research from start to finish. Meanwhile, exclusion criteria are set to avoid potential bias, namely students who experience serious obstacles in the use of digital devices and students who do not take one of the important tests, both pretest and posttest. Thus, only participants who meet these criteria are involved so that the data obtained is more valid and representative. The characteristics of the research participants between the experimental class and the control class can be seen in Table 2.

Table 2. Participant Characteristics by Group (Experimental vs Control)

Characteristic	Experimental Classes	Control Class
Number of students	30	30
Average age	13.5 years	13.6 years
Gender (L/P)	14 / 16	15 / 15
Teacher	Same	Same
Average pretest score	68,3	68,2

Data Collection Techniques and Procedures

The data collection technique uses a multi-method approach, to ensure that the research results have high validity.

1. Learning Outcome Test) The test form is in the form of multiple-choice questions with five answer options, so that students can choose the answer that is considered most appropriate.
   b) This test is used to measure students' mastery of ICT theory and practice, covering aspects of concept understanding and application ability in practicum activities.
2. The Learning Motivation
   Questionnaire a) Compiled using a Likert scale of 1–5, where a score of 1 indicates the lowest level of motivation and a score of 5 indicates the highest level of motivation. This scale includes aspects of intrinsic motivation (internal motivation) and extrinsic motivation (external motivation).b) Instrument validation was carried out through Confirmatory Factor Analysis (CFA) with the help of SmartPLS software, to ensure that each indicator actually measures the motivation construct in question.
3. Activity Observation Sheet) Serves to record the level of participation and activeness of students during the learning process using AR media, such as interaction, attention, and involvement in class activities.b) The data obtained is analyzed using NVivo software, so that student learning behavior patterns can be mapped systematically and in-depth.

Data Collection Instruments

The research instruments were compiled based on the Revised Bloom Taxonomy. Total number of questions = 20 questions (4 indicators × 5 questions).

Data Analysis Techniques

Data analysis is carried out in stages to ensure reliable and valid results. Details of the research instruments used along with their validity and reliability tests are presented in Table 3.

Table 3. Data Collection Instruments and Measurement Details

Stages of Analysis	Statistical Test	Software Used	Purpose
Instrument validity & reliability test	CFA, Cronbach Alpha, Rasch Model	SPSS, MINISTEP, SmartPLS 4	Ensuring the instrument is valid and reliable
Data normality test	Kolmogorov-Smirnov / Shapiro-Wilk	SPSS, JAMOVI	Ensure data is distributed normally
Homogeneity test	Levene's Test	SPSS	Knowing the similarities of variance between groups
Main hypothesis test	Independent Sample T-Test	SPSS, JAMOVI	Comparing the differences in learning outcomes between the two groups
Analysis of improved learning outcomes	N-Gain Score	SPSS, Excel	Measuring the effectiveness of AR learning
Qualitative analysis of learning activities	Coding Analysis	NVivo	Mapping patterns of student interaction and participation

3. Results and Discussion

Description of Class Conditions

The research was conducted with grade VIII students of SMP Negeri 2 Woha during the 2024/2025 academic year. Two classes were involved, each consisting of 30 students, resulting in a total of 60 participants. The experimental class consisted of 14 male and 16 female students, while the control class consisted of 15 male and 15 female students. The average age of participants was approximately 13.5 years in both classes. Importantly, both groups were taught by the same teacher to minimize bias in teaching style. Based on school records, both classes also demonstrated similar academic performance before the intervention, with comparable pretest averages. Prior to this research, teaching in ICT subjects largely relied on conventional methods, such as lectures and textbooks, which limited opportunities for interactive engagement.

Media Used in the Experimental Class

The experimental class utilized AR-based learning through the Assemblr EDU application. This application allows teachers and students to interact with three-dimensional visualizations of ICT hardware and software components. For instance, students could manipulate virtual objects such as computer parts, observe how networks are configured, and practice interactive procedures that would otherwise be difficult to demonstrate in a regular classroom. Through this approach, abstract theoretical concepts were transformed into concrete learning experiences, and practicum procedures became more engaging and easier to follow. The AR-based learning media used has a simple and interactive initial appearance, as seen in Figure 1

Figure 1. Media Ar Prefix Display

Figure 1 shows the initial view of the Augmented Reality (AR)-based learning media used in this study. On the home screen, students are introduced to the simple and user-friendly *interface of the Assemblr EDU* application , making it easier for them to start the learning process. This view serves as a gateway to interactive learning content, where students can choose a three-dimensional material or object they want to learn. The attractive initial design also aims to increase students' curiosity while creating a more enjoyable learning atmosphere. Additionally, the clear navigation feature helps students understand the flow of using the app without having to get a lot of direction from the teacher. This initial view not only serves as an opening page, but also as a key link to a more immersive technology-driven learning experience. With this display, students can feel the nuances of digital learning from the beginning, which distinguishes the learning process from conventional methods. Therefore, Figure 1 is an important representation of how AR was introduced as an innovative medium in the classroom. In addition, the AR camera feature for scanning markers is shown in Figure 2.

Figure 2. Ar Camera Display

Figure 2 shows the camera view in an AR application that is used to scan markers or markers as a trigger for three-dimensional object visualization. At this stage, students are directed to point their device's camera at a specific marker that has been provided by the teacher. Once the marker is detected, virtual objects in the form of computer hardware components or illustrations of other ICT materials appear on the screen interactively. This camera feature allows for direct integration between the real world and the virtual world, so that students can interact with learning objects in a more real way. It also provides an immersive learning experience, where students can rotate, zoom in, or view details of the objects displayed. Thus, the learning process that was previously abstract becomes more concrete and easy to understand. The function of the camera in AR is not only as a viewing tool, but also as a practicum simulation medium that can replace the limitations of physical tools in schools. Figure 2 shows how AR technology helps students understand ICT concepts in a more visual, contextual, and fun way.

Results

1. Pretest Results

Pretests are carried out in both classes before treatment to find out the initial ability of students. Pretest data were used to ensure the homogeneity of the initial abilities of the two groups. A description of the results of the pretest of both groups of students can be seen in Table 4.

Table 4. Descriptive Statistics of Pretest Scores of Experimental Class and Control Class

Statistics	Experimental Class (AR)	Control Class (Conventional)
N (Number of Students)	30	30
Minimum Score	52	50
Maximum Value	80	78
Red (Average)	68,33	68,20
Std. Deviation	7,25	7,14

Based on Table 4, it can be seen that the pretest values in the experimental class and the control class show a relatively balanced initial condition. The average score of the experimental class was 68.33 with a standard deviation of 7.25, while the control class had an average of 68.20 with a standard deviation of 7.14. The range of minimum and maximum values was also not much different, namely 52–80 in the experimental class and 50–78 in the control class. This indicates that the initial abilities of the two groups are almost the same, so the difference in learning outcomes obtained at the next stage can be more attributed to the learning treatment given. Therefore, normality and homogeneity tests are carried out as a condition of parametric statistical analysis to ensure that the data meet the assumptions required in hypothesis testing. The results of the data normality test using the Shapiro–Wilk method are presented in Table 5.

Table 5. Normality Test Results (Shapiro–Wilk)

Group/Class	p-value	Interpretation
Experimental Class	0.234	Data are normally distributed
Control Class	0.192	Data are normally distributed

Table 5 displays the results of the normality test conducted using the Shapiro–Wilk method to determine whether the data in both groups followed a normal distribution. In the experimental class, the p-value obtained was 0.234, which is greater than the significance threshold of 0.05. Similarly, the control class achieved a p-value of 0.192, which also exceeded 0.05. These results indicate that the distribution of data in both the experimental and control classes did not deviate significantly from normality, meaning the assumption of normality was satisfied. Meeting this assumption is an important prerequisite before conducting parametric statistical tests, as it ensures the validity of inferential comparisons. By confirming that both datasets are normally distributed, the study can proceed to hypothesis testing using t-tests with confidence. Thus, the normality test results provide a solid foundation for subsequent statistical analysis, particularly in evaluating the effect of Augmented Reality (AR) media on student learning outcomes. Furthermore, the results of the homogeneity test with Levene's Test can be seen in Table 6.

Table 6. Homogeneity Test Results (Levene's Test)

Comparison	F Value	p-value	Interpretation
Experimental vs Control Class	0.142	0.708	Variances are homogeneous

Table 6 presents the results of the homogeneity test, which was performed using Levene's Test to evaluate the equality of variances between the two groups. The comparison between the experimental and control classes yielded an F value of 0.142 with a p-value of 0.708. Since the p-value is greater than the significance level of 0.05, it can be concluded that the data variances between the two groups are homogeneous. This finding is critical because the assumption of equal variance must be met for the independent sample t-test to be valid. Homogeneity of variance suggests that differences in the outcomes between the two groups are not influenced by unequal data spread, thereby strengthening the reliability of the analysis. The results also confirm that the experimental and control groups were comparable in terms of variance before the intervention was applied. Therefore, further inferential testing, such as the independent sample t-test, can be performed with assurance that statistical assumptions are satisfied, making the conclusions drawn from the data more robust.

2. Posttest Results

After treatment for four meetings, a posttest was given to measure learning outcomes after the intervention. A summary of posttest data is shown in Table 7.

Table 7. Descriptive Statistics of Posttest Scores of Experimental Class and Control Class

Statistics	Experimental Class (AR)	Control Class (Conventional)
N (Number of Students)	30	30
Minimum Score	70	60
Maximum Value	95	85
Red (Average)	85,40	75,23
Std. Deviation	6,52	7,21

Based on Table 7, there is a striking difference in posttest results between the experimental class and the control class. The experimental class that participated in learning using Augmented Reality (AR) media obtained an average score of 85.40 with a score range of 70–95, while the control class that learned with conventional methods only reached an average of 75.23 with a score range of 60–85. In addition, the standard deviation in the experimental class (6.52) was relatively lower than in the control class (7.21), which indicates that the learning outcomes of students in the experimental class were more even. This data shows that the use of AR media is able to have a positive and significant impact on improving student understanding, making it more effective than conventional learning methods.

3. N-Gain Analysis

The effectiveness of improving learning outcomes was analyzed with N-Gain, as presented in Table 8.

Table 8. N-Gain Analysis Results

Group	Red Pretest	Mean Posttest	N-Gain	Criterion
Experimental Class (AR)	68,33	85,40	0,54	Keeping
Control Class	68,20	75,23	0,22	Low

Based on Table 6, the results of the N-Gain analysis showed that the experimental class obtained a score of 0.54 in the medium category, which indicates that learning using Augmented Reality (AR) media is quite effective in improving student understanding. Meanwhile, the control class only achieved a score of 0.22 with a low category, so it can be concluded that conventional learning methods are less than optimal in providing increased understanding. This difference corroborates the finding that AR media is able to make a more significant contribution to learning outcomes compared to traditional methods.

4. Hypothesis Test (Independent Sample T-Test)

The results of the hypothesis test using the Independent Sample T-Test can be seen in Table 9.

Table 9. t-Test Results

Variable	T-Count	Df	p-value (Sig. 2-tailed)	Conclusion
Posttest Experiment vs Control	5,89	58	0,000	Significant

Based on Table 9, the results of the t-test show that the t-value is 5.89 with a p-value of 0.000, which means it is smaller than 0.05. This confirms that there is a significant difference between student learning outcomes in experimental classes that use Augmented Reality (AR) media and control classes that use conventional learning. Thus, it can be concluded that the application of AR media has proven to be significantly more effective in improving student learning outcomes than traditional learning methods.

5. Learning Motivation Analysis

In addition to measuring learning outcomes, this study also analyzed students' learning motivation through a questionnaire based on the Likert Scale (1–5). The validity and reliability of the questionnaire were tested using SmartPLS 4, with AVE > 0.50 and Cronbach Alpha > 0.70, indicating a valid and reliable instrument. An analysis of student learning motivation between experimental and control classes is shown in Table 10

Table 10. Average Learning Motivation

Motivation Aspect	Experimental Class (AR)	Control Class (Conventional)
Intrinsic Motivation	4,35	3,10
Extrinsic Motivation	4,42	3,20
Total Average	**4,38**	**3,15**

Based on Table 10, it can be seen that students' learning motivation in the experimental class is higher than in the control class, both in intrinsic and extrinsic aspects. The experimental class using Augmented Reality (AR) media obtained an average total motivation of 4.38, with details of intrinsic motivation of 4.35 and extrinsic motivation of 4.42. In contrast, the control class that used conventional methods only achieved a total average of 3.15, with intrinsic motivation of 3.10 and extrinsic motivation of 3.20. This difference shows that the use of AR not only improves learning outcomes, but is also able to encourage more in-depth student engagement. This is in line with Self-Determination Theory which emphasizes that interactive media such as AR can strengthen students' intrinsic motivation through a more active, engaging, and meaningful learning experience (Li, 2025)(Sources, 2025).

Discussion

The results of the study show that the use of Augmented Reality (AR) media has a significant influence on improving student learning outcomes in ICT subjects. This increase is evidenced by the average posttest score of the experimental class of 85,40 with an N-Gain score 0,54 (medium category), higher than the control class which only obtained an average 75,23 with an N-Gain score 0,22 (low category). The results of the t-test also confirmed a significant difference ($p = 0.000 < 0.05$), indicating that AR-based learning is more effective than conventional methods. These findings are consistent with recent research by (Eisenhower, 2023; Simpson & colleagues, 2024) who found that AR-based learning is able to improve students' cognitive engagement through more interactive visual experiences.

The significant differences between the two groups can be explained through Multimedia Learning Theory submitted by (Al-Ansi & Al-Ansari, 2023; Mayer, 2023). This theory emphasizes that conceptual understanding is more optimal if learning combines visual and kinesthetic elements. In the experimental class, students not only hear the teacher's explanations but also interact directly with 3D objects through AR applications, thereby improving information retention and understanding of abstract concepts. Thus, AR functions as a medium that facilitates the transition of concepts from abstract to more concrete, while lowering the cognitive load of students.

In addition, the results of the motivation questionnaire showed that the experimental class obtained an average motivation of 4,38, higher than the control class that only 3,15. This increase occurred in both intrinsic (4.35 vs 3.10) and extrinsic (4.42 vs 3.20) motivation aspects. This proves that AR is capable of creating a fun, interactive, and challenging learning environment, which psychologically triggers students' intrinsic motivation. These findings are in line with research (Editors, 2024; Zhang & colleagues, 2023) which states that AR media has great potential in improving *Student Engagement* and motivation to learn through immersive experiences.

From a practical perspective, the results of this study provide important implications for teachers and curriculum developers, namely the need to integrate AR technology in ICT learning, especially in junior high schools which are still limited in the use of digital media. With the right implementation, AR can become an innovative medium that not only improves learning outcomes, but also develops 21st-century skills such as digital literacy, creativity, and problem-solving. Thus, this study strengthens the argument that AR deserves to be integrated sustainably in ICT learning as a strategy to improve the quality of education.

4. Conclusion

This study concludes that the integration of Augmented Reality (AR) media in ICT subjects at SMP Negeri 2 Woha significantly enhances both student learning outcomes and learning motivation. AR, implemented through the Assemblr EDU application, provides students with interactive experiences that bridge the gap between theoretical understanding and practical application. By engaging directly with 3D visualizations and simulations, students were able to grasp abstract concepts more concretely and perform practicum tasks more effectively. In addition to improving performance, AR also created a more enjoyable and stimulating learning environment, which fostered both intrinsic and extrinsic motivation. These findings reinforce the argument that AR is not merely a supplementary tool but a transformative medium that can reshape ICT education at the junior high school level. Its ability to make learning more interactive, motivating, and effective positions AR as a viable innovation for improving the quality of education and preparing students with the technological literacy demanded by the 21st century. Future research may further explore its scalability in different contexts, including rural schools with limited resources.

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