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Innovation In Learning Media Using An Assemblr Edu–Based Augmented Reality Website On Students' Learning Outcomes

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A B S T R A C T

Twenty-first-century learning requires students to master critical thinking, creativity, collaboration, and technological literacy to face global challenges. However, learning in elementary schools is still largely dominated by conventional methods, which often result in low student engagement and difficulties in understanding abstract concepts, especially in the IPAS subject. This study aimed to examine the effectiveness of an Assemblr Edu–based Augmented Reality (AR) website in improving students' learning outcomes. The research employed a quantitative approach using a pretest–posttest control group design involving two sixth-grade classes at SD Muhammadiyah Program Unggulan Colomadu. Data were collected through learning outcome tests and observation sheets that were validated and tested for reliability. Of the 20 test items, 13 were declared valid, and reliability analysis using Cronbach's Alpha produced a coefficient of 0.936, indicating very high consistency. Statistical tests showed that the use of Assemblr Edu had a significant effect on learning outcomes. The experimental class posttest scores increased from 56.92 to 81.15, while the control class showed a decline. These findings indicate that AR technology provides more concrete, interactive, and meaningful learning experiences for IPAS instruction in elementary schools.

1. Introduction

Twenty-first-century education emphasizes the importance of mastering critical thinking, creativity, collaboration, and technological literacy skills; however, learning in elementary schools is still predominantly teacher-centered, resulting in passive student participation (Syahid et al., 2024). This condition contradicts the Merdeka Curriculum, which prioritizes meaningful and participatory learning experiences. On the other hand, educational technology has been proven to enhance student motivation when appropriately integrated into learning activities (Khoirina

& Adriyani, 2024). Learning that involves concrete visualization is particularly necessary for elementary school students who are still at the concrete operational stage and therefore require digital media support to understand abstract concepts (Egista et al., 2025).

Students often experience difficulties in understanding abstract concepts and tend to be less active during the learning process, indicating the need for more innovative instructional approaches (Dewi 2025). Research by Zhang et al. (2022) demonstrates that Augmented Reality (AR) technology consistently increases student engagement and comprehension, making it highly relevant for supporting twenty-first-century learning demands. These findings are reinforced by Sholicha and Ratnaningrum (2025), who reported that Assemblr Edu–based media demonstrated high validity and effectively improved elementary students' understanding of IPAS content. Furthermore, Muspita and Rodiyah (2022) found that interactive and visually rich learning experiences significantly enhance students' motivation and learning outcomes, particularly at the elementary level (Adinda 2025).

The rapid development of digitalization provides significant opportunities for educational transformation. The integration of technology into learning has been shown to increase student motivation and engagement. According to Khoirina and Adriyani (2024), educational technology innovation is essential to ensure learning remains aligned with contemporary developments. For elementary students, learning tends to be more effective when it incorporates strong visual elements, kinesthetic activities, and direct learning experiences. Augmented Reality (AR) technology offers an alternative by presenting 3D objects that make abstract concepts more accessible to elementary students (Ilham, 2023). The effectiveness of AR has also been observed in science learning, such as significantly improving students' understanding of food chains through visualizing relationships among ecosystem components (Qorimah et al., 2024). These findings confirm the relevance of AR for IPAS learning, which requires strong visual support.

One web-based AR platform that is easily accessible is Assemblr Edu, which allows teachers and students to utilize AR content without requiring specialized devices. Assemblr Edu provides content in the form of 3D models, animations, and interactive simulations that can be integrated into learning materials (Ainulfais & Sari, 2025). The use of AR through Assemblr Edu helps students understand IPAS topics such as human organs, celestial objects, and natural phenomena more concretely. Elementary school teachers perceive AR as effective in attracting students' attention, although technical understanding still needs improvement (Riyantono & Makmur., 2024). In addition, AR-based media have been shown to enhance students' visual-spatial intelligence through direct interaction with three-dimensional digital objects (Anita et al., 2024).

To strengthen the urgency of AR implementation in learning, numerous previous studies have examined its benefits; however, research gaps remain. Although many studies report that AR improves conceptual understanding, several have not comprehensively assessed students' learning experiences, including motivation,

interaction, and learning satisfaction (Nur & Putri, 2023). Learning outcomes should encompass cognitive, affective, and psychomotor aspects to reflect holistic mastery of learning content. Buchori et al. (2023) confirmed that AR media significantly improved students' geometry learning outcomes through realistic 3D interaction. These findings are further supported by Hussein et al. (2023), who reported that QR-based WebAR increased academic achievement and learning interest among elementary students.

Other studies, such as that of Riyantono & Makmur (2024), focused on teachers' understanding of AR media and found that teachers perceived AR as engaging and enjoyable; however, the study did not examine students' learning experiences or outcomes. Similarly, Anita et al. (2024) succeeded in enhancing students' visual-spatial intelligence using AR-based Google Sites but did not assess learning motivation or interaction. Hussein et al. (2023) also confirmed that QR-based WebAR improved elementary students' English achievement, yet it has not been applied to science content requiring more complex visualization. These findings indicate opportunities for further research focusing on the effectiveness of AR in enhancing students' learning experiences and outcomes in IPAS learning (Ratnasari et al., 2022).

Within the context of the Merdeka Curriculum, schools require learning media that support visual and interactive needs, including SD Muhammadiyah Program Unggulan Colomadu. However, learning remains dominated by lecture-based methods, causing students to become easily bored and struggle with abstract IPAS concepts such as the solar system and water cycle (Kurnia et al., 2025). This situation highlights the importance of presenting learning materials concretely to facilitate students' understanding (Hikmah et al., 2023). Additionally, low learning interest and motivation also affect students' learning outcomes, as current learning processes have not fully accommodated the visual and contextual learning needs of elementary students (Pingge & Wangid, 2016).

The lack of innovative learning media makes the learning process less engaging and meaningful for students. Elementary students require concrete, visual, interactive, and enjoyable learning experiences to achieve deep conceptual understanding (Agustin et al., 2025). The use of AR through Assemblr Edu can support this need by providing 3D models that allow students to explore IPAS content more clearly. Research by Swarmahardika and Widiana (2024) indicates that AR-based visualization effectively enhances understanding and learning interest, such as in water cycle topics that become easier to comprehend through interactive displays. Moreover, engaging learning media positively influence students' attitudes and participation during learning, contributing to improved learning outcomes (Nurul et al., 2023). Therefore, this study focuses on the implementation of an Assemblr Edu–based Augmented Reality website in IPAS learning to create more meaningful, engaging, and interactive learning experiences in elementary schools. Additionally, this study aims to quantitatively examine the effectiveness of WebAR by comparing learning outcomes between an experimental group using WebAR and a control group employing conventional methods. Thus, this research not only addresses gaps in previous studies but also provides a tangible contribution to the

development of innovative learning media aligned with twenty-first-century learning demands and the Merdeka Curriculum.

2. Methodology

This study employed a quantitative approach using a pretest–posttest control group design to examine the effect of Website-based Augmented Reality learning media (Assemblr Edu) on students' learning outcomes and learning experiences in the IPAS subject. Two groups were involved in this study: an experimental group that received instruction using Assemblr Edu and a control group that received conventional instruction. Data collection instruments included learning outcome tests (pretest and posttest) to measure the cognitive domain, as well as observation sheets to assess students' engagement and interactivity during the learning process. This experimental approach was selected because it provides strong quantitative evidence regarding the effectiveness of the treatment compared to traditional instructional methods.

The study was conducted at SD Muhammadiyah Program Unggulan Colomadu during the odd semester of the 2025 academic year. The research subjects were sixth-grade students selected through purposive sampling based on the relevance of the learning materials and students' readiness to use digital devices. This sampling technique aligns with Campbell et al. (2020), who stated that purposive sampling is appropriate when researchers require participants with specific characteristics that are most relevant to the research context. Two classes were designated as samples: one class as the experimental group and one class as the control group. This selection was based on technical considerations at the school and the relevance of sixth-grade IPAS content, which involves many abstract concepts requiring concrete visualization. Supporting data were collected through documentation, including photographs of learning activities, students' scores, and instructional process records to strengthen the analysis.

Data analysis techniques included descriptive statistical analysis to describe trends in students' scores, as well as prerequisite tests comprising validity, reliability, normality, and homogeneity tests to ensure the data were suitable for parametric analysis. To test the research hypotheses, an independent samples t-test was used to examine differences in learning outcomes between the experimental and control groups, while a paired samples t-test was employed to analyze improvements in learning outcomes within each group before and after the treatment. The use of these techniques allowed the researchers to obtain a comprehensive understanding of the effectiveness of Assemblr Edu both comparatively and longitudinally.

3. Results and Discussion

At the beginning of the research implementation, Classes VI A and VI B demonstrated relatively balanced characteristics in terms of the number of students, academic abilities, and daily learning dynamics. Each class consisted of 20 students

with an almost equal gender composition: Class VI A comprised 11 male and 9 female students, while Class VI B consisted of 12 male and 8 female students. Both classes had previously participated in IPAS learning using conventional methods, including lectures, question-and-answer sessions, and the use of textbooks as the primary learning resource. Teachers typically relied on simple visual aids, such as textbook images or the whiteboard, to explain abstract material. This condition caused some students to experience difficulties in visualizing concepts related to cultural diversity, particularly when learning about traditional houses, traditional clothing, or regional musical instruments that they had never encountered directly. Consequently, learning activities tended to be passive, with many students waiting for teacher explanations and showing limited interaction.

In addition, initial observations indicated that students in both classes possessed relatively good learning motivation; however, their concentration was easily disrupted when learning activities became monotonous. Several students displayed high enthusiasm when the teacher presented images or videos, yet their interest declined when the material was delivered verbally without strong visual support. Although simple digital devices such as tablets and smartphones were frequently used in school activities, they had not been optimally utilized as learning media for IPAS. This condition provided a strong rationale for testing Augmented Reality (AR) technology. Therefore, both classes were considered suitable to serve as control and experimental groups based on their basic technological skills, stable learning environment, and terachers' readiness to implement innovative instructional strategies.

The implementation of learning using Augmented Reality (AR) media was conducted over two instructional sessions on the topic of "National Cultural Diversity." In the experimental class, the teacher began the lesson with a brief introduction to cultural diversity in Indonesia, followed by an explanation of Assemblr Edu as an interactive visual learning medium. The teacher ensured that each student had access to a device capable of scanning AR codes through the prepared website. This step was essential to confirm technical readiness before students explored the 3D objects. Subsequently, the teacher guided students in accessing AR-based modules displaying three-dimensional models of traditional houses. The first AR object used in this study was a 3D model of the Tongkonan traditional house, featuring its distinctive curved roof and authentic color details.

In the subsequent session, students were directed to study traditional clothing from various regions using AR objects. The second AR image utilized was a 3D model of Balinese traditional clothing, which displayed garment structures, colors, and distinctive ornaments that are difficult to comprehend through two-dimensional textbook images alone. While observing the object, students engaged in increased interaction and discussion regarding differences in traditional clothing, cultural contexts, and symbolic meanings. The teacher facilitated these discussions by providing guiding questions, such as the reasons behind color differences, the functions of specific ornaments, and the relevance of traditional attire to regional cultural identity. Through the AR-based approach, learning became more dynamic, as students experienced a more immersive and realistic visual learning

environment. Through this media, students were able to rotate the model, zoom in on details, and closely observe the structure of the house, thereby making conceptual understanding more concrete, as illustrated in Figure 1.

Figure 1. Trial process of scanning 3D flashcards using Augmented Reality

The use of Augmented Reality media in visualizing Balinese traditional clothing provided students with a more concrete and immersive learning experience. Through the AR display, students were able to observe the structure, color composition, and ornamental details of traditional clothing in three-dimensional form, which are difficult to capture through conventional two-dimensional images. This visualization helped students distinguish regional characteristics more clearly and supported conceptual understanding of cultural diversity. In addition, the interactive features allowed students to rotate and zoom in on the object, encouraging active exploration rather than passive observation. During the learning process, students demonstrated increased curiosity and engagement when interacting with the AR-based clothing model. These interactions indicate that AR media can enhance students' attention and support meaningful learning, as illustrated in Figure 2.

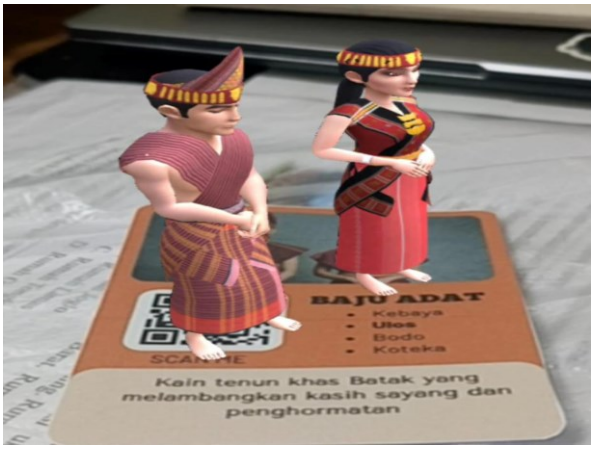

Figure 2. Visualization of traditional clothing flashcards through Augmented Reality

The learning process also incorporated a third AR object in the form of a 3D model of the traditional musical instrument Angklung. This media was used during the elaboration stage to help students identify the instrument's shape, the number of bamboo tubes, and its basic sound-producing principles. When the AR image appeared on their devices, students were able to manipulate the model, observe the bamboo arrangement, and view simple animations demonstrating how the instrument is played. This level of interactivity provided a learning experience that was significantly more engaging than conventional instruction. The teacher then asked students to complete activity worksheets that linked the AR models to the concepts being studied. The use of AR-based media enabled students to absorb visual information more effectively, leading to a noticeable improvement in content mastery, as illustrated in Figure 3.

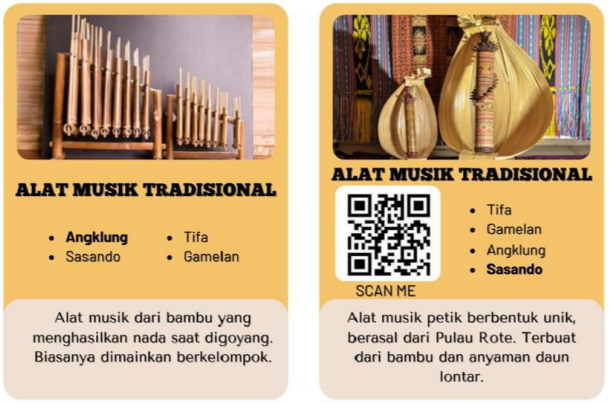

Figure 3. Results of scanning traditional musical instrument flashcards using Augmented Reality

Throughout the learning process, data collection was conducted through classroom observations, documentation of learning activities, and assessment of learning outcomes using posttests. The teacher observed students' levels of participation, enthusiasm, and ability to identify cultural objects using AR media. Observation records indicated that students in the experimental class were more actively involved, more confident in asking questions, and demonstrated higher curiosity compared to those in the control class. In addition, during the AR scanning activities, the researcher collected documentation as evidence of media utilization, including screenshots of AR models, photographs of students interacting with the media, and recordings of classroom activities. After the learning sessions concluded, students completed a posttest consisting of 13 items identical to the pretest, aimed at measuring improvements in understanding following the implementation of AR.

Data collection was also conducted in the control class without the use of AR media. The teacher delivered instruction using lectures and textbooks, as typically practiced. Observation results showed lower student engagement compared to the experimental class, and several students experienced difficulties in visualizing unfamiliar cultural objects. These data served as an important comparison for evaluating the effectiveness of the different treatments applied to each class. Thus, the learning implementation and data collection procedures were conducted in a

structured and systematic manner, ensuring that any changes observed in the experimental class were attributable to the use of AR media rather than external factors.

This study aimed to determine differences in learning outcomes between the experimental class, which received instruction using Assemblr Edu media, and the control class, which was taught using conventional methods. To examine changes in students' abilities before and after the treatment, pretest and posttest measurements were administered in both classes. The comparison of the average pretest and posttest scores of the experimental and control classes is presented in Table 1. The data in Table 1 show that the experimental class experienced a substantial improvement in learning outcomes, while the control class demonstrated a decline in performance.

Table 1. Average Pretest and Posttest Scores of the Experimental and Control Classes

Class	Pretest (Mean)	Posttest (Mean)	Change
Experimental (Assemblr Edu)	56.92	81.15	Increased by 24.23
Control	68.45	60.00	Decreased by 8.46

Based on Table 1, there is a clear difference between the learning outcomes of students in the experimental class and those in the control class. The average pretest score of the experimental class was 56.92, which increased significantly to 81.15 in the posttest, showing an improvement of 24.23 points. This increase indicates that the use of Assemblr Edu media was able to help students understand the learning material more effectively. Interactive and visual learning media enable students to be actively involved in the learning process. In contrast, the control class showed a decline in scores, from an average pretest score of 68.45 to 60.00 in the posttest. This decrease of 8.46 points indicates that conventional learning methods are less capable of maintaining and improving students' understanding. Therefore, the use of Assemblr Edu is proven to be more effective in improving learning outcomes compared to conventional teaching methods.

Validity Test

Before the instrument was used in the pretest and posttest stages, a validity test was conducted to ensure that each test item was truly capable of measuring the competencies under study. The testing was carried out at SD Negeri 1 Gagaksipat involving 33 sixth-grade students and was analyzed using the Pearson Product Moment correlation through SPSS. The calculated r values were then compared with the r table at a 5% significance level. Of the 20 test items analyzed, 13 items were declared valid, while 7 items were excluded because they did not meet the validity criteria. The valid items were used in the main study as they represented the indicators of learning achievement in the cognitive, affective, and psychomotor domains. These results confirm that the test instrument is appropriate for assessing students' learning outcomes before and after the implementation of the Assemblr Edu learning media

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Reliability Test

After obtaining test items that were declared valid through the validity test, the next stage of this study was to conduct an instrument reliability test. The reliability test aims to determine the level of consistency of the instrument in measuring students' abilities repeatedly under relatively similar conditions. A reliable instrument produces stable and trustworthy data, thereby making the research conclusions more accurate. In this study, the reliability test was conducted on all test items that had passed the validity test. Reliability testing is essential because the test instrument is used as the main tool for measuring students' learning outcomes. Therefore, it is necessary to ensure that each test item has good internal consistency. The results of the reliability test are then presented in Table 2 to provide a quantitative description of the instrument's level of reliability.

Table 2. Results of the Reliability Test

Reliability Statistics	Value
Number of respondents (N)	33
Number of items (test questions)	13
Cronbach's Alpha	0.936

Based on Table 2, the results of the reliability test indicate that the instrument consisted of 13 test items administered to 33 respondents. The obtained Cronbach's Alpha value was 0.936, which falls into the category of very high reliability. This value indicates a very strong internal consistency among the test items in the instrument. In other words, each item supports one another in measuring students' overall abilities. The high reliability coefficient suggests that the instrument is capable of producing stable measurement results and is not easily influenced by random factors. Therefore, the instrument used in this study can be considered reliable and suitable as a data collection tool, ensuring that the research findings are trustworthy and scientifically accountable.

Normality Test

The normality test was conducted as an initial stage of analysis to ensure that the research data met the assumption of a normal distribution before performing further statistical tests. Fulfilling this assumption is essential because most parametric statistical tests require normally distributed data for accurate interpretation of results. In this study, the normality test was used to examine the distribution of pretest and posttest scores in both the experimental and control classes. The normality testing was carried out using the Shapiro–Wilk test, as the sample size was fewer than 50 respondents. The decision criterion in this test is that the data are considered normally distributed if the significance value (Sig.) is greater than 0.05. The results of the normality test are presented in Table 3.

Table 3. Results of the Normality Test

Class	Shapiro–Wilk Statistic	df	Sig.
Pretest of Experimental Class A	0.956	20	0.529
Posttest of Experimental Class A	0.948	20	0.341

Pretest of Control Class B	0.926	20	0.128
Posttest of Control Class B	0.926	20	0.128

The results of the normality test indicate that all pretest and posttest data in both the experimental and control groups have significance values above 0.05 and are therefore normally distributed. In the experimental class, the significance value of the pretest was 0.529 and that of the posttest was 0.341, while in the control class, the significance values for both the pretest and posttest were 0.128. These findings confirm that both the initial abilities and the learning outcomes after treatment in the two groups follow a normal distribution. Consequently, the data are appropriate for further analysis using parametric statistical tests.

Homogeneity Test

The homogeneity of variance test was conducted to ensure that the variance distribution of scores between the experimental class and the control class was equivalent before further statistical analysis was performed. Equality of variances is an important assumption in the use of parametric statistical tests, particularly the t-test. In this study, the homogeneity test was carried out using Levene's Test with the assistance of SPSS. This test aims to determine whether the variance differences between groups are statistically significant. The decision criterion in the homogeneity test is that the data are considered homogeneous if the significance value (Sig.) is greater than 0.05. The detailed results of the homogeneity of variance test are presented in Table 4.

Table 4. Results of the Homogeneity Test

Test of Homogeneity of Variance	Levene Statistic	df1	df2	Sig.
Based on Mean	1.058	1	38	0.310
Based on Median	0.882	1	38	0.354
Based on Median (Adjusted df)	0.882	1	37.212	0.354
Based on Trimmed Mean	1.033	1	38	0.316

Based on the results of the homogeneity test presented in Table 4, all calculation bases in Levene's Test—whether based on the mean, median, median with adjusted degrees of freedom, or trimmed mean—show significance values greater than 0.05. Specifically, the calculation based on the mean produced a significance value of 0.310, which meets the criterion for homogeneity of variance. These results indicate that there is no significant difference in variance between the experimental class and the control class. Therefore, it can be concluded that both groups have homogeneous variances. The fulfillment of this assumption confirms that the research data are suitable for further analysis using a parametric *t*-test, allowing the results of the analysis to be interpreted in a valid and accurate manner.

Hypothesis Testing

The Paired Sample t-Test was conducted to determine the difference in the mean pretest and posttest scores within each group, namely the experimental class and the control class. This test was applied because the data were obtained from the

same subjects measured at two different points in time, namely before and after the treatment. The purpose of this analysis was to examine the effectiveness of the treatment in improving students' learning outcomes. The decision criterion for the Paired Sample t-Test is that if the significance value (Sig. 2-tailed) is less than 0.05, there is a significant difference between the pretest and posttest scores. The detailed results of the Paired Sample t-Test analysis are presented in Table 5**.**

Table 5. Results of the Paired Sample t-Test

Paired Differences	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
				Lower	Upper			
Pair 1 (Pretest–Posttest A)	-24.233	20.468	4.577	-33.813	-14.653	-5.295	19	
Pair 2 (Pretest–Posttest B)	8.549	17.453	3.903	0.291	16.627	2.167		

Based on the results of the Paired Sample t-test presented in Table 5, there are significant differences between pretest and posttest scores in both classes. In the experimental class, the mean pretest score of 56.92 increased significantly to 81.15 in the posttest. This result is supported by a Sig. (2-tailed) value of 0.000, which is lower than 0.05, indicating a significant improvement in learning outcomes after the implementation of the Assemblr Edu media. In contrast, in the control class, the mean pretest score of 68.46 decreased to 60.00 in the posttest. The Sig. (2-tailed) value of 0.043, which is also lower than 0.05, indicates a significant difference; however, this difference reflects a decline in learning outcomes. These findings suggest that conventional learning methods are less effective in maintaining and improving students' academic achievement. Overall, the results of this test confirm that the use of Assemblr Edu media has a more positive impact on improving students' learning outcomes compared to conventional learning approaches.

Differences in Learning Outcomes Between Students Who Participate in Learning Using Assemblr Edu and Students Who Learn Through Conventional Methods

Based on the analysis of pretest and posttest scores, a considerable gap can be observed between the two groups. The experimental class that received treatment using AR-based media demonstrated a more stable and evenly distributed improvement in scores. The mean posttest score reached 81.15, showing a substantial increase from the mean pretest score of 56.92. This improvement does not merely reflect a numerical increase but also represents a qualitative change in students' understanding after directly engaging with 3D visual objects presented through Assemblr Edu. In contrast, the control class, which learned through lecture-based instruction and the use of textbooks, showed only limited improvement. This pattern serves as an initial indicator that innovation through AR-based media is able to provide a more effective learning experience compared to conventional instruction.

The difference in learning outcomes was further strengthened after the data were analyzed through a series of prerequisite tests. The normality test using Shapiro–Wilk indicated that all pretest and posttest data in both classes were normally distributed, as the significance values were greater than 0.05. In addition, the homogeneity test using Levene's Test produced a significance value of 0.310, indicating that the two groups had equal or homogeneous variances. The fulfillment of these two assumptions is essential, as it confirms that the data met the requirements for conducting an independent samples t-test. When the t-test was applied, the results showed a significant difference between the posttest scores of the experimental and control classes. In other words, the improvement in the experimental class did not occur by chance but was truly the result of the implementation of Assemblr Edu media.

These differences illustrate that the presentation of learning materials through AR technology directly influences how students process information. Three-dimensional visualization helps bridge cultural concepts that are typically abstract when conveyed only through text or static images. During the learning sessions, students were observed to grasp information such as the characteristics of traditional houses, traditional clothing, and various other cultural elements more quickly. When objects could be rotated, enlarged, and examined in detail, the process of understanding became more natural, and students were able to recall key aspects more easily. This contrasts with students in the control class, who tended to rely more on memorization and lacked strong visual learning experiences.

These observations are supported by the findings of Hussein et al. (2023), which indicate that Augmented Reality is effective in improving learning achievement at the elementary school level. Their study revealed that direct interaction with AR objects helps students better understand concepts that were previously considered difficult. The ability of AR to present complex visuals in a simplified manner makes the learning process more meaningful. The relevance of this study is evident in the present findings, where students in the experimental class demonstrated deeper understanding after directly viewing and interacting with cultural models in 3D form.

The findings are also consistent with the research of Ilham (2023), which demonstrated that the use of AR in teaching three-dimensional geometry had a positive impact on students' understanding. Although the subject matter differs this study focused on IPAS content, particularly national cultural diversity the underlying principle of AR effectiveness remains consistent, namely its ability to provide visual–spatial experiences that reduce students' cognitive load. When students can see, rotate, and directly observe objects, comprehension occurs more naturally, leading to faster and more substantial improvements in learning outcomes (Natasya 2025).

Overall, the combination of quantitative posttest data, classroom observations, and comprehensive statistical analyses provides strong evidence that the use of Assemblr Edu has a tangible impact on improving learning outcomes. Students not only benefit cognitively but also experience a more active and engaging learning

process. The test instruments used were also proven to be valid and reliable, ensuring that the data obtained are trustworthy and accurately reflect students' actual abilities. Therefore, the first research question can be answered by concluding that there is a significant difference in learning outcomes between students who use Augmented Reality technology based on Assemblr Edu and those who learn through conventional methods, with AR-based learning through Assemblr Edu producing markedly superior results compared to conventional approaches.

The Effect of Using Assemblr Edu Media on Students' Learning Outcomes Compared to Conventional Learning Methods

Based on the analysis of posttest results and the series of prerequisite tests conducted, it is evident that the use of AR media not only affects final learning achievement but also influences the learning process that takes place during instruction. The increase in the experimental class's posttest mean score to 81.15, with data that have been proven to be normally distributed and homogeneous through the Shapiro–Wilk and Levene's tests, reinforces that this improvement did not occur randomly but was the result of the treatment applied. Therefore, the results obtained can be statistically justified and provide objective evidence that the learning experience using Assemblr Edu plays a significant role in enhancing students' understanding.

During the learning process, students who used Assemblr Edu demonstrated clear changes in learning behavior compared to the control group. Enthusiasm emerged when students began scanning objects and observing 3D models such as traditional houses or traditional clothing. This activity made the classroom more dynamic, with students actively asking questions, engaging in discussions, and exploring learning materials without continuously relying on teacher direction. This condition contrasts with conventional learning, where most interactions are centered on teacher explanations and students tend to spend more time listening or taking notes.

The impact of using Assemblr Edu can be observed across three main domains of learning outcomes. In the cognitive domain, 3D visualization helps students connect cultural concepts with concrete representations, making it easier to understand material that was previously presented only through two-dimensional images. This finding is consistent with the t-test results, which show that the experimental group achieved significantly higher posttest scores than the control group. In the affective domain, students appeared more motivated and demonstrated a stronger sense of curiosity. Their interactions during learning indicate that AR media are able to create an enjoyable learning atmosphere and provide new learning experiences. In the psychomotor domain, students' ability to operate digital devices improved, particularly when scanning objects, enlarging displays, or rotating 3D models to observe specific details. The impact of using Assemblr Edu on these three main domains of learning outcomes is presented in the following table 6:

Table 6. Impact of Using Assemblr Edu

No.	Domain	Impact of Using Assemblr Edu
1.	Cognitive	The presentation of learning materials in 3D form enables students to understand cultural concepts in a more structured and concrete manner. This improvement in understanding is reflected in the higher posttest scores of the experimental group compared to the control group.
2.	Affective	The use of AR media encourages increased learning motivation and student interest through a more engaging and enjoyable learning experience with Assemblr Edu.
3.	Psychomotor	Students demonstrate improved skills in using digital devices, such as scanning objects, manipulating displays, adjusting viewing angles, and independently exploring 3D content.

The findings of this study are reinforced by the research of Kurnia et al. (2025), which demonstrates that the use of Assemblr Edu in STEM-based learning is able to improve students' critical thinking skills. Although the focus of their study is not entirely the same as that of the present research, the pattern of influence remains similar. The AR technology applied in the classroom provides students with opportunities to explore learning materials more independently, observe 3D objects from various perspectives, and draw conclusions based on their observations. Such visual exploration processes foster curiosity and encourage students to be actively engaged throughout the learning activities.

The study by Ainulfais and Sari (2025) also supports the results of this research. Their findings indicate that AR media not only enhance learning outcomes in the IPAS subject but also increase students' activeness and participation. The direct visualization of cultural objects helps students understand the material more easily and motivates them to ask questions and participate in discussions. These two studies serve as external evidence that the improvement in learning outcomes found in this research did not occur by chance but is closely related to the characteristics of Augmented Reality media based on Assemblr Edu, which support visual representation, high levels of engagement, and a more engaging and meaningful learning environment.

Based on the overall data including the validity and reliability tests of the instruments, the normality and homogeneity tests, as well as posttest results and observational notes it can be concluded that the use of Assemblr Edu has a strong positive effect on students' learning outcomes. This effect is reflected not only in the significant improvement in achievement scores but also in a more dynamic, interactive, and meaningful learning atmosphere. Therefore, the second research question is clearly answered, confirming that Augmented Reality media based on Assemblr Edu provide a more beneficial impact than conventional learning methods.

4. Conclusion

There are clear differences in learning outcomes between students who use Assemblr Edu–based learning media and those who engage in conventional

learning. Statistical analysis shows that the experimental class experienced a significant increase in posttest scores compared to pretest results. The mean posttest score of the experimental group reached 81.15, a substantial improvement from the pretest mean of 56.92. In contrast, the control class that relied on conventional teaching methods demonstrated a relatively lower level of improvement. This difference between the two groups was further confirmed by the t-test results, which indicated a statistically significant difference in posttest scores. These findings suggest that the use of Assemblr Edu contributes positively to students' learning outcomes and is more effective than traditional instructional approaches.

The implementation of Assemblr Edu–based learning media also positively influences students' conceptual understanding and overall learning experiences in IPAS subjects. The interactive nature of AR media, particularly through 3D visualizations, enables students to understand national cultural diversity in a more concrete and meaningful way. Students can explore traditional houses, clothing, and other cultural elements through engaging three-dimensional representations. Classroom observations reveal increased student motivation and participation, as learners became more active in asking questions, discussing ideas, and exploring content using digital devices. This active engagement supports deeper conceptual understanding and more meaningful learning experiences. Overall, AR-based media create a more dynamic and student-centered learning environment, making Assemblr Edu an effective alternative learning medium for IPAS and other subjects that require concrete visualization.

References

Adinda, N., Azhar, A., & Nasir, M. (2025). Implementation of the STAD Type Cooperative Learning Model with Gimkit to Improve Student Learning Outcomes on Substances and Their Changes. *Journal of Educational Sciences,* 9(5), 3234-3244. https://doi.org/10.31258/jes.9.5.p.3234-3244

Agustin, N., Dewi, A., & Rifqi, M. (2025). Analisis Media Pembelajaran Untuk Meningkatkan Minat Belajar Siswa Melalui Pembelajaran Berbasis Teknologi. *Jurnal Multidisiplin Ilmu Akademik*, 2(1), 397–408. https://doi.org/10.61722/jmia

Ainulfais, F. A., & Sari, Y. (2025). Pengembangan Media Flashcard Berbasis Augmented Reality Untuk Meningkatkan Pengetahuan IPAS Siswa Kelas III Sekolah Dasar. *Nusantara Journal of Multidisciplinary Science*, 2(7). https://jurnal.intekom.id/index.php/njms

Anita, Y., Alfi, C., & Fatih, M. (2024). Pengembangan Media Google Sites Berbasis Augmented Reality Materi Kenampakan Alam Untuk Meningkatkan Kecerdasan Visual Spasial Siswa Kelas V Sekolah Dasar. *Literasi: Jurnal Kajian Pendidikan*, 15(1). https://www.ejournal.almaata.ac.id/literasi

Buchori, A., Sulianto, J., & Osman, S. (2023). Interactive Learning Media With Augmented Reality (AR) GeoGebra for Teaching Geometry in Elementary School. *Profesi Pendidikan Dasar*, 10(3), 190–203. https://doi.org/10.23917/ppd.v10i3.4469

Campbell, S., Greenwood, M., Prior, S., Shearer, T., Walkem, K., Young, S., Bywaters, D., & Walker, K. (2020). Purposive Sampling: Complex or Simple? Research Case Examples. *Journal of Research in Nursing*, 25(8), 652–661. https://doi.org/10.1177/1744987120927206

Dewi, R. K., Harjito, H., & Nurkolis, N. (2025). The Role Of The School Principal As A Manager In Instilling Character Education At SD Negeri 01 Doro, Pekalongan Regency. *Journal of Educational Sciences,* 9(6), 6160-6173. https://doi.org/10.31258/jes.9.6.p.6160-6173

Egista, E., Haryanto, H., & Mustofa, H. A. (2025). The Effectiveness of Augmented Reality as a Learning Medium in Enhancing Students' Motivation and Their Ability to Analyze Physics Concepts. *Jurnal Pendidikan Sains Indonesia*, 13(1), 202–212. https://doi.org/10.24815/jpsi.v13i1.42239

Hikmah, S., Kanzunnudin, M., & Kragan, K. M. (2023). Pengembangan Media 3D Materi Indera Pendengaran Manusia Dengan Augmented Reality Assemblr Edu. *Journal on Education*, 5(3), 7430–7439.

Hussein, H. A., Ali, M. H., Al-Hashimi, M., Majeed, N. T., Hameed, Q. A., & Ismael, R. D. (2023). The Effect of Web Augmented Reality on Primary Pupils' Achievement in English. *Applied System Innovation*, 6(1). https://doi.org/10.3390/asi6010018

Ilham, S. (2023). Pengaruh Media Augmented Reality (AR) Bangun Ruang Terhadap Hasil Belajar Siswa Sekolah Dasar. *Jurnal Basicedu*, 7(5), 2824–2833. https://doi.org/10.31004/basicedu.v7i5.5974

Khoirina, A., & Adriyani, Z. (2024). Inovasi Pembelajaran Era Digital: Pengembangan Teknologi Augmented Reality Di Sekolah Dasar. *Didaktika: Jurnal Kependidikan*, 13(1), 31–42.

Kurnia, M. P. A., Waris, & Gita, R. S. D. (2025). STEM-Based Learning Using Assemblr Edu to Improve Students' Critical Thinking Skills: A Case Study in Elementary School. *Jurnal Penelitian Pendidikan IPA*, 11(7), 178–185. https://doi.org/10.29303/jppipa.v11i7.11301

Muspita, Z., & Rodiyah, H. (2022). Peningkatan Aktivitas Dan Hasil Belajar Siswa Melalui Model Pembelajaran Berbasis Pengalaman (Experiential Learning) Pada Siswa Kelas II. *Golden Age: Jurnal Pendidikan Anak Usia Dini*, 6(2), 671–677. https://doi.org/10.29408/goldenage.v6i02.8661

Riyantono, N. N. E., & Makmur, A. (2024). Efektivitas Penggunaan Media Pembelajaran Berbasis Augmented Reality Di Sekolah Dasar. *Pendas: Jurnal Ilmiah Pendidikan Dasar*, 9(4). https://journal.unpas.ac.id/index.php/pendas/article/view/19057

Natasya, A. L., & Maksum, M. N. R. (2025). Principal's Innovation At MTS Negeri 1 Boyolali: Improving School Quality Though Superior Programs. *Journal of Educational Sciences,* 9(3), 1179-1189. https://doi.org/10.31258/jes.9.3.p.1179-1189

Nur, K. A., & Putri, D. A. P. (2024). The Potential Use of Augmented Reality as an Interactive Learning Media for Student Learning Motivation (Undergraduate thesis). *UMS E-Prints Repository*. https://eprints.ums.ac.id/124456/

Nurul, Rustan, E., & Ajigoena, A. M. (2023). Penilaian Afektif Siswa Terhadap Perubahan Sikap Sosial Siswa Sekolah Dasar. *Jurnal Penelitian Dan*

Pengembangan Pendidikan, 7(2), 231–241. https://doi.org/10.23887/jppp.v7i2.58498

Pingge, H. D., & Wangid, M. N. (2016). Factors Affecting Elementary School Students' Learning Outcomes in Tambolaka District. *Jurnal Pendidikan Dasar*.

Qorimah, E. N., Sutama, S., & Hidayati, Y. M. (2024). An Augmented Reality-Based Interactive Learning Application for Teaching Food Chains in Elementary Schools. *Profesi Pendidikan Dasar*, 11(3), 236–250. https://doi.org/10.23917/ppd.v11i3.6145

Ratnasari, L. T., Mariatun, I. L., & Arief, Z. (2022). Development of Instagram-Based Learning Media to Increase Learning Motivation of Tenth Grader in Economics Subjects at SMA Ar-Raudhah. *Journal of Educational Sciences,* 6(3), 332-340. https://doi.org/10.31258/jes.6.3.p.332-340

Sholicha, A. P., & Ratnaningrum, I. (2025). Pengembangan Media Pembelajaran Augmented Reality Berbasis Assemblr Edu Untuk Meningkatkan Hasil Belajar IPAS Siswa Sekolah Dasar. *Nusantara: Jurnal Pendidikan Indonesia*, 5(3). https://doi.org/10.62491/njpi.2025.v5i3-13

Swarmahardika, I. K. P., & Widiana, I. W. (2024). Interactive Learning Media Based on Augmented Reality to Improve Elementary School Grade V Students' Understanding of the Water Cycle Concept. *MIMBAR PGSD Undiksha*, 12(2), 351–359. https://doi.org/10.23887/jjpgsd.v12i2.74930

Syahid, M., Ardianto, D., & Arifin, M. Z. (2024). Efektivitas Pembelajaran IPA Berbasis Augmented Reality Di Sekolah Dasar. *Prosiding Seminar Nasional Pendidikan Dasar*, 1(1), 163–178.

Zhang, J., Li, G., Huang, Q., Feng, Q., & Luo, H. (2022). Augmented Reality in K–12 Education: A Systematic Review and Meta-Analysis of the Literature from 2000 to 2020. *Sustainability*, 14(15). https://doi.org/10.3390/su14159725

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