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Development of Augmented Reality Learning Media Based on Assemblr Studio Web for Grade VII Junior High School Informatics Subjects

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Abstract

Local Area Network (LAN) concepts in the seventh-grade Informatics curriculum are relatively abstract, making it difficult for students to understand network topologies, inter-device relationships, and data communication processes. This study aimed to develop Augmented Reality (AR)-based learning media using Assemblr Studio Web and evaluate its validity and practicality for teaching LAN concepts. The study employed a Research and Development approach based on the 4D model, comprising the define, design, develop, and disseminate stages. Conducted at SMP Negeri 4 Palupuh, the study involved one subject-matter expert, two media experts, and 24 seventh-grade students. Data were collected using validation sheets and practicality questionnaires and analysed through mean scores and percentages. The findings showed that the developed learning media obtained a material validity score of 4.46 and a media validity score of 4.74, both of which were categorised as highly valid. The practicality assessment yielded a score of 86%, indicating that the media was highly practical for classroom use. The AR-based media provided interactive visualisations of Bus, Star, and Ring network topologies, thereby facilitating

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students' understanding of LAN structures, relationships among devices, and data communication processes. The study concludes that the developed AR learning media is valid and practical for use in seventh-grade Informatics instruction. These findings demonstrate the potential of AR technology to support the concrete visualisation of abstract concepts, promote interactive learning, and strengthen the pedagogical integration of digital technology in Informatics education.

Keywords: Assemblr Studio Web; Augmented Reality; Informatics Education; Learning Media; Local Area Networks

INTRODUCTION

The rapid advancement of information technology in the digital era has encouraged the education sector to utilize technology as a means of creating more innovative, interactive, and student-centered learning environments (Batubara, 2020; Kusumah, 2022; Yaumi, 2018). In line with the implementation of the Merdeka Curriculum, teachers are expected to integrate technology into the learning process to provide students with more meaningful learning experiences and facilitate a more concrete understanding of concepts (Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi, 2022). One of the subjects that requires technology-based learning media is Informatics, particularly the topic of Computer Networks and the Internet (Caroline et al., 2021).

The development of technology-based learning media should be supported by a systematic instructional design model to ensure that the resulting media are pedagogically appropriate, effective, and aligned with learning objectives. According to Ardianti (2022), the ADDIE model provides a structured framework consisting of analysis, design, development, implementation, and evaluation stages that guide the development of digital learning media. Through these systematic stages, learning media can be designed based on learners' needs, curriculum requirements, and learning characteristics, thereby improving the quality of instructional materials and facilitating meaningful learning experiences (Hartono et al., 2025). Furthermore, digital learning media developed through an appropriate instructional design process are capable of increasing students' motivation, engagement, and learning effectiveness because they provide more interactive, flexible, and learner-centered learning environments (Safitri & Aziz, 2022).

Local Area Network (LAN) is one of the core topics in the Grade VII junior high school Informatics curriculum, covering concepts of computer networks, network topologies, inter-device connections, and data communication processes (Mushthofa et al., 2021). This topic is inherently abstract because students are required to understand network topologies, device configurations, and data communication mechanisms that cannot be directly observed. Learning activities that continue to rely primarily on textbooks, static images, and two-dimensional presentation media often make it difficult for students to distinguish the characteristics of Bus, Star, and Ring topologies and to comprehend the relationships among devices within a computer network (Arsyad, 2017; Falahudin, 2020).

Based on classroom observations and interviews with the Informatics teacher at SMP Negeri 4 Palupuh, several challenges were identified in teaching the LAN topic. Students experienced difficulty understanding network topology concepts because the instructional media used were unable to realistically visualize network structures. Consequently, students' learning outcomes remained relatively low. Of the 24 Grade VII students, only six students (25%) achieved the Learning Objective Achievement Criteria (KKTP), while the remaining 18 students (75%) did not meet the required level of mastery, with an average class score of 64.6. These findings indicate the need for innovative learning media capable of presenting LAN concepts in a more concrete and comprehensible manner.

Interactive multimedia has become one of the most effective forms of digital learning media because it integrates text, images, audio, animation, and user interaction into a single learning environment. Unlike conventional instructional media, interactive multimedia enables learners to actively control the learning process, thereby increasing engagement, motivation, and conceptual understanding. Shaquille & Parga, (2023) emphasized that interactive multimedia developed through a systematic instructional design process provides more meaningful learning experiences by encouraging active student participation rather than passive information reception. Their study also demonstrated that the developed multimedia achieved a high level of validity and usability, indicating that well-designed interactive media can effectively support classroom learning and improve students' learning experiences .

Considering these conditions, an innovative instructional medium is required that not only presents information visually but also provides interactive learning experiences, enabling students to construct their understanding independently (Raharjo et al., 2021; Batubara, 2020). One technology with considerable potential to achieve this objective is

Augmented Reality (AR), which integrates three-dimensional virtual objects into real-world environments in real time (Mustaqim, 2016; Lee et al., 2022). The application of AR in education enables students to observe virtual objects from multiple perspectives, allowing abstract concepts to be learned in a more concrete and meaningful way. Therefore, AR-based learning media are considered highly relevant for addressing students' difficulties in understanding Local Area Network (LAN) concepts (Mustaqim, 2016; Zubaidah, 2016).

One promising alternative is the implementation of Augmented Reality (AR)-based learning media. AR technology combines three-dimensional virtual objects with the real environment, allowing students to interactively observe objects from various perspectives (Mustaqim, 2016). Through three-dimensional visualization, concepts such as network topologies, inter-device relationships, and data communication processes can be presented more realistically than through conventional two-dimensional media (Assemblr, 2023; Pratama, 2024; Slick, 2020). In this study, the learning media were developed using Assemblr Studio Web because it is a web-based platform, is user-friendly without requiring advanced programming skills, and supports the development of interactive AR learning media.

Previous studies have demonstrated that the implementation of Augmented Reality (AR) as an instructional medium has a positive impact on both the learning process and students' learning outcomes. Mustaqim (2016) reported that AR-based media effectively transform abstract objects into concrete visual representations, thereby facilitating students' conceptual understanding. Furthermore, Ramadhan (2022) found that the development of AR learning media using Assemblr Edu for the Solar System topic achieved high levels of validity and practicality while increasing students' interest during the learning process. Similarly, Pratama (2024) reported that Assemblr Studio Web enables educators to develop interactive learning media efficiently because it is web-based, easy to operate without programming expertise, and capable of presenting engaging three-dimensional objects. These findings were further supported by Sari (2025), who developed learning media using Assemblr Studio Web for the Human Respiratory System topic and concluded that the resulting media were highly feasible for classroom implementation, demonstrating high levels of validity and practicality while significantly enhancing student engagement. Collectively, these studies indicate that AR-based learning media can improve the quality of instruction by providing interactive three-dimensional visualizations, increasing students' learning motivation, and facilitating the comprehension of abstract concepts. Nevertheless, studies focusing on the development of Augmented Reality learning media based on Assemblr

Studio Web for the Local Area Network (LAN) topic in Grade VII junior high school Informatics remain limited. Therefore, this study seeks to address this research gap by developing AR learning media tailored to the characteristics of LAN content and evaluating its validity and practicality.

The novelty of this study lies in the development of Augmented Reality learning media based on Assemblr Studio Web, specifically designed for the Local Area Network (LAN) topic in Grade VII junior high school Informatics in accordance with the implementation of the Merdeka Curriculum. The developed media not only provide three-dimensional visualizations of Bus, Star, and Ring network topologies but also enable students to interact directly with virtual objects, thereby creating a more contextualized and meaningful learning experience. Furthermore, this study evaluates the quality of the developed media through analyses of validity and practicality as the basis for determining its feasibility for classroom implementation.

Based on the foregoing discussion, this study aims to develop Augmented Reality learning media based on Assemblr Studio Web for the Local Area Network (LAN) topic in Grade VII junior high school Informatics, to analyze the validity of the developed media based on evaluations conducted by subject matter experts and media experts, and to evaluate its practicality based on students' responses, thereby producing learning media that are suitable for implementation in the Informatics learning process.

METHODS

This study employed a Research and Development (R&D) approach to develop Augmented Reality (AR)-based learning media using Assemblr Studio Web for the Local Area Network (LAN) topic in the Grade VII junior high school Informatics curriculum. The development process adopted the 4D model proposed by Thiagarajan, Semmel, and Semmel, which consists of four stages: Define, Design, Development, and Disseminate. The study was conducted at SMP Negeri 4 Palupuh.

The research participants consisted of one subject matter expert, two media experts, and 24 Grade VII students of SMP Negeri 4 Palupuh who participated as respondents in the practicality evaluation. The validators were selected using purposive sampling based on their expertise and competence in subject matter and instructional media development. Meanwhile, the student participants were selected using total sampling, as all students in the

class designated for the field trial were involved in the study. A total of 24 students participated in the practicality testing.

The research instruments consisted of a subject matter expert validation sheet, a media expert validation sheet, and a student practicality questionnaire. The validation instruments were used to evaluate the appropriateness of the content, material presentation, media appearance, interactivity, and technical aspects of the developed learning media. The practicality questionnaire was designed to collect information regarding the ease of use, attractiveness, usefulness, and effectiveness of the learning media in facilitating students' understanding of the instructional content. Data were collected by administering the validation sheets to the expert validators and distributing the practicality questionnaire to the students after they had used the Augmented Reality learning media. The collected data comprised quantitative data in the form of evaluation scores and qualitative data in the form of comments and suggestions provided by the validators, which served as the basis for revising and improving the developed media.

The data were analyzed using descriptive quantitative techniques. The validity data were analyzed by calculating the mean score across all evaluation aspects and subsequently interpreting the results according to predetermined validity criteria to determine the feasibility of the developed learning media. The practicality data were analyzed using a percentage formula by comparing the total score obtained with the maximum possible score and multiplying the result by 100%. The resulting percentage was then interpreted based on the established practicality criteria to determine the practicality level of the learning media. The findings from the validity and practicality analyses served as the basis for determining the feasibility of the Augmented Reality learning media based on Assemblr Studio Web for implementation in Grade VII junior high school Informatics instruction.

RESULTS

1. Validity of the Augmented Reality Learning Media

Table 1. Content Validity of the Augmented Reality Learning Media

Item	Aspect	Mean Score
1	Content appropriateness and accuracy	5
2	Alignment with learning objectives	4,33
3	Quality of content presentation	4,5

Item	Aspect	Mean Score
4	Instructional feedback	4
Mean		4,46

The content validity assessment table 1 was conducted by one subject matter expert, while the media validity assessment involved two media experts. The results of the content validation indicated that the developed Augmented Reality (AR) learning media achieved a mean score of 4.46, which falls within the very good category. The evaluation covered the appropriateness and accuracy of the content, alignment with the learning objectives, quality of content presentation, and instructional feedback. These findings demonstrate that the instructional content incorporated into the developed media is appropriate, accurate, and consistent with the intended learning objectives for the Local Area Network (LAN) topic.

Table 2. Media Validity of the Augmented Reality Learning Media

No	Aspect	Assesment	
		V1	V2
1	Visual media design	4,25	4,5
2	Visual quality	5	5
3	User interactivity	4,67	5
4	Media accessibility	4,5	4,5
5	Usefulness for learning	5	5
Mean		4,68	4,8

The media validation in table 2 was conducted in two stages. During the first stage, the developed media obtained a mean score of 3.87 from Validator I and 3.98 from Validator II, both of which were categorized as good. Based on the recommendations and comments provided by the validators, several revisions were implemented to improve the quality of the learning media. Following these revisions, the second-stage validation demonstrated a significant improvement, with mean scores increasing to 4.68 from Validator I and 4.80 from Validator II, resulting in an overall mean score of 4.74, which is classified as very valid.

Overall, the results of both the content and media validation indicate that the developed Augmented Reality learning media based on Assemblr Studio Web possesses a high level of validity. The media satisfactorily fulfilled the evaluation criteria related to content quality, instructional design, visual presentation, interactivity, accessibility, and instructional usefulness. Therefore, the developed learning media can be considered highly

valid and suitable for implementation in Grade VII junior high school Informatics instruction.

2. Practicality of the Augmented Reality Learning Media

The practicality evaluation was conducted with 24 Grade VII students at SMP Negeri 4 Palupuh after they had used the Augmented Reality (AR) learning media during the instructional process. The analysis revealed that the developed learning media obtained a total score of 1,440 out of a maximum possible score of 1,680.

The practicality level was calculated using the following formula:

$$P = \frac{Obtained\ Score}{Maximum\ Score} \times 100\%$$

Based on the calculation, the Augmented Reality learning media for the Local Area Network (LAN) topic in Grade VII junior high school achieved an overall practicality percentage of 86%. According to the predetermined practicality criteria, this result falls within the Very Practical category.

These findings indicate that the developed AR-based learning media is easy to use, engaging, and beneficial for students during the learning process. Furthermore, the high practicality score suggests that the media can be implemented effectively in Informatics instruction, as it facilitates students' understanding of the Local Area Network (LAN) topic while providing an interactive and meaningful learning experience.

DISCUSSION

The findings of this study indicate that the Augmented Reality (AR)-based learning media developed using Assemblr Studio Web achieved the very valid category based on evaluations conducted by the subject matter expert and media experts. These results demonstrate that the developed media are well aligned with the intended learning outcomes, present instructional content systematically, and are supported by high-quality visual representations and interactive features that facilitate students' understanding of Local Area Network (LAN) concepts. The three-dimensional visualization effectively transforms abstract concepts into concrete representations, thereby supporting a more meaningful learning process.

The practicality evaluation further revealed that the developed learning media achieved a practicality score of 86%, which falls within the very practical category. The students perceived the media as easy to use, visually appealing, and effective in facilitating their understanding of the instructional content through interactive features such as object rotation, zooming, and annotations. Moreover, the media can be accessed using both smartphones and computers, providing flexibility and convenience during the learning process.

These findings suggest that the three-dimensional visualization provided by the Augmented Reality learning media effectively reduces the abstract nature of the Local Area Network (LAN) topic. Rather than receiving information solely through verbal explanations, students are able to observe the relationships among network devices and the characteristics of each network topology more realistically. This finding is consistent with the Cognitive Theory of Multimedia Learning, which posits that presenting information through a combination of text, images, animations, and interactive visualizations enhances conceptual understanding because learners process information through both visual and verbal channels simultaneously. Consequently, the AR-based learning media function not only as visual aids but also as instructional tools that promote more meaningful learning experiences.

The results of this study are consistent with those of previous research demonstrating that Augmented Reality-based learning media possess a high level of feasibility and contribute positively to instructional quality. Mustaqim (2016) reported that AR learning media effectively facilitate students' understanding of abstract concepts through three-dimensional object visualization. Similarly, Ramadhan (2022) found that Augmented Reality learning media achieved high levels of validity and practicality, indicating their suitability for classroom implementation. These findings are further supported by Pratama (2024), who concluded that Assemblr Studio Web enables teachers to develop interactive instructional media efficiently without requiring programming expertise. Furthermore, Sari (2025) reported that learning media developed using Assemblr Studio Web significantly enhanced students' engagement throughout the learning process. The consistency of these findings indicates that the application of Augmented Reality technology has a positive and sustained contribution to improving instructional quality across various learning topics.

Overall, the findings demonstrate that the Augmented Reality learning media based on Assemblr Studio Web are feasible for implementation as an alternative instructional

medium for teaching the Local Area Network (LAN) topic in Grade VII junior high school Informatics. These findings reinforce the potential of Augmented Reality technology to improve instructional content delivery while creating more interactive, engaging, and meaningful learning experiences for students.

This study also provides both theoretical and practical implications. From a theoretical perspective, the findings strengthen the evidence that Augmented Reality technology can serve as an effective instructional medium for facilitating the learning of abstract concepts in Informatics education. From a practical perspective, the developed learning media can be utilized by teachers as a supplementary instructional resource to enhance students' interaction with learning materials, facilitate demonstrations of network topologies, and create more active, engaging, and student-centered learning experiences. Furthermore, the developed media represent a practical example of integrating digital technology into classroom instruction to support the implementation of the Merdeka Curriculum.

Despite these contributions, this study has several limitations. First, the field testing was conducted in only one school involving 24 students, limiting the generalizability of the findings to broader educational contexts. Second, the study evaluated only the validity and practicality of the developed learning media and did not examine its effectiveness in improving students' learning outcomes through an experimental research design. Third, the developed media were specifically designed for the Local Area Network (LAN) topic in the Grade VII Informatics curriculum; therefore, future studies should extend the development and evaluation of AR-based learning media to other Informatics topics.

CONCLUSION

This study successfully developed Augmented Reality (AR)-based learning media using Assemblr Studio Web for the Local Area Network (LAN) topic in the Grade VII junior high school Informatics curriculum by adopting the 4D development model, which consists of the Define, Design, Development, and Disseminate stages. Based on the validation results obtained from the subject matter expert and media experts, the developed learning media were categorized as very valid, while the practicality evaluation yielded a score of 86%, indicating that the media fall within the very practical category. These findings demonstrate that the developed learning media satisfy the criteria for content appropriateness, visual

design, interactivity, and usability, confirming their suitability for implementation in the Informatics learning process.

The developed Augmented Reality-based learning media effectively visualize Bus, Star, and Ring network topologies in a three-dimensional format, enabling students to transform their understanding of the inherently abstract Local Area Network (LAN) concepts into more concrete and meaningful knowledge. These findings indicate that the integration of Augmented Reality technology through Assemblr Studio Web has considerable potential to support more interactive, engaging, and student-centered Informatics instruction, while also serving as an alternative instructional medium that supports the implementation of the Merdeka Curriculum.

Future research is recommended to investigate the effectiveness of the developed learning media in improving students' learning outcomes through experimental research designs, involve larger and more diverse participant samples, and extend the development of Augmented Reality-based learning media to other Informatics topics. These recommendations are proposed based on the scope and limitations of the present study and should be interpreted as directions for future research rather than as additional research findings.

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