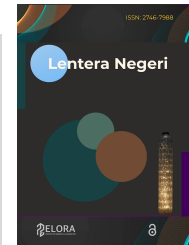




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Enhancing elementary students learning motivation through assemblr edu-based augmented reality media on ecosystem topic

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ABSTRACT

Student difficulties in understanding the Natural and Social Sciences (IPAS) subject are caused by the conceptual essence of the content and the restricted utilization of engaging educational resources. This research seeks to create and evaluate the validity, feasibility, and efficacy of Augmented Reality (AR) media through the Assemblr Edu application concerning ecosystem content. This research utilized a Research and Development (R&D) approach using the ADDIE model, comprising the phases of analysis, design, development, implementation, and evaluation. The study participants included 1 teacher and 20 third-grade pupils from SDN 1 Mulyoharjo, comprising 10 female and 10 male students. The implementation of the study was conducted over three meetings. Data gathering methods were conducted using observation, interviews, and surveys. The instrument for measuring learning motivation was validated and assessed for reliability before its use, and it was found to be both valid and reliable. The results showed that the media validity score was 86% (valid category), while the material validity score was 89.3% (valid category). Student feedback regarding media usage received a percentage of 91.1% (excellent category). Additionally, the outcomes of the paired sample T-test revealed a significance value of $0.000 < 0.05$, and the N-Gain value was 0.3611 (moderate category, lower threshold), signifying a moderate enhancement in student learning motivation. Consequently, the use of Augmented Reality media through the Assemblr Edu app is deemed practical and fairly efficient in enhancing ecosystem education.



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Introduction

The IPAS subject is among the subjects taught in elementary school that requires media to systematically construct a concept so that students can fully understand natural and social phenomena. However, the learning process found in the field indicates that the media used by teachers is visual and predominantly conventional. This results in students having difficulty understanding a concept, leading to a lack of interest and motivation to learn. Several studies have proven that motivation is a decisive element in reaching learning goals; the greater the motivation among students, the greater the chance of their learning success (Nugraheny et al., 2024). As proven by the fact that there are three grade 3 students at SDN 1 Mulyoharjo who have not achieved the KKM score on the ecosystem material. Meanwhile, the use of media in learning is an effective way to stimulate and motivate students to learn (Muna et al., 2025). Additional research indicates that digital educational resources have great potential in supporting several aspects, such as

improving learning outcomes, strengthening conceptual understanding, developing critical thinking skills, and shaping attitudes and character (Ulya et al., 2025). This emphasizes the need for using digital media that provides students with an in-depth understanding of the IPAS subject.

The current education curriculum applied in elementary schools combines two subjects into one, one of which is the IPAS subject. These two elements are presented as a unified whole, not broken down into separate learning objectives. This makes the IPAS material very complex, and the insufficient utilization of educational resources by teachers becomes an obstacle to achieving these objectives. Research shows that the broad scope of IPAS material and the many abstract concepts lead to students' inability to understand the material (Suprapmanto & Zakiyah, 2024). The 2025 learning outcomes focus more on implementing in-depth learning, thus involving several important components, one of which is the utilization of digital technology. Digital technology serves not only as a tool for presentation and information dissemination but can also be applied in planning, execution, and evaluation of learning. Learners achieve a more engaging, adaptable, and cooperative educational experience (Badan Standar et al., 2025). However, other research results explain that the integration of technology in IPAS education remains limited, so the learning process tends to focus on explaining the material without considering students' learning styles and needs (Satriani et al., 2025). This indicates that IPAS learning requires digital media capable of making abstract concepts more concrete.

Field findings indicate that IPAS learning on Ecosystem material still faces obstacles in delivering information that is both engaging and systematic. Based on interview results in the third grade of SDN 1 Mulyoharjo, the teacher still used conventional picture-based media making it difficult for students to understand various forms of ecosystems. Students showed low engagement and participation. Research confirms that digital media is better and more interesting than conventional media (Yuniarti et al., 2023). Other research indicates the need for more interactive digital media platforms, such as Android-based Augmented Reality applications that combine the real world with virtual elements (Aisyah & Sumadi, 2025). This gap indicates the need to develop Augmented Reality content with Assemblr Edu application that can present Ecosystem material more concretely.

Based on research conducted by Prabowo & Wakhudin (2024), The N-Gain score assessment for the effectiveness of enhancing student motivation through the use of Augmented Reality (AR) media achieved an average value of 66.92%. Therefore, the utilization of Augmented Reality (AR) media in IPAS education is significantly effective in enhancing student motivation for learning. Furthermore, Azizah & Pamujo (2024) exhibited an N-Gain of 0.5 (medium category), indicating that Augmented Reality-based visual learning media was effective as a learning resource in the classroom. The effectiveness of this media is found not just in statistics but also in its capability to address the key obstacles of science education in elementary schools. Assemblr Edu's effectiveness came from its capacity to convert abstract ideas into tangible and engaging three-dimensional visual experiences. This visualization process not only enhances conceptual understanding but also significantly increases student motivation and active engagement. Thus, this study confirms that the integration of AR technology through platforms like Assemblr Edu is a powerful pedagogical strategy. This media served not only as an instructional aid but also as an effective solution to improve the quality and outcomes of science learning in elementary schools.

Based on various previous studies, It can be deduced that learning media based on Augmented Reality through the Assemblr Edu application is highly effective for application in educational settings. This application positively influences students and offers a more interactive and engaging educational experience. The creation of media based on Augmented Reality through the Assemblr Edu application has various urgencies, one being the necessity to address the difficulty students face in grasping abstract concepts. Therefore, Assemblr Edu media serves as a crucial 3D visual tool that can connect material abstraction, rendering it more tangible and comprehensible, consequently aiding students in enhancing their understanding and motivation. The advancement of this medium not only enhances a more significant and interactive learning experience but also provides an answer to the ongoing advancements in digital technology.

Despite the growing number of studies highlighting the effectiveness of Augmented Reality (AR) in improving learning outcomes and motivation, several limitations remain. Most previous studies focus on upper elementary levels and employ experimental designs, while limited attention has been given to the development of AR media specifically for lower elementary students, particularly in Grade 3. In addition, previous studies rarely integrate AR media development using the ADDIE model in a systematic manner. Therefore, this study aims to fill this gap by developing and evaluating Assemblr Edu-based AR media tailored to third-grade students on ecosystem material.

Based on the description above, the problem formulations of this study are: 1) What is the need for learning media required for Assemblr Edu media to increase student motivation in the third grade of SDN 1 Mulyoharjo? 2) What is the development process of Assemblr Edu media on Ecosystem material to increase student motivation in the third grade of SDN 1 Mulyoharjo? 3) What is the feasibility level of Assemblr Edu media on ecosystem material according to material and media expert validation? 4) What is the effectiveness of Assemblr Edu media on ecosystem material? 5) How do teachers and students react to the application of Assemblr Edu media regarding ecosystem content to enhance student learning motivation in the third grade at SDN 1 Mulyoharjo. Simultaneously, the aims of this research are: 1) To evaluate the requirements necessary for developing Assemblr Edu learning media on Ecosystem material in the third grade of SDN 1 Mulyoharjo, 2) To describe the development process of Assemblr Edu media on Ecosystem material, 3) To analyze the feasibility level of Assemblr Edu media on Ecosystem material according to material and media expert validation, and 4) To describe the effectiveness of the developed Assemblr Edu media on Ecosystem material.

Method

The ADDIE model was used in this study together with Research and Development (R&D). The five phases of the ADDIE model are as follows: Analysis, Design, Development, Implementation, and Evaluation. Other studies support the conclusion that using the ADDIE model in developing interactive learning media provides significant results in increasing student learning motivation (Siregar & Rhamayanti, 2025). Here is a summary of the phases of the ADDIE development model.



Figure 1. Stages of the ADDIE Development Model

The first stage, Analyze, includes needs analysis conducted through observation and interviews to formulate learning problems. The design stage includes conceptualizing and creating the initial prototype of the Assemblr Edu media. Furthermore, the develop stage realizes the product created in the design stage and involves expert validation. The implement stage is where the developed product begins to be applied in actual learning situations. At this stage, the researcher uses the media, modules, or prepared devices with the students. The final stage, evaluation, aims to evaluate the product's effectiveness based on the analysis of student response questionnaires. Assessment was carried out continuously at each phase and ultimately at the conclusion of execution to evaluate the overall efficacy of the created media.

This research was conducted at SDN 1 Mulyoharjo, grade 3, with 20 students (10 female and 10 male) as subjects. This study also involved one material expert validator and one media expert validator. In this study, data collection methods included observation, interviews, and questionnaires to evaluate the effectiveness of the developed media. The motivation questionnaire for learning was created using six indicators, which include: (1) the wish and desire to succeed, (2) the need and drive to learn, (3) future aspirations and hope, (4) the value placed on learning, (5) engaging activities in learning, and (6) the supportive learning environment. This tool includes five Likert scale items and has undergone testing for validity and reliability prior to implementation. Data analysis was conducted using both qualitative and quantitative methods. Qualitative data were examined through feedback, recommendations, and expert validation gathered from surveys. Quantitative data were subsequently analyzed employing a Likert scale. This scale assesses perceptions by evaluating the degree of agreement or disagreement regarding a specific subject or object (Sugiyono, 2020). Meanwhile, to determine the feasibility of the media, the percentage formula that can be used is as follows (Marlinda et al., 2023).

$$P = \frac{\sum x}{\sum xi} \times 100\%$$

Description:

P = Feasibility percentage
 $\sum x$ = Total score obtained from respondents
 $\sum xi$ = Maximum total score

The results of the validity test data can be computed using the aforementioned formula to derive quantitative data, which can subsequently be expressed as a percentage (%). To assess the validity of the created product, see the table 1.

Table 1. Classification of Validity Assessment Aspects

Percentage (%)	Validity Category
90% - 100%	Strongly Valid
80% - 89%	Valid
65% - 79%	Quite Valid
55% - 64%	Less Valid
≤ 54%	Invalid

(Sepriana et al., 2023)

To assess the viability of the created product, consult the criteria table 2:

Table 2. Conversion Achievement Rate

Percentage	Feasibility Category	Remark
81% - 100%	Very Feasible	No need for revision
61% - 80%	Feasible	No need for revision
41% - 60%	Quite Feasible	Revision
21% - 40%	Less Feasible	Revision
0% - 20%	Not Feasible	Revision

(Murdani et al., 2024)

The method for analyzing data to evaluate the effectiveness of the Assemblr Edu media development employed descriptive quantitative techniques, specifically a paired sample T-test and an N-Gain test. Before performing the paired sample t-test, tests for assumptions were executed. The Shapiro–Wilk test showed that data for both pretest ($p = 0.530$) and posttest ($p = 0.384$) followed a normal distribution. Additionally, Levene’s test indicated that the data were homogenous ($p = 0.947$). Consequently, the conditions for parametric testing were satisfied, and the paired sample t-test was correctly utilized. The following table illustrates the interpretation categories for N-Gain values tabel 3.

Table 3. N-Gain Interpretation Categories

N-Gain Score (g)	Category
$N\text{-Gain} \geq 0.7$	High
$0.3 \leq N\text{-Gain} < 0.7$	Moderate
$N\text{-Gain} < 0.3$	Low

(Muna et al., 2025)

Results and Discussions

Need Analysis For The Development Of Augmented Reality Media

This research yields an Augmented Reality tool that serves as a teaching aid for ecosystem topics in elementary education. Utilizing Augmented Reality-centered media through the Assemblr Edu app can greatly enhance student involvement, comprehension of concepts, and overall learning experience (Joseph et al., 2024). The development process of Assemblr Edu media on ecosystem material used the ADDIE model, which has 5 steps: Analyze, Design, Develop, Implement, and Evaluate.

The first phase is Analyze, where the needs of the teacher are assessed. This study was carried out via interviews with teachers and observations at SDN 1 Mulyoharjo. The outcomes of the teacher interview are presented in the table 4. Based on the needs analysis results shown in Table 4, interview data is qualitative, so it can't be quantified like a numerical questionnaire. Therefore, I converted it into a binary score (1 = indication, 0 = no) based on the teachers' answers.

Table 4. Results of teacher interviews

Dimension	Indicator	Percent age
Learning Needs	The teacher experiences limitations in using interactive media	100%
AR Media Needs	The teacher shows interest and high expectations towards AR media	100%
Evaluation and Motivation	Assessment is still simple, but the teacher realizes the importance of student learning motivation	100%
Implementation Support	The school provides facilities, but they have not been utilized optimally	100%

The interview results indicate that all indicators of learning needs were identified, including limitations in media use, the need for AR-based media, awareness of student motivation, and support for implementation. This shows that the need for innovative learning media is categorized as very high. Meanwhile, the results of observations in grade 3 can be seen in the following table 5.

Table 5. Result of grade 3 observations

Dimension	Indicator	Percent age
Teacher Activities	The teacher explains the material but has not optimized the use media	66,67%
Students Activities	Students are quite active and enthusiastic, but not evenly distributed across all students	66,67%
Learning Media	Media is available but still limited to conventional media (pictures)	66,67%
Student Learning Motivation	Students show interest, but it is not yet maximized due to the lack of media variation	0%
Facilities and Infrastructure	Facilities such as projectors are available but have not been utilized optimally	100%

Based on the observation results shown in Table 5, the observation results show that teacher and student activities are relatively adequate (66.67%), but the use of learning media remains conventional. The most critical finding is that student learning motivation is still very low (0%), indicating a significant gap in the learning process. On the other hand, school facilities are fully available (100%), suggesting that the main issue lies not in infrastructure but in the lack of innovative media utilization.

AR media using the Assemblr Edu application was considered an effective solution to meet the needs of learning about ecosystems at the elementary school level. Research conducted by Zhang et al., (2025) states that Augmented Reality applications can improve student learning motivation and performance, as well as reduce cognitive load if designed according to student characteristics. Other research conducted Maziyah & Zumrotun (2025) states that Assemblr Edu media makes students the center of learning activities and constructs their own understanding. The three-dimensional features of the Assemblr Edu application help students interact and can be adapted to the needs and learning styles of each student (Balo et al., 2025). Thus, AR media using the Assemblr Edu application on ecosystem material not only answers the teacher's need to deliver material more effectively but is also able to create interactive learning so that it can increase the learning motivation of elementary school students.

Development Of Augmented Reality Media On Ecosystem Material

The following phase is Design. According to the needs analysis, the researcher created a media that is challenging to represent visually, like ecosystem resources. At this point, the researcher created the product by defining the concept or notion of the media format. The researcher created the media form like flashcards using PVC material so that it is not easily broken and the writing and images are more durable. In addition, the 3D features in the Assemblr Edu application and the flashcard design were also chosen in a manner that enhances the appeal of the media. In addition to product design, the researcher developed validation tools for materials and media, along with student feedback survey forms concerning the application of AR media via the Assemblr Edu app.

In the Develop stage, the ideas or designs that had been planned were then applied into a product in the form of visual and simple technology-based ecosystem flashcards. This product is in the form of picture cards displaying various types of ecosystems, such as marine, forest, lake, desert, rice field, and grassland

ecosystems. The front of the card presents contextual and visually engaging illustrations accompanied by brief explanations of basic ecosystem concepts, such as individuals, populations, communities, and ecosystems, thus helping students understand the material gradually and structurally.

The back of the card was equipped with representative images of each ecosystem and a QR code that can be scanned using a digital device. The integration of QR codes enabled students to access additional interactive content. Colorful and contextual visualizations can increase student interest, while the integration of simple technology such as QR codes supports more interactive learning. Thus, this card media not only helps students remember concepts but also facilitates understanding of abstract ecosystem material through a combination of visual and technological elements.

Validation and Feasibility of Augmented Reality Media with The Assemblr Edu Application on Ecosystem Material

At the product validation In the phase of Augmented Reality media utilizing the Assemblr Edu application, the researcher executed validation assessments with 1 media validator and 1 material validator. The media validator assigned a score of 86%, placing it in the valid category. Additionally, the material validator assigned a score of 89.3% (valid classification).

Table 6. Product Validation Result

Validator	Results (%)	Category
Media Expert	86%	Valid
Material Expert	89,30%	Valid

According to Table 6, the Augmented Reality media created by the researcher demonstrates significant validity. The media effectively showcased educational resources in a more interactive and captivating way, thus enhancing students’ interest, motivation, and participation during class activities. In addition, the implementation of AR media also supported the development of students’ confidence and active participation in learning. Therefore, the developed media was considered pertinent and practical to assist the educational process in primary schools. The outcomes of AR media creation can be observed in the subsequent depiction.



Figure 2. Results of AR Media Development for ecosystem material

Effectiveness of Augmented Reality media with the Assemblr Edu application on ecosystem material

The subsequent phase is Execution. Following the acquisition of media validation from experts in media and materials, and being deemed suitable for application in ecosystem materials, the researcher began implementing it in the learning process. However, a pre-questionnaire was administered to measure the level of student motivation before using the media. Subsequently, The ecosystem material was provided using AR flashcard media during three sessions. During the third meeting, the researcher distributed a post-questionnaire. Subsequently, to assess the efficacy of the AR media in education, a paired sample T-Test was performed. The findings from the test analysis are displayed in the table 7.

Table 7. Paired Sample T-Test Results

Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		T	df	Sig. (2- tailed)
			Lower	Upper			
-3.90000	3.66922	.82046	-5.61725	-2.18275	-4.753	19	.000

Table 7 indicates that the outcomes of the paired sample t-test reveal a significance value (sig.2-tailed) of 0.000, suggesting ($0.000 < 0.05$). This showed that student motivation for learning before and after utilizing AR media with the Assemblr Edu app on ecosystem topics underwent a significant shift ($0.000 < 0.05$). Additionally, an N-Gain assessment was performed to evaluate the rise in motivation using the pre-questionnaire and post-questionnaire, with the results displayed as table 8.

Table 8. N-Gain Results

N	Minimum	Maximum	Mean	Std. Deviation
20	-1.33	01.00	.3611	.50560

The N-Gain value is calculated by taking the difference between the post-questionnaire score and the pre-questionnaire score, then dividing that by the ideal score. According to Table 8, the N-Gain result achieved is 0.3611, placing it in the moderate range, lower threshold. However, this study has numerous constraints that need to be taken into account. The research lacked a control group, and the sample size was quite small, potentially restricting the applicability of the results. Moreover, the brief period of execution (three meetings) may have influenced the extent of improvement in students' learning motivation. Therefore, overall, AR media with the Assemblr Edu application showed potential in improving student learning motivation. Next, To assess the degree of AR's impact on enhancing student learning motivation, the effect size formula was applied. The outcomes of this test evaluation are shown in the table beneath (Murdani et al., 2024):

Table 9. Effect sizes results

Pair 1	Pre-questionnaire	Post-questionnaire
Mean	41.35	45.25
Std. Deviation		3.048
Effect Size		1.36
Results		Large Effect

Based on Table 9, the result showed a Cohen's d value of 1.38, classified as a significant effect size. This suggests that employing Augmented Reality media through the Assemblr Edu application had a significant positive impact on enhancing students' learning motivation. Even though the N-Gain value (0.3611) is classified as moderate (lower threshold), the large effect size suggests that the intervention provides substantial improvement in students' motivation.

The last phase is Assessment. This phase seeks to evaluate the extent to which the media aids students in reaching learning objectives pertaining to ecosystem topics. At this point, surveys were handed out to assess student reactions to the utilization of AR media through the Assemblr Edu app, which can subsequently serve as evaluation tools later on. The outcomes of student replies as media consumers are presented in the table 10.

Table 10. Student response results

Indicator	Score
Suitability with learning needs	183
Media design and display	180
Development quality and material	187
Ease and implementation of media use	181
Benefits and impact of the media	363
Total score	1.094
Maximum score	1.200
Percentage	91,1%

According to Table 10, the total of each indicator results in a score of 1,572 with a highest possible score of 1,625. In the meantime, the typical rating of student feedback regarding AR media with the Assemblr Edu application yielded a percentage of 91.1%. This indicates that student assessments of AR media with the Assemblr Edu application also fall into the very good category. These responses indicate that AR media utilizing the Assemblr Edu application is contributed positively for use in ecosystem material. The media's ability to present abstract concepts in an engaging way has been shown to increase student motivation. The average N-Gain value of 0.3611 indicates that it belongs to the moderate category.

Research conducted by Marlinda et al., (2023) states that AR media had been able to develop a more dynamic and diverse educational experience, minimizing the dull and uninspiring environment that had often become a barrier in conventional education. Attractive visual displays and elements of play indicate that AR media with the Assemblr Edu app serves as a valuable aid in the educational process (Suhati et al., 2023). Other research conducted by Tias & Purnamasari (2025) showed an applicability rate of AR-based flashcards of 92%, indicating that the media is potentially useful. Students are actively engaged with the learning material, making the learning process more interesting. It can be concluded that AR media utilizing the Assemblr Edu application is demonstrated to be effective for use as a learning tool in elementary schools.

The various advantages of AR media with the Assemblr Edu application, packaged in the form of flashcards, make it an supportive for ecosystem material. Besides being able to present more attractive and contextual visualizations through a combination of images and AR technology, this media also encourages active student involvement in the learning process. By scanning QR codes on flashcards, students can access virtual objects, making the learning experience more interactive and less monotonous. The implementation of AR-based flashcard media enhances learning effectiveness while also fostering a more enjoyable and significant learning environment. In addition to its benefits, this research has multiple limitations that should be taken into account. Initially, the utilization of Augmented Reality-driven media strongly relies on the presence of suitable devices, like smartphones. Additionally, the quality of the internet connection influences the seamless functioning of the Assemblr Edu app. Third, students possess varying levels of digital literacy, necessitating a period of adaptation when utilizing the media. These constraints could impact the efficiency of media usage in the educational process. Nevertheless, AR-integrated flashcard tools have been shown to boost student interest, motivation, and involvement in learning, allowing for more effective achievement of learning goals.

Conclusions

This research finds that the creation of Augmented Reality (AR) media through the Assemblr Edu application on ecosystem topics has fulfilled the standards of validity and feasibility, reflected in expert validation ratings of 86% (media) and 89.3% (material), both deemed valid. The results of the implementation indicate a statistically significant rise in students' motivation to learn ($p < 0.05$). The N-Gain value of 0.3611 positions the enhancement within the lower range of the moderate category, suggesting that the media's effectiveness is sufficient but not ideal. This study theoretically strengthens the importance of Augmented Reality as a constructivist educational resource that converts abstract ideas into more tangible and engaging experiences, thus fostering motivation in elementary science education. In practice, the results indicate that Assemblr Edu-based AR media can act as an alternative teaching tool to boost student involvement, especially in subjects that need visualization like ecosystems. Nevertheless, this research has various limitations, such as a comparatively small sample size, no control group, and a brief implementation period (three sessions), which could influence the generalizability and robustness of the results. Consequently, it is suggested that future studies utilize experimental or quasi-experimental methodologies with bigger sample sizes and extended intervention durations to gather stronger evidence on the efficacy of AR-based educational media.

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