

Project-Based Learning for Assemblr Edu Augmented Reality Media: Products and Experiences of Primary School Teacher Education Students

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Abstract

The development of digital technology requires prospective teachers to have the ability to design innovative, technology-based learning media. This study, involving 35 primary school teacher education students, aims to describe the implementation of Project-Based Learning (PjBL) in the development of Augmented Reality (AR)-based learning media using Assemblr Edu and to examine the products and learning experiences of the students. This study uses a qualitative descriptive approach with a case study design. The research subjects consisted of 35 primary school teacher education students taking the Learning Multimedia course. Data were collected through observation, interviews, and documentation of students' AR products. Data analysis was carried out using the Miles, Huberman, and Saldaña model through the stages of data condensation, data display, and conclusion drawing. The results showed that the implementation of PjBL was carried out in a "very good" category with an implementation percentage of 89%, while the interview results indicated an increase in collaboration skills (90%), the development of digital technology skills (80%), and an increase in creativity (70%). The analysis of AR media products showed that students were able to develop media with good aspects of material suitability, visual design, and interactivity. This research practically contributes to the development of digital, collaborative, and creative competencies for prospective elementary school teachers through authentic project-based learning experiences. The research findings indicate that the application of Assemblr Edu AR-based PjBL provides authentic learning experiences that support the development of digital competencies, creativity, and the ability of primary school teacher education students to produce innovative learning media.

Keyword: Project-Based Learning, Augmented Reality, Assemblr Edu, Learning Multimedia

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INTRODUCTION

The development of digital technology has brought changes to the world of education, including the competency demands for elementary school teachers (Khoridah, et al., 2025). Teachers are not only required to master learning materials but also to possess the ability to design innovative learning media capable of supporting active, interactive, and meaningful learning (Khoridah, et al., 2025; Lubis, et al., 2024). Therefore, primary school teacher education students, as prospective teachers, need to be equipped with digital literacy and skills in developing technology-based learning media (Wijayanti & Azlya, 2025). The Learning Multimedia course plays an important role in equipping primary school teacher education students with the ability to design and produce learning media (Sari &

Angreni, 2018). However, in practice, multimedia learning still frequently focuses on conceptual understanding and technical application use, resulting in students not fully gaining authentic experiences in developing media products that suit the learning needs of elementary schools (Nugraha, et al., 2023; Fitriannor & Utama, 2024). Several studies have indicated that the digital competence of prospective teachers in developing technology-based learning media is still relatively low, and they often face difficulties in integrating technology into instructional design (Astriani, 2020; Siregar & Siregar, 2024).

To address this issue, students need to be provided with learning experiences that allow them to go through the process of designing, developing, testing, and improving media products. One approach that can be used to provide these experiences is Project-Based Learning (PjBL) (Lubis, et al., 2024). This model offers opportunities for students to learn through the process of completing real projects, thus enabling them to develop creative thinking, collaboration, problem-solving abilities, and product generation skills (Lubis, et al., 2024; Nugraha, et al., 2023). In the context of prospective teacher education, PjBL is highly relevant to apply because students do not merely understand the theory of learning media, but also produce products that can be utilized in teaching practices (Sari & Angreni, 2018). The syntax of PjBL observed in this study included five main stages: (1) determining fundamental questions, (2) designing the project plan, (3) creating a schedule, (4) monitoring the project progress, and (5) evaluating the results (Nababan et al., 2023).

One form of digital media innovation that can be developed is Augmented Reality (AR) (Hermawan & Hadi, 2024). AR technology can merge digital objects with real environments, thereby providing a more visual and interactive learning experience (Wijayanti & Azlya, 2025; Sriwahyuni, 2026). The utilization of the Assemblr Edu platform allows students to develop AR-based media more easily as it provides features for creating 3D objects, animations, and learning visualizations without requiring complex programming skills (Fitriannor & Utama, 2024). Assemblr Edu was chosen over other AR platforms such as Unity or Vuforia because it is more user-friendly and specifically designed for educational purposes, making it more suitable for primary school teacher education students who do not have a background in programming. Its intuitive interface and available templates enable students to focus more on pedagogical content development rather than technical coding.

Although the use of AR in learning is increasingly developing, studies on how the PjBL implementation process in multimedia learning guides primary school teacher education students to produce AR media still require further investigation (Resa & Muchtar, 2025). Many studies primarily highlight the effectiveness of using AR media on students, whereas studies regarding the experiences of prospective teacher students in developing AR media through project-based learning processes remain limited (Efendhi, et al., 2025). This research gap underscores the need for a more in-depth exploration of how PjBL can facilitate the development of digital competencies, creativity, and collaboration among prospective teachers in the context of creating AR-based learning media.

Based on these issues, this study aims to describe the implementation of Project-Based Learning in the development of Augmented Reality-based learning media using Assemblr Edu for primary school teacher education students, and to illustrate student experiences during the digital learning media product development

process. The research questions guiding this study are: (1) How is the implementation of PjBL in developing AR media using Assemblr Edu carried out? (2) What are the characteristics of the AR learning media products developed by students? and (3) What are the learning experiences of primary school teacher education students during the AR media development process?

METHOD

This study uses a descriptive qualitative approach with a case study design. The case study design was chosen because it allows for an in-depth, holistic, and contextualized exploration of the PjBL implementation process, student products, and experiences within a bounded system (the Learning Multimedia course). It aims to describe the implementation of Project-Based Learning (PjBL) in the development of Augmented Reality (AR)-based learning media using Assemblr Edu, and to examine the characteristics of the resulting products and the learning experiences of primary school teacher education students during the media development process. A qualitative approach was selected because the research focuses on the processes, experiences, and meanings obtained by students while participating in project-based learning.

The subjects of the study were students of the Primary School Teacher Education Study Program taking the Learning Multimedia course in semester 2, totaling 35 students. The subjects were in their second semester and had diverse backgrounds in technology use, ranging from limited to moderate experience with digital applications. Subject selection was conducted purposively based on student involvement in the AR media development project using Assemblr Edu. Data on student learning experiences were obtained through interviews with 10 students, selected based on variations in involvement (active participation in group discussions) and the results of the developed products (high, medium, and low-quality products).

Data collection was carried out through observation, interviews, and documentation. Observation was conducted during the learning process to determine the implementation of the Project-Based Learning stages, which included activities such as determining the project, designing the product, developing the media, evaluating the product, and presenting the project results. The observation instrument used an observation sheet with a rating scale referring to the PjBL stages. The indicators assessed at each stage included: relevance of the project idea to learning objectives, clarity of the storyboard design, effectiveness of feature utilization on Assemblr Edu, quality of the product presentation, and depth of the evaluation provided. Observation data were analyzed descriptively using the percentage of activity implementation; the percentage results were then interpreted based on learning implementation categories. The observation sheet and interview guides were validated through expert judgment by two lecturers who are experts in learning media and educational research.

Semi-structured interviews were conducted to obtain information regarding student learning experiences while developing AR learning media using Assemblr Edu. The explored aspects included experiences participating in project-based learning, technological proficiency, creativity in media design, obstacles faced during the development process, and the project's benefits toward student competencies as

prospective teachers. Interview data were analyzed through thematic analysis, which included coding, categorization, and theme determination processes. The coding process involved identifying key phrases, grouping them into categories, and then synthesizing them into broader themes. The frequency of theme occurrences in the interview results was analyzed descriptively using percentages to illustrate student experience tendencies.

Research documentation in the form of student AR media products, storyboards, project reports, and presentation results was analyzed to identify product characteristics based on aspects of material suitability, visual design, creativity, and media interactivity. Product quality was assessed using a rubric developed specifically for this study, focusing on these four aspects. Research data analysis refers to the interactive model by Miles, Huberman, and Saldaña, encompassing three stages: data condensation, data display, and conclusion drawing. Observation, interview, and documentation data were compared and interpreted to gain a comprehensive overview of the PjBL implementation in AR learning media development. Data validity was verified through technical triangulation by systematically comparing observation results, interview data, and documentation of the students' produced products to ensure convergence of evidence.

RESULT AND DISCUSSION

Implementation of Project-Based Learning in the Development of Augmented Reality Learning Media

The implementation of Project-Based Learning (PjBL) in the Learning Multimedia course was carried out through the stages of planning, development, product presentation, and reflection. Based on observations during the learning process, students demonstrated active involvement in every stage of the Augmented Reality (AR)-based learning media development project using Assemblr Edu. Observation results of the PjBL stages' implementation are presented in Table 1.

Table 1. Implementation of Project-Based Learning in AR Media Development

PjBL Stage	Implementation Percentage	Category
Idea determination and project planning	92%	Very good
Media storyboard design	88%	Very good
AR product development using Assemblr Edu	86%	Very good
Product presentation and evaluation	90%	Very good

Based on these results, the implementation of PjBL falls into the "very good" category. Students were capable of following the learning flow, from determining media concepts and designing layouts to developing products and evaluating the created media.

These findings indicate that the application of PjBL provides a learning experience oriented toward the process of yielding tangible products. Through project activities, students not only theoretically understood the concept of learning multimedia but also directly experienced the media design and development stages applicable to elementary school learning contexts. This aligns with the characteristics of PjBL, which positions students at the center of learning via investigation, problem-solving, and product creation activities.

Characteristics of Student Augmented Reality Learning Media Products

Documentation results indicate that students were able to generate various AR-based learning media products using Assemlr Edu. The developed products included elementary school learning materials such as science concepts, environmental topics, and abstract materials requiring visualization. **Product analysis** was conducted based on aspects of material suitability, visual design, media interactivity, and creativity, with a more detailed breakdown of indicators for each aspect.

Table 2. Analysis of Student AR Media Products

PjBL Stage	Implementation Percentage
Idea determination and project planning	92%
Media storyboard design	88%
AR product development using Assemlr Edu	86%
Product presentation and evaluation	90%

Examples of AR projects created by students can be seen in Figure 1.

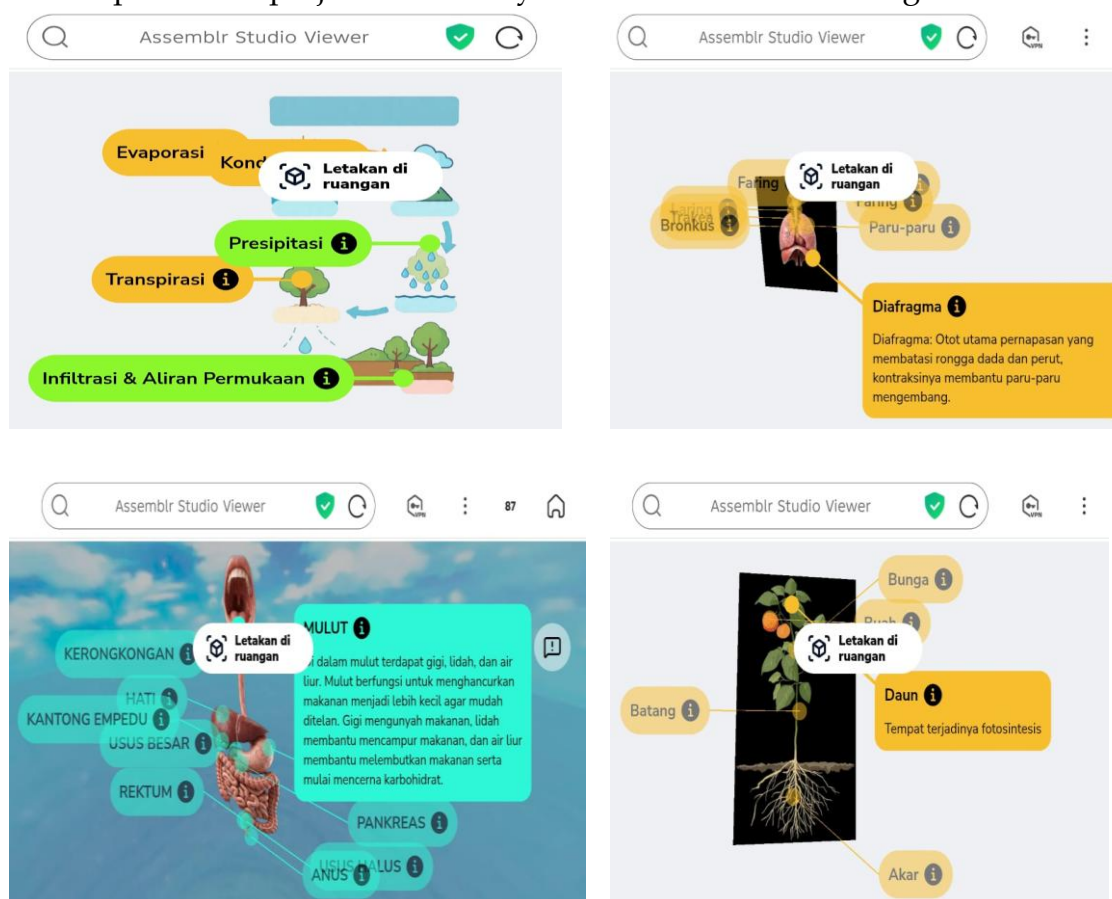


Figure 1. Example of Student Project Results for Assemlr Edu AR Learning Media

The analysis results show that the products developed by students were not exclusively oriented towards technology usage but also considered pedagogical aspects. Students began to understand that digital learning media must interconnect visual appearance, learning objectives, and student characteristics. Utilizing Assemlr Edu supported students in generating AR media, as the platform enables the development of interactive visual objects without requiring complex programming

skills. Consequently, primary school teacher education students, as prospective teachers, can more easily integrate digital technology into instructional design.

Student Learning Experiences in PjBL Implementation

Based on interviews with 10 students, several main themes concerning learning experiences during AR media development were obtained.

Table 3. Results of Student Interview Theme Analysis

Theme	Number of Students	Percentage
Increased ability to use digital technology	8	80%
Increased creativity in designing media	7	70%
Development of collaboration skills	9	90%
Experienced obstacles in using applications	6	60%

The analysis results demonstrated that students' learning experiences were predominantly related to collaboration skills and the development of digital abilities. The results indicated a process of technological adaptation through direct experience. Students underwent learning stages ranging from initial difficulties and exploring Assemblr Edu features to successfully producing learning media products. Project-based learning provides space for students to learn actively through processes of trial, refinement, and product evaluation. In addition to yielding AR media, this process also develops 21st-century skills such as creativity, communication, collaboration, and problem-solving.

The implementation of Project-Based Learning (PjBL) in the Learning Multimedia course was executed through activities developing Augmented Reality (AR)-based learning media projects using Assemblr Edu. The learning process is designed so that students do not merely comprehend the concept of multimedia learning development but are also capable of generating digital media products relevant to learning needs in elementary schools. Project implementation occurs through several PjBL stages, specifically determining project ideas, compiling media designs, developing products, presenting results, and conducting reflections on the development process (Nababan et al., 2023).

Based on observations, students demonstrated active involvement throughout the learning process. Each stage of PjBL contributed to different aspects of competency development. The project planning stage served as the initial step for students to determine learning materials to be developed into AR, consider the traits of elementary school students, and design visual concepts suited to learning objectives, thereby fostering their ability to analyze content and learner needs (Astriani, 2020; Sari & Angreni, 2018). Observation results of the PjBL stages' execution indicate that all learning stages could be carried out effectively. Project planning activities garnered an implementation percentage of 92%, product development 86%, and product presentation and evaluation activities 90%. These results signify that students were able to systematically follow the media development process from the ideation stage to producing the final product (Rexa, 2018).

The application of PjBL in multimedia learning grants a more contextual learning experience as students are directly involved in the product creation process (Dewi, 2021). Students act not only as technology users but also as learning media designers (Siregar & Siregar, 2024). This proves that PjBL can foster learning oriented

towards 21st-century skills via problem-solving, creativity, communication, and collaboration activities (Siminto, et al., 2025). This finding aligns with previous research, such as Astriani (2020) who found that PjBL enhanced student creativity, and Dewi (2021) who reported improved student engagement in multimedia courses. Furthermore, Sari & Angreni (2018) demonstrated that PjBL was effective in fostering collaborative skills, corroborating the high percentage (90%) of collaboration reported in this study.

Documentation outcomes show students could produce various AR-based learning media products using Assemblr Edu. The developed products possess variations based on selected learning materials, ranging from science concepts and the environment to abstract matters needing visual aid. Analyses of student products reveal that the developed AR media incorporate multiple multimedia components, such as three-dimensional objects, visual illustrations, explanatory texts, and interactive elements. Based on the product analysis, the material suitability aspect received a good category, demonstrated by the students' capacity to connect learning content with elementary school learning goals (Meliyani, 2022). Furthermore, the visual design aspect shows that students are beginning to be able to utilize Assemblr Edu features to create more engaging and easily understandable media (Haryani, 2024). Developing AR media via Assemblr Edu offers opportunities for students to explore technology within pedagogical contexts (Dewi, 2021). Technology utilization is understood not only as an operational skill but also as part of the process of designing meaningful learning experiences (Putri, et al., 2024). This is crucial for primary school teacher education students as prospective teachers, as the ability to select and develop learning media is a professional competency that must be possessed (Pratiwi, et al., 2025).

Based on interview results, several core themes describing students' learning experiences while undergoing project-based learning were identified. The analytical results showed that most students perceived developmental growth in their capability to utilize digital technology, design learning media, and work collaboratively in groups. Interview coding results highlighted that the theme of enhanced technological capability appeared in 8 out of 10 students (80%), increased creativity in media design in 7 students (70%), and collaborative experiences in 9 students (90%). Such data illustrate that AR project development activities bestow learning experiences relating not only to technological aspects but also social and pedagogical facets (Hermawan, & Hadi, 2024). These findings denote an adaptation and capability development process among students through direct experiences (Sriwahyuni, 2026). For instance, students initially struggled with Assemblr Edu features but gradually became more proficient through exploration and peer support. They also learned to negotiate and divide tasks effectively within their groups.

The obstacles faced by students (reported by 60% of interviewees) included limited prior experience with AR applications, difficulty in creating complex 3D objects, and challenges in managing time to complete the project within the course schedule. However, students also reported overcoming these challenges through lecturer guidance, peer collaboration, and trial-and-error learning, which ultimately strengthened their problem-solving skills and technological resilience.

Students undergo a learning progression from an initial state of lacking technological understanding to being capable of producing learning media products

(Astuti, et al., 2026). This process acts as one of the primary characteristics of PjBL, namely providing opportunities for learners to learn via real experiences and project completion (Resa, & Muchtar, 2025). Aside from bolstering technological abilities, project activities propel students to think creatively in determining media designs (Diani, et al., 2026). Students must contemplate how learning materials can be visualized through AR objects to suit elementary students' traits (Efendhi, et al., 2025). Thus, the media development process not only yields digital products but also cultivates the pedagogical abilities of students in instructional design. The findings also have significant implications for the PGSD curriculum, particularly in courses like Learning Multimedia. The success of this PjBL model suggests that similar project-based approaches could be integrated into other courses to enhance the development of 21st-century skills among prospective teachers. It highlights the need for curriculum designers to incorporate authentic, technology-driven projects that bridge theory and practice.

Although PjBL implementation provides positive learning experiences, several obstacles were encountered during the AR media development process. Based on interview results, students faced constraints such as limited preliminary experience utilizing the Assemblr Edu application, difficulties formulating visual designs, and time management in completing projects. These obstacles underline that technology-based media development necessitates continuous mentoring and feedback processes. Within the primary school teacher education students learning context, lecturers serve as facilitators aiding students in bridging technological capabilities with pedagogical needs. Mentorship throughout the project process assists students in executing evaluations and refinements so that the resulting products align more accurately with learning objectives (Burhanuddin, et al., 2023). This study has several limitations, including its implementation over a single semester, which may not fully capture the long-term development of competencies. Additionally, this research did not measure the effectiveness of the AR products when used in actual elementary school classrooms, which would be a crucial step for future research.

Overall, the research results signify that the implementation of Project-Based Learning in the development of AR learning media using Assemblr Edu can provide authentic learning experiences for primary school teacher education students. The learning process does not merely yield digital media products but also advocates for the development of prospective teachers' competencies in designing innovative technology-based learning.

CONCLUSION

The implementation of Project-Based Learning (PjBL) in developing Augmented Reality (AR) learning media using Assemblr Edu in the Learning Multimedia course has been successfully carried out in the "very good" category (implementation percentage of 89%). Primary school teacher education students were able to produce diverse AR media products with good quality in terms of material suitability, visual design, and interactivity. The students' learning experiences showed significant improvements in collaboration skills (90%), digital technology abilities (80%), and creativity (70%). Thus, PjBL is proven to be effective in developing the digital competencies, creativity, and collaboration of prospective elementary school

teachers, while also providing authentic learning experiences that bridge theory and practice in designing innovative technology-based learning media. This study has limitations, including its implementation over only one semester and the lack of measurement of the effectiveness of the AR products when used directly in elementary school classrooms.

RECOMMENDATION

Based on the findings of this study, it is recommended that lecturers teaching the Learning Multimedia course and similar courses continue to integrate PjBL models based on AR technology into their instruction to optimally equip students with 21st-century skills. Further research should be conducted to test the effectiveness of the AR media products developed by students when implemented in actual elementary school learning environments. Additionally, the PjBL model could be adapted and applied to other courses within the teacher education curriculum to enhance the development of prospective teachers' competencies in designing innovative and technology-integrated learning experiences.

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