Journal of Educational Sciences
Journal homepage: https://jes.ejournal.unri.ac.id/index.php/JES
P-ISSN 2581-1657
E-ISSN 2581-2203

The Utilization of Assembler Edu (AR) as a Learning Media to Increase Students' Learning Interest in Komjardas Class X Computer and Network Engineering Vocational School Unitomo Surabaya

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ARTICLE INFO

Article history:

Received: 22 Nov 2025
Revised: 19 Des 2025
Accepted: 24 Des 2025
Published online: 05 Jan 2026

Keywords:

Augmented Reality,
Assemblr Edu,
Learning Interests,
Learning Media,
KOMJARDAS

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Article Doi:

https://doi.org/10.31258/jes.10.1.p.1522-1535

A B S T R A C T

The research is motivated by the challenges in Basic Computer and Network learning (Komjardas) that require concrete visualization of network devices, while conventional media such as textbooks are considered less interactive and cause students' interest in learning to decrease. The purpose of the research was to analyze the use of Augmented Reality (AR)-based Assemblr Edu media in increasing the learning interest of students in class X of Computer and Network Engineering at SMK Unitomo Surabaya. The study used a descriptive qualitative approach of 33 students. Data was collected through observation, interviews, documentation, and learning outcome tests. Research shows that the implementation of Assemblr Edu significantly increases students' interest in learning, characterized by enthusiasm, activeness of questioning, independent exploration, and collaboration. Cognitive learning outcomes also improved with an average post-test score of 83.2-84.3 and a completeness of 83.6%, compared to a pre-test of 75.6-76.2 with a completeness of 75.9%. An effective Edu assembly creates immersive and interactive learning, thereby increasing students' interest and learning outcomes. Teachers need to be able to consider the integration of AR technology and training.

1. Introduction

Education that encourages transformation in human life, not only serves as a means of acquiring knowledge but also as the main foundation in the development of an individual's character and potential. As mandated in the Law of the Republic of Indonesia Number 20 of 2003 concerning the National Education System,

education is an effort that is planned to create a learning atmosphere that allows students to develop their full potential, including spiritual aspects of religion, self-control, personality, intelligence, noble morals, and skills necessary for themselves and society (Hakim, 2016). This goal demands learning that not only transfers knowledge but must also arouse students' active involvement and interest, so that they can become adaptive and competent individuals in the face of the dynamics of the global era. To realize these educational goals, the learning process in the classroom is important to involve dynamic interaction between teachers and students. The success of this process depends heavily on strategies, approaches, and most importantly, the selection of the right learning media by educators (Harisnur, 2022; Jufri et al., 2023). Learning media serves as a bridge that connects abstract material with students' concrete understanding. The use of appropriate media not only clarifies the delivery of material systematically and consistently, but is also able to create a more meaningful, reflective, and in-depth learning experience (Hidayat et al., 2025; Irmayu et al., 2024). So that innovation in learning media is a necessity to create an effective and fun learning environment.

The development of digital technology opens great opportunities for the creation of more interesting and interactive learning media innovations. Technology allows material to be presented not only through verbal narratives and static images, but also through visualization, simulation, and high interactivity that can bring students closer to concepts that are difficult to imagine (Aisyah et al, 2024; Pribadi, 2017). However, the major disruption that occurred in early 2020 due to the Covid-19 pandemic forced the world of education to make a drastic transformation from conventional face-to-face learning to technology-based distance learning (online) (Kurniawan & Wanto, 2023; Baharuddin, 2020). This shift poses significant challenges, especially for vocational education such as vocational schools, where many materials that require hands-on practice and real visualization are very difficult to reach optimally through conventional media such as textbooks or Student Worksheets (LKS).

This challenge is felt in the subject of Basic Computers and Networks (Komjardas) at SMK, which requires an in-depth visual understanding of physical objects such as computer hardware, cable arrangements, and network topology. These textbooks with static two-dimensional images often fail to provide adequate representation, causing students to become passive, disinterested, and have difficulty imagining the complex structure of a device (Rozali et al., 2022; Widyatama et al., 2025). This condition, which is exacerbated by the one-way lecture method is still dominantly used, has the potential to reduce students' interest in learning (Mahmudah, 2016). So, a media breakthrough is needed that can display objects in three dimensions, be more interactive, and accessible in any learning environment. One of the innovative solutions that answers these challenges is the use of Augmented Reality (AR) technology. AR technology enables the real-time addition and visualization of digital objects into the real environment through smartphone or tablet devices, creating an immersive, dynamic, and realistic learning experience (Indahsari & Sumirat, 2023; Salsabila & Putra, 2024). The Assemblr Edu platform is present as an educational application specifically designed to facilitate teachers in creating and presenting 3D and AR-based learning media (Damayanti & Putra, 2024). With its

features that allow the manipulation of virtual objects and their embedding in the real world, Assemblr Edu has the potential to be a portable virtual laboratory that can significantly increase students' sense of understanding and interest in learning (Dewi et al., 2022).

Based on the above problems and potential solutions, this study aims to be able to analyze the influence of the use of Assemblr Edu (AR) media in increasing students' interest in learning in Komjardas subjects and to describe their conditions. This research is focused on analyzing the extent to which the application of the platform can increase the involvement and enthusiasm of students in class X of Computer and Network Engineering at SMK Unitomo Surabaya, as well as to find out how their learning interests change after participating in the learning process with this interactive and contextual media. This research is expected to make a real contribution to the development of learning strategies that are relevant to the demands of education in the 21st century. The purpose of the research was to analyze the use of Augmented Reality (AR)-based Assemblr Edu media in increasing the learning interest of students in class X of Computer and Network Engineering at SMK Unitomo Surabaya.

2. Methodology

This study uses a descriptive qualitative approach. This approach was chosen to gain a deep and comprehensive understanding of the phenomenon of using Assemblr Edu in a real context in the classroom, as well as to narratically describe how the process can affect students' interest in learning. This research focuses on naturalistic descriptions of behavior, interactions, and perceptions of research subjects that cannot be measured numerically, but through in-depth observation of the dynamics that occur during the learning process (Sugiyono, 2017). This research was carried out from April to May 2025 with a time allocation of 6 meetings, which provided sufficient space for the observation process and test of repeated and in-depth learning outcomes on the development of student interests. During this period, researchers will be directly involved in the classroom to teach, observe, record, and analyze any changes in student learning behavior that occur.

The subjects in this study are all students of Class X Computer and Network Engineering at SMK Unitomo Surabaya which totals 33 people. The selection of this subject was carried out using the convenience sampling technique, where all members of the population were made the subject of the study because the number was limited and in accordance with the purpose of the research (Golzar et al., 2022). Student participation is non-participant for observation, meaning they will be observed in normal learning activities without intervention that interferes with the natural process. Before the research begins, permission will be obtained from the school and the student's parents/guardians to ensure all research ethics procedures are met. This class was specifically chosen because it was taking a subject, namely Komjardas whose material is very relevant to the use of Augmented Reality media for the implementation of network device visualization.

The main research instrument is the researcher himself assisted by several data collection tools. The supporting instruments consist of: 1) Observation sheet, containing 10 indicators of student learning interest behavior to be observed; 2) Semi-structured interview guidelines, containing 10 guiding questions that will be asked to 5 randomly selected students to dig deeper into their interests; 3) Documentation sheets, used to record and collect learning artifacts such as photos and videos of classroom activities; and 4) Learning outcome tests (pre-test and post-test) which are used as supporting data to see the indirect impact of increased interest on concept comprehension (Sugiyono, 2017). All these instruments have been validated by one learning media expert and one linguist to ensure their clarity and suitability with the research objectives.

The data collection procedure is carried out by triangulating methods to increase the validity of the data (Sugiyono, 2017). First, the observation of passive participants was carried out for 6 meetings with a focus on 10 indicators of learning interest behavior. The researcher teaches while regularly surrounding students in the classroom and records all student behaviors related to the learning interest indicator. Second, learning outcome tests are given pre-test and post-test at each of the meetings to be able to obtain supporting quantitative data. Third, in-depth interviews were conducted outside of class hours with 5 students who represented a variation in interests based on the results of temporary observations, with the aim of exploring the reasons behind the behavior shown. Fourth, documentation is carried out continuously by photographing and recording critical moments during the use of Assemblr Edu, such as facial expressions, body gestures, and students' interactions with AR objects.

The data analysis technique follows the Miles and Huberman interactive model which includes four stages that run simultaneously (Sugiyono, 2017). The first stage is data collection, where all observation, interview, documentation, and test data is collected. The second stage is data reduction, which is the process of selecting, focusing, simplifying, and abstracting raw data from field records to bring up important themes related to learning interests. The third stage is data presentation, where the reduced data is arranged in the form of descriptive narratives, matrices, and flowcharts to facilitate conclusions drawn. The last stage is conclusion drawn/verification, where the researcher re-checks the findings while continuing to conduct analysis. The validity of the data was tested through triangulation methods (comparing observation, interview, and documentation data) and source triangulation (comparing the opinions of several students interviewed). In addition, member checking is carried out by confirming the interpretation of the data to the interviewed subjects (Birt et al., 2016).

3. Results and Discussion

This study involved the entire population of Class X TKJ students at SMK Unitomo Surabaya which amounted to 33 people. In terms of gender composition, the class consists of 28 male students and 5 female students, which reflects the general demographic trends in the engineering study program. Prior to the intervention in

the use of Assemblr Edu, the learning of Komjardas material in this class was carried out with a conventional method dominated by teacher lectures, the use of textbooks, and two-dimensional images to explain network devices such as routers, switches, and hubs. Based on initial observations and informal interviews with the teaching teacher, although some students show basic interest, in general the classroom dynamics tend to be passive with limited involvement. The participation rate in the question and answer is low, and the students' enthusiasm for material that is considered abstract and technical is not optimal. The background of students' academic abilities in this class is quite diverse, with the average score of previous tests ranging from a sufficient level but not yet showing a deep understanding of the functions and physical differences of network devices visually and spatially.

The selection of class X TKJ as the research subject is based on the suitability of the curriculum material with AR potential. Material on computer network hardware is concrete but is often presented in the abstract through flat images, creating a gap of understanding for students. The learning context before the study showed that students had difficulty imagining three-dimensional structures, port locations, and physical differences between devices, which could ultimately affect their interests and learning outcomes. This class is also an environment that is familiar with gadget technology, so the potential for the adoption of application-based media such as Assemblr Edu is highly valued. With the characteristics of classrooms that are homogeneous in terms of study program but diverse in initial level of understanding, this study aims to observe how the integration of immersive media can transform the interests and dynamics of learning that were previously dominated by one-way methods into an interactive, visual, and collaborative learning experience.

The implementation of learning during the study was designed in 6 meetings in April-May 2025, with a consistent structure to ensure data consistency. Each meeting begins with a short pre-test to measure initial understanding, followed by an exploration session using Assemblr Edu media. In this session, the teacher guides students to scan the markers that have been prepared using the Assemblr Edu app on their smartphones, so that the 3D objects of the network device (such as routers, switches, hubs) appear in the real world. Students are then given the freedom to observe, enlarge, rotate, and interact with the 3D object individually or in groups. The data collection process is carried out in parallel during the learning process.

The researcher, who also acted as a teacher, observed passive participants using an observation sheet containing 10 indicators of learning interest. Based on in-depth observation during 6 meetings, it was seen that there was a very real qualitative change in the behavior of students' learning interests after the use of the application of Assemblr Edu media. Observation shows the presence or absence of behavioral indicators. This is shown by the diffusion of interest in students. This change does not happen instantly, but through an adaptation process where students slowly explore, ask questions, and collaborate. These findings provide an answer to the formulation of the first problem, showing an increase in interest in learning occurs, which has been shown by Table 1.

Table 1. Observation of Learning Interest with Assemblr Edu

No.	Observation Aspect	Activity		Information
		Available	None	
1.	Enthusiasm for the lesson.	✓		Initially, only a few students quickly sat down. At the end of the meeting, most of the students had turned on their smartphones and opened the Assemblr Edu app before the lesson started, showing anticipatory excitement.
2.	Activeness of asking questions.	✓		The questions at the beginning tended to be technical, such as how to use it, sir?. The question at the end is already based on material and exploration Why is the switch port more than the router, sir?, shows the depth of engagement.
3.	Willingness to experiment with the Assembler Edu platform.	✓		Students don't just use the features they teach. They independently discovered the zoom, rotate, and screenshot features of AR objects, showing a sense of ownership over their learning.
4.	Interested & amazed facial expressions.	✓		Expressions of admiration and excitement are often heard, especially when the first time you see a 3D object appear from the marker. This expression is a strong indicator of the surprise and positive attraction experienced.
5.	Cooperation & positive interaction.	✓		Students who understand the instructions quickly help friends who are still struggling. A group of 3-4 people was formed to observe one device, showing the growth of collaborative learning.
6.	Determination to listen and focus.	✓		The duration of students' attention increased significantly. The classroom atmosphere became quiet as the teacher explained with the AR object, as their visual attention was glued, indicating a high level of concentration.
7.	Initiative to help friends.	✓		This behavior began to appear in the middle of the

			study. Not all students do it, but the emergence of initiative from some students who are usually quiet is a sign of developing confidence and a sense of social responsibility.
8.	Desire to complete tasks.	✓	The tasks given are completed with enthusiasm because it is felt as a fun challenge, not a burden. Some students even collect assignments early to explore further.
9.	Curious behavior (rotating objects).	✓	Almost all students manipulate 3D objects to see from different angles. This exploratory behavior is a testament to the curiosity that the media has managed to arouse.
10.	Provide positive feedback.	✓	Spontaneous feedback such as Cool, Sir!, the material becomes easy to understand, or Cool! ejected. This feedback is a direct validation of students' acceptance of the media.

The evidence of these observations, which is strengthened by several learning photos, such as in the classroom showing the atmosphere of students who are focusing on paying attention and observing the teacher in using Assemblr Edu which depicts involvement, is shown in Figure 1.

Figure 1. Students Who Focus on Paying Attention to Edu Assemblr Media

The picture at this fourth meeting shows a spark of interest, where some students show curious expressions, although they still look hesitant. Their facial expressions, which show admiration and lively discussion, represent the culmination of social interaction and collaborative interest. The change recorded in the photo is not only about activities, but about the shift in energy and class dynamics from passive to active and full of participation. The main learning media used is the Assemblr Edu

application, which is operated through students' smartphones. The media formation is as shown in Figure 1, Figure 2, and Figure 3 below.

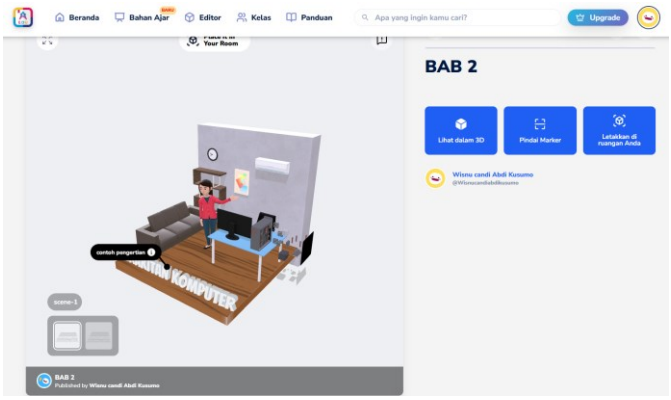

Figure 2. Edu Assemblr Media Loaded with Computer Assembly Materials

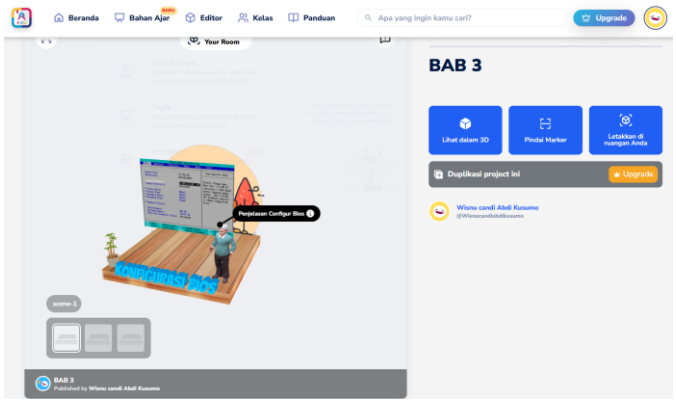

Figure 2. Edu Assemblr Media Loaded Bios Configuration Material

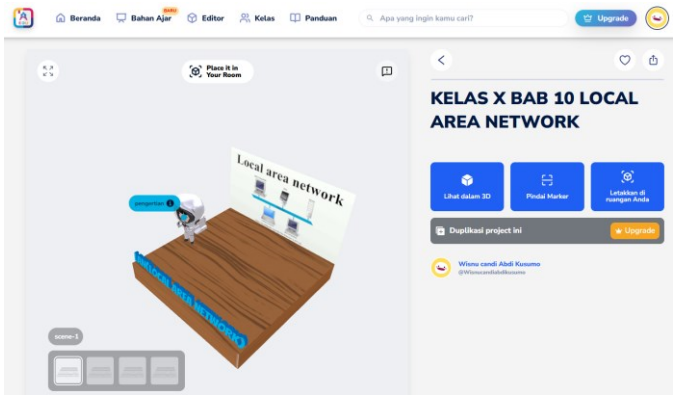

Figure 3. Edu Assembler Media Loaded with Local Area Network Material

With this media, learning then takes place interactively. In addition to the observed behavioral changes, this study also reveals a significant impact of the application of Assemblr Edu on students' cognitive learning outcomes, with the dynamics of assessment in Table 2.

Table 2. Dynamics of Student Learning Outcome Assessment in the Classroom

No.	Aspects and Criteria Assessed	Meetings To	
		1 - 3 in April 2025	4 - 6 in May 2025
1.	Understanding of computer hardware.	75 - 90	75 - 90
2.	Understanding of the assigned tasks.	75 - 90	75 - 90
3.	Students' skills in practice.	75 - 90	75 - 90

In line with the assessment mechanism that has been developed, the data obtained from the pre-test and the final test (post-test) show very encouraging developments. The pre-test held at the first to third meetings in April 2025 resulted in an average score that was still relatively low, reflecting the limited initial understanding of the students of computer network device materials, which is shown in Table 3.

Table 3. Student Learning Test Results Before Using Edu Assembler

Meeting Date	Grade Point Average
15 April 2025	75,6
22 April 2025	76,2
29 April 2025	75,9
Completion Percentage	75,9%

Based on the data presented, it was interpreted that the initial level of students' understanding of Basic Computers and Networks material was sufficient and stable even before the Assemblr Edu media intervention was carried out. The average grade point average at three consecutive meetings ranged from a consistent score, which was between 75.6 to 76.2. This stability indicates the student has an adequate foundation of knowledge about the material being taught, perhaps obtained from other sources such as textbooks, teacher explanations, or previous experience. Although the score was relatively good, there was no significant upward trend from the first to the third meeting. These values tend to be stagnant in the same range, which indicates that conventional learning methods (such as lectures or the use of textbooks) reach a maximum point in transferring knowledge to students.

These methods are no longer considered effective in encouraging deeper understanding or to improve learning outcomes beyond these limits. The completion percentage of 75.9% strengthens the above interpretation. This figure shows that most students have met the Minimum Completeness Criteria (KKM). However, there are still students who have not reached completion. Groups of students who are most likely to have difficulties with conventional learning methods and need a more visual and interactive approach to be able to understand the material in its entirety. In contrast, the post-tests that have been given at the fourth to sixth meetings that show a dramatic jump in grades, indicate that this Augmented Reality-based learning approach that not only affects learning interest but also effectively improves students' conceptual comprehension processes presented in Table 4.

Table 4. Student Learning Test Results After Using Edu Assembler

Meeting Date	Grade Point Average
15 April 2025	83,2
22 April 2025	83,3
29 April 2025	84,3
Completion Percentage	83,6%

Based on the data presented above, it is interpreted that there is a significant and consistent increase in the learning outcomes of students after the application of Assemblr Edu media as a learning medium. The average score in the class at the three meetings after the intervention showed a steady positive trend, rising from 83.2 to 84.3. This increase is not only quantitative but also indicates a continuous strengthening of conceptual understanding in students. The increase in the average score from the pre-intervention condition proves that the Edu Assemblr functions as a support for solving learning problems that occur in conventional methods. This media is not only able to transfer knowledge but also plays a role in increasing students' interest in learning and deep understanding of abstract and technical materials. The percentage of learning completeness reached 83.6%, indicating that this intervention managed to reach most students of various ability levels. Compared to the percentage of completeness before the intervention (75.9%), there was an increase of 7.7% which indicates that about a quarter of students who had not previously completed managed to achieve the minimum level of completeness. This proves that the AR visualization in Assemblr Edu is effective in helping students who have learning difficulties with conventional methods.

The stability of the score in the range of 83-84 indicates that the increase that occurs is not incidental but is the result of a continuous and consistent learning process. AR media succeeds in creating a memorable learning experience and has a long-term impact on students' understanding (Rachim, 2024, Wu et al., 2013). This data reinforces another methodological process that students increased affectively, and behavioral interests have transformed into measurable cognitive improvement. Assemblr Edu not only keeps students interested and excited, but also effectively helps them in constructing a more solid knowledge of networking device material.

Based on the results of interviews with five students, it was shown that the implementation of Assemblr Edu succeeded in increasing interest in learning through three main dimensions: enthusiasm, visual comprehension, and interactivity. The A.H.D.I. student revealed, "At first I was sleepy when I saw the pictures of the router in the book, but when I used Assemblr it was like disassembling a device. I would like to know more about each of the ports." This statement shows how AR media transforms monotonous perceptions into exploratory experiences that stimulate curiosity. The D.R.S. student added, "Usually I just see the teacher explaining, now I can check the 3D model myself and see it from any angle. It's like having a virtual lab on a cellphone." This transformation from passive to active learning proves that Assemblr Edu has succeeded in creating a learning agency in students (Ramadan & Cahyaningsih, 2025).

The results of other interviews revealed that this increase in interest has a direct impact on the depth of students' conceptual understanding of abstract material. The N.M.S.S. student explained, "I used to be confused about the difference between a switch and a hub, the shape is similar in the book. Now I can zoom in, see the details of the ports, and even virtual go inside the device. So, it is understandable that the switch is smarter because it can choose the destination port." The ability of this AR media to provide structural and functional visualization answers the main difficulty of students in understanding the technical differences between devices. The R.A.A. student explained, "When I practiced making a network, I became more confident because I had memorized the shape and position of the port from Assemblr Edu. It's like you've trained in the virtual world before." This suggests that the learning experience with AR not only increases interest but also builds a cognitive scaffolding that facilitates the transfer of knowledge to real situations (Juwairiah et al., 2025). From the perspective of social motivation, Assemblr Edu also triggers collaborative dynamics that previously did not appear in conventional learning. Z.L.R. students said, "Usually I am embarrassed to ask the teacher, but now I often discuss it with my group friends to work on the AR project. We show each other the discovery of cool features in the app." These behavioral changes indicate that AR media serves as a driver of social interaction that encourages collaborative learning (Resti et al., 2024). The D.R.S. student added, "When I got home, I tried the application again and shared screenshots with the class group. It's been a great conversation." This extension of learning outside of school hours shows that the interest that has developed into a sustainable and independent engagement.

The findings of this interview prove that Assemblr Edu not only answered the formulation of the first problem about the increase in students' interest in learning but also explained the mechanism of how the increase occurred. The transformation of students' learning interest after the implementation of Assemblr Edu in the formulation of the second problem can be mapped into three phases: 1) phase of positive surprise to immersive visualization; 2) a phase of self-exploration that encourages conceptual understanding; and 3) the internalization phase where the knowledge gained becomes the basis for confidence in real practice. These findings reinforce the Multimedia theory that interactive and responsive multimedia design can stimulate emotional and cognitive engagement simultaneously (Mayer, 2017).

The implementation of Assemblr Edu successfully optimizes students' learning potential by pushing them beyond the limits of initial abilities that have been achieved with conventional methods. This media has proven to be effective as cognitive scaffolding that is able to bridge the gap between abstract knowledge and concrete understanding, while providing an inclusive learning platform for different levels of students' abilities. Students are not only "delighted" and "interested", but they are able to understand complex concepts about networking devices because they are presented visually, interactively, and can be explored at their own learning pace. So that the formulation of the second problem is that students' learning interests after the implementation of Assemblr Edu-based learning are transformed into intrinsic, exploratory, and collaborative interests. This interest manifests itself in various forms of behavior that are consistently observed and produce a

significant positive impact on their conceptual understanding, thus forming a more positive and continuous learning cycle.

4. Conclusion

The use of Assemblr Edu as an Augmented Reality-based learning media has proven to be effective in increasing the learning interest of students in class X of Computer and Network Engineering in the subject of Komjardas at SMK Unitomo Surabaya. This increase in interest can be seen from the transformation of student behavior from passive to active, characterized by enthusiasm for welcoming lessons, the desire to explore independently with application features, and the growth of collaborative interaction between students. Students' cognitive learning outcomes also experienced a significant improvement, which was demonstrated by an increase in grade point average and a percentage of classical completeness, proving that the interest that was built was not only affective but also contributed to conceptual understanding. These findings answer the purpose of the research by showing that Assemblr Edu has succeeded in creating a more immersive and interactive learning environment, overcoming the limitations of conventional media in visualizing network devices. Further research is suggested to explore the application of similar media in other practicum subjects at vocational schools and conduct comparative studies with other AR tools. For educational institutions, it is recommended to provide training for teachers in developing AR-based learning content and consider the integration of this technology in the curriculum more broadly.

Acknowledgement

The author expresses his deepest gratitude to those who have supported the smooth running of this research. Thank you to the Principal of SMK Unitomo Surabaya for providing permits, facilities, and full support during the research process. Gratitude was also conveyed to the students of class X who had participated with enthusiasm, honesty, and enthusiasm for learning, so that the data obtained could describe the real conditions. Not to forget, the author would like to thank the media and language expert validators who have provided invaluable input for the improvement of this research instrument.

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How to cite this article:

AbdiKusumo, W. C., Sucipto., & Tobing, V. M. T. L. (2026). The Utilization of Assembler Edu (AR) as a Learning Media to Increase Students' Learning Interest in Komjardas Class X Computer and Network Engineering Vocational School Unitomo Surabaya. *Journal of Educational Sciences*, *10(1)*, 1522-1535.