CHAPTER I

INTRODUCTION

In this chapter, the researcher discusses several key components, including the background, problem statement, objectives of the research, significance of the research, and scope of the research.

A. Background

English has become an essential global language, functioning not only as a medium of communication but also as a crucial tool in education, science, and technology. In the era of globalization and the Industrial Revolution 4.0, English language proficiency has become an essential skill for students. Mastering this language allows students to access global information, improve career opportunities, and communicate effectively in an international context. Mastering English enables individuals to access vast amounts of information and compete in a globalized world.

According to Richards (2017), English proficiency serves as a gateway to academic success and international communication, particularly in countries where English is taught as a foreign language. Tulung, G. J. (2020), also emphasized that one of the key benefits of mastering English lies in the ease of accessing global knowledge, as most academic literature, scientific journals, and digital resources are available in English. Proficient English skills allow students to broaden their horizons and stay updated with the latest scientific developments.

In the 21st century, the ability to communicate in English has become increasingly crucial, as it is the dominant language in global communication, education, and business. For students, mastering English is important not only for academic success but also for future career prospects. In Indonesia, where English is a foreign language, it is a compulsory subject in schools. However, many students struggle in learning English, particularly in developing their reading comprehension skills, an essential component of language learning that enables students to understand, interpret, and analyze texts effectively.

Rahman and Sari (2022) revealed that learning English enhances students' abilities to solve complex problems and make well-informed decisions in situations requiring critical thinking. This is supported by Mulyani (2020), who stated that English proficiency is associated with improved analytical skills, which are vital across various disciplines. Similarly, Mauliska and D'Angelo (2024) discovered that English mastery not only boosts cognitive and critical thinking skills but also opens up greater opportunities in higher education and international careers.

Despite English being taught at various educational levels in Indonesia, students often face challenges related to motivation and activeness in English learning. Kianinezhad (2023) identified that one of the main issues in English language teaching is encouraging student engagement and participation, which are essential for effective language acquisition. Active involvement helps students internalize new knowledge and improve their speaking, listening, reading, and writing skills. The effectiveness of English learning is closely

linked to how engaged and active students are in the classroom. Active participation helps students internalize new knowledge and enhances their speaking, listening, reading, and writing skills.

Larsen and Freeman (2000) emphasized that student-centered and interactive approaches are more effective in enhancing language skills compared to traditional, teacher-centered methods. Student activeness in learning is influenced by various factors, including teaching strategies, the learning environment, and especially the use of technology. Integrating technology in English classrooms has been proven to significantly boost student motivation and participation (Serajuddin, 2023). Thus, interactive learning media have become a focal point of innovation in education, underlining the need for effective tools to support English language learning.

Education has undergone significant transformation in the digital age, especially through the integration of technology into the teaching and learning process. Interactive learning media play a crucial role in increasing student motivation, engagement, and activeness in the classroom. The shift from conventional methods to technology-enhanced learning is driven by the desire to accommodate diverse learning styles. According to Hwang et al. (2015), interactive learning technologies help create more dynamic and participative learning environments that enhance students' activeness and motivation. Chen et al. (2017) supported this by showing that technology-enhanced learning environments foster collaboration and active participation, improving both learning outcomes and retention.

The effectiveness of interactive learning media in increasing student activeness has been demonstrated across various educational settings. Alalwan et al. (2020) found that interactive tools such as Augmented Reality (AR) and Virtual Reality (VR) significantly boost student activeness and participation. Likewise, Huang et al. (2016) revealed that AR-based learning environments enhance motivation and interest, resulting in increased activeness and academic performance.

The integration of AR in education has gained momentum due to its ability to create immersive and interactive learning experiences. Akçayır and Akçayır (2017) concluded that AR technology enhances student motivation, activeness, and academic achievement by offering visually appealing and interactive environments. Bacca et al. (2014) also found that AR-based tools help students understand abstract concepts and increase their interest in the subject matter. These findings suggest that Assemblr Edu, an AR-based platform, has the potential to enhance comprehension through more interactive and engaging learning experiences.

Interactive media, particularly those based on Augmented Reality (AR), have the potential to transform passive learning environments into engaging and immersive experiences. Assemblr Edu is one such AR-based learning platform that enables teachers to present materials in 3D and interactive formats. Research by Köse and Güner-Yildiz (2021) suggests that AR-based applications foster student-centered learning and increase student activeness.

Assemblr Edu provides interactive features that support visual and kinesthetic learning styles, enabling students to explore content more deeply. Rohi et al. (2024) emphasized that multimodal learning environments increase student engagement and comprehension, particularly in language learning. Additionally, AR media have been linked to improved retention and learning outcomes. Dewanto et al. (2024) demonstrated that AR significantly enhances students' learning experiences and outcomes across education levels. AR is positively impacting student activeness and learning outcomes. This supports the notion that AR platforms like Assemblr Edu can play a critical role in English language education.

Creating enjoyable and meaningful learning experiences is also key to increasing student activeness. Lin et al (2017) found that digital learning has a better positive impact on learning motivation and learning outcomes compared to traditional learning. Praheto et al. (2020) showed that learning language skills through interactive multimedia is more effective than through other types of media. Mahmawati, et al., (2025) added that students' learning outcomes better after digital media was used as an interactive medium. They suggest that digital media can be used to improve the quality of learning in higher education, especially by helping students understand the material better and getting them more involved in the classroom. It can be concluded that students who learn through interactive and gamified media show higher levels of enthusiasm and involvement compared to those taught through conventional methods.

AR tools like Assemblr Edu provide visual aids and interactivity, helping students to better understand and retain such content, which is in line with Liono et al. (2021) stated that AR is an effective learning medium that helps students understand abstract concepts in concrete terms, motivates them to study more, and aids in easy memory and recall due to its engaging experience with reproduced real objects. Saidin et al. (2015) also noted that AR enhances the learning process by enabling interaction with virtual and real-time applications, offering natural and engaging experiences. The integration of AR in education has garnered attention for its ability to immerse students in realistic experiences.

Anjali et al. (2024) highlighted that Assemblr Edu enhances students' thinking skills, problem-solving abilities, and conceptual understanding, making the learning process more enjoyable and less monotonous. Majid et al. (2023) found that the Assemblr Edu application enhances learning and teaching activities by making them interesting, easy to use, and providing an attractive content display. The application also presents complete and relevant features following the subject category, making it an effective learning tool. Its user-friendly nature allows for effective learning. In addition to technological benefits, using Assemblr Edu also supports differentiated instruction. Students with varying proficiency levels can benefit from visual, audio, and interactive content at their own pace, resulting in more inclusive and engaging learning experiences.

With the increasing availability of mobile technology in schools, implementing AR platforms like Assemblr Edu is becoming more feasible.

Yang (2020) reported that mobile-assisted language learning applications significantly improve student interaction and motivation in English as a Foreign Language (EFL) classrooms

Based on observations and the researcher's personal teaching experience, it was found that students have begun to feel bored and disengaged when using conventional interactive audio-visual learning media such as YouTube, Quizizz, Quizlet, and similar applications in the classroom. As members of Generation Z, who are naturally inclined toward technological advancements, students no longer find these repetitive and familiar applications appealing. This lack of interest has directly affected their learning outcomes and reduced their active participation during classroom activities.

Students tend to be more active, engaged, and actively involved when abstract concepts, which are often confined to the imagination, can be visualized directly in front of them. This is supported by the Cognitive Theory of Multimedia Learning (Mayer, 2020), which states that people learn more effectively when information is presented through a combination of words and pictures, rather than words alone. When abstract ideas are transformed into tangible visual representations, students' cognitive load is reduced, allowing them to form a deeper understanding more easily. As a result, motivation and activeness increase.

Furthermore, a study by Saidin et al. (2021) on Augmented Reality (AR) in education showed that the ability to visualize and manipulate 3D objects

significantly enhances students' conceptual understanding and maintains their interest in the subject matter.

However, the teaching and learning process commonly implemented remains teacher-centered. Teachers often dominate the classroom by explaining material without meaningful feedback or interaction from students. This traditional approach results in passive learning. Hiver et al. (2021) emphasize that teacher-centered instructional models often fail to create the interactive learning environments necessary for deep understanding, particularly in language learning.

As a result, two-way communication does not occur, and classroom interaction is limited to one-way delivery from the teacher. This situation not only reduces student motivation and learning outcomes but also leads to teacher fatigue. According to the Control-Value Theory of Achievement Emotions (Pekrun, 2020), a lack of autonomy and interaction in a teacher-dominated environment can lead to boredom and decreased motivation to learn. Khalil et al. (2023) also found that passive learning environments are directly correlated with lower academic achievement and declining student engagement.

In previous classroom implementations, the researcher had utilized various interactive learning applications such as Quizizz and Quizlet in English lessons. Initially, these applications were well received by students, offering engaging features like group competitions and interactive quizzes that stimulated enthusiasm and increased activeness. Furthermore, many existing studies have

widely explored the use of these applications in enhancing students' engagement and academic performance, particularly through 2D-based media.

However, in line with rapid technological developments in education and the emergence of 3D/AR (Augmented Reality) and VR (Virtual Reality)-based learning technologies, there remains a gap in the integration of these innovations into language learning contexts, especially at the senior high school level in Indonesia. Most existing research on AR-based educational media has been predominantly conducted in STEM-related subjects such as mathematics and science, with limited studies examining its application in English language teaching. Additionally, prior research has often focused solely on either students' motivation or learning outcomes, without investigating both aspects simultaneously.

In response to this research gap, the researcher recognized the potential of integrating AR-based technology into the classroom through the Assemblr Edu app, a 3D/AR-based interactive learning platform. By incorporating the Assemblr Edu app into English language teaching, this study aims to improve students' learning outcomes and see their activeness during learning English in the classroom, thereby offering a more dynamic, immersive, and student-centered learning environment.

The researcher introduced the Assemblr Edu application to the students, followed by a trial session to explore several of its features. The students showed a high level of enthusiasm and interest during this introduction. The process began with students creating their accounts on the platform. Afterward,

they were guided to access several features, including the Teaching Aid feature, which provides ready-to-use materials with 3D and Augmented Reality (AR) objects. Following this initial exploration, students were encouraged to independently navigate and use other features within the application.

Out of the 33 students involved in the study, 19 were able to download and access the Assemblr Edu application via their mobile devices, while the remaining 14 accessed it through the web version. Some students were unable to use the mobile application due to various technical issues, such as insufficient storage space on their devices or incompatibility, despite having installed the app.

The trial phase revealed both strengths and limitations of the Assemblr Edu app. One of its main advantages is that it represents a modern and innovative learning medium that students have never encountered before, which sparked their excitement and curiosity. It allows them to explore interactive learning materials and 3D teaching aids, and it is accessible on both mobile and web-based platforms, making it more flexible and inclusive.

However, the implementation of such applications faces several significant limitations. Research has consistently shown that the large storage requirements of educational apps prevent students with older or lower-capacity devices from installing them, creating an immediate barrier to access (Radu et al., 2022). Furthermore, the common "freemium" model, where advanced features are locked behind a paywall, can create a tiered and inequitable learning experience, favoring students from higher socioeconomic backgrounds (Lee & Kim, 2021).

Perhaps the most critical barrier is the dependence on a stable internet connection and the lack of an offline mode. This severely limits usability in areas with poor connectivity, leading to frustration, disrupted learning, and the exclusion of students in rural or low-income areas (Crompton & Burke, 2022; Zhang & Basham, 2021). These technical and economic challenges must be addressed to ensure equitable educational opportunities.

Based on the above considerations, it is essential to investigate the impact of the Assemblr Edu app on students' learning outcomes and activeness in learning English, especially at the high school level. This research aims to explore the effectiveness of the Assemblr Edu app as an interactive learning media in enhancing students' learning outcomes and activeness in the 12th grade of UPT SMA Negeri 2 Parepare.

B. Problem Statement

Based on the background described above, the researcher formulates the following research questions:

1. Does the use of the Assemblr Edu app improve the students' learning outcomes in English at the 12th grade of UPT SMA Negeri 2 Parepare?
2. How is students' activeness during the use of Assemblr Edu in English learning at the 12th grade of UPT SMA Negeri 2 Parepare?
3. What is the effect of using the Assemblr Edu application on students' learning outcomes and activeness in learning English at the 12th grade of UPT SMA Negeri 2 Parepare?

C. Objective of the research

In line with the problem statements above, the objective of this research are:

1. To examine whether the use of the Assemblr Edu app improves the students' learning outcomes in English at the 12th grade of UPT SMA Negeri 2 Parepare.
2. To describe students' activeness during the use of Assemblr Edu in English learning at the 12th grade of UPT SMA Negeri 2 Parepare.
3. To analyze the effect of using the Assemblr Edu application on both students' learning outcomes and their activeness in learning English at the 12th grade of UPT SMA Negeri 2 Parepare.

D. Significance of the research

The findings of this research are expected to provide the following feedback:

1. Theoretical Significance

   The results of this study are expected to contribute to the development of interactive learning media theories, particularly those related to the use of 3D and AR-based applications like the Assemblr Edu app in English education.

2. Practical Significance

   For teachers, this study can serve as a reference for implementing innovative and interactive learning strategies in English classrooms. For students, it offers engaging and effective learning experiences that can improve their learning outcomes and classroom activeness.

3. Institutional Significance

For schools, the findings of this research can be a consideration in adopting interactive digital media to support the implementation of Kurikulum Merdeka and improve the quality of learning.

E. Scope of the research

The scope of this research is delimited by four aspects, namely discipline, content, activities, and location:

1. Discipline, this research is limited to English language teaching and learning that utilizes the Assemblr Edu app as an interactive learning media.
2. Content, this research focuses on two research objectives: (1) to examine the effectiveness of the Assemblr Edu app as an interactive learning media in improving students' learning outcomes; and (2) to assess students' activeness during the English learning process when using the Assemblr Edu app.
3. Activities, the researcher employed two instruments: a test and an observation checklist. The test is used to measure the use of the Assemblr Edu app in enhancing students' learning outcomes, while the observation checklist is used to assess students' activeness during the learning process with the media.
4. The location of this research was conducted at UPT SMA Negeri 2 Parepare.

CHAPTER II

REVIEW OF RELATED LITERATURE

A. The previous research-related findings

The integration of technology in education has brought significant changes in how teaching and learning processes are conducted. Various studies have examined the use of digital tools and interactive media to support and improve student engagement and learning outcomes. In particular, Augmented Reality (AR) allows users to see and interact with digital objects embedded in their real environment, using devices such as tablets or smartphones. This technology creates learning experiences that combine real-world elements with digital elements, opening up opportunities for more dynamic and relevant learning. One of the recent innovations that has gained attention for its potential in enhancing student activeness and learning experiences is the Assemblr Edu app, an augmented reality (AR)-based educational platform.

Supporting this, a study by Mursyida et al. (2023) emphasized that the Assemblr Edu app with AR technology has proven to be very effective in stimulating student interest, increasing learning motivation, and helping students understand learning materials and complete tasks more efficiently. Their findings suggest that AR media encourages students to be more active participants rather than passive receivers of information, indicating its potential as a powerful educational tool.

Similarly, Kurniawan et al. (2024) demonstrated that the use of AR technology in language learning, specifically through Assemblr Studio, has

shown positive results in increasing student participation, understanding, satisfaction, and motivation. These findings further promote the development and adoption of similar technologies in various educational settings, reinforcing the value of integrating AR-based media into classroom activities.

In addition, Rosyidah & Khatijah (2023) stated that AR is an interactive and practical teaching approach that encourages student participation and engagement. It not only enhances input but also helps students connect classroom learning with real-world situations. Their research indicated that Assemblr Edu-based augmented reality is effective, particularly when students describe the appearance of an object in 3D views, which significantly increases their interest and understanding.

Echoing these results, Azimova & Solidjonov (2023) also conclude that AR is an interactive and practical teaching approach that encourages student participation and engagement. It enhances input and helps students connect classroom learning with real-world situations. The research found that Assemblr Edu-based augmented reality is effective, indicating a positive perception of the media as a learning media. This is particularly true when students describe the appearance of an object in 3D views, where they are more interested in understanding the object's appearance. Their findings showed that Assemblr Edu-based AR technology was positively perceived as a learning media, especially in cases where students interact with 3D visualizations to better comprehend complex materials.

Furthermore, Asadi & Ebadi (2024) found that AR applications can effectively motivate and engage students, leading to a deeper understanding of reading material. Teachers involved in the study reported that AR's interactive features, such as 3D models and videos, facilitate understanding by providing multimodal information. Integrating text, images, audio, and video into the AR app can result in richer learning experiences. The study also explored teachers' perceptions of AR and its benefits for teaching English as a Foreign Language (EFL). Teachers had positive attitudes towards using AR in language learning, valuing its potential for deep learning, enhancing motivation, and increasing their willingness to use AR-based approaches. AR technology facilitates instruction by providing interactive and differentiated learning experiences, allowing for personalized instruction and catering to diverse student needs.

Adding to this evidence, Hikam et al. (2024) discovered that students using learning media, specifically Assemblr Edu app, achieved significantly different cognitive results compared to those who did not. The test analyses revealed a significant difference in cognitive learning outcomes. The study also found that the Assemblr Edu app was advantageous for vocabulary acquisition among junior high school students. This suggests that AR-based media can effectively support language learning.

Likewise, Suhati et al. (2023) highlighted that one of the innovations produced by the Assemblr Edu is its ability to enhance student learning outcomes. This was corroborated by Triana & Hariyastuti (2024), who found through teacher and student response surveys that AR-based learning materials

developed via Assemblr Edu app were deemed highly viable for educational use.

In a related study, Nugrohadi & Anwar (2022) explained that Assemblr Edu app, as an AR application, is user-friendly for both teachers and students due to its interactive teaching materials. The application, offering both two-dimensional and three-dimensional images with a variety of themes, received positive responses indicating its feasibility and effectiveness in improving learning outcomes. This application-based learning media has been proven to be effective in the learning process.

Moreover, Putra (2024) revealed that AR in the 5th grade significantly improved student engagement and learning results. AR enhances visual interest, enhances comprehension, and improves test results, making it an effective reinforcement learning tool. Teachers and education specialists support this, highlighting its practicality and ease of use. The research emphasizes the importance of integrating technology into classrooms to meet the demands of 21st-century students. AR's ability to make complex subjects accessible suggests its widespread adoption across various disciplines and grade levels, enhancing overall educational performance.

Lastly, Hasanah (2022) highlighted the Assemblr Edu app as a valuable tool for language learning, especially in practical subjects. It maximizes learning objectives, stimulates students' interest, and promotes independence. Students can discuss and ask for explanations from peers, enhancing concentration and reasoning. Assemblr Edu app encourages active practice and home

demonstrations, meeting educational demands in technology media. Overall, it enhances the learning experience. As a result, Assemblr Edu app is an alternative offering for creating interactive and innovative audiovisual learning media, increasing student attention and activity in language learning.

Overall, the reviewed studies consistently demonstrate that interactive learning media, particularly AR tools like the Assemblr Edu app, have a positive impact on student activeness, motivation, comprehension, and learning outcomes. These findings indicate the significant potential of integrating Assemblr Edu into various educational contexts, including English language learning at the senior high school level in Indonesia. Despite the abundance of research on AR in STEM subjects, studies focusing on AR-based media for language teaching remain limited. This highlights the need for further investigation into the effectiveness of Assemblr Edu in enhancing both students' activeness and learning achievements in English language classrooms.

B. Some pertinent ideas

1. The concept of the Assemblr Edu app

1.1. The definition of the Assemblr Edu app

The Assemblr Edu app is a digital platform that allows students and teachers to create and experience augmented reality (AR) learning materials through mobile devices or desktop computers. As explained by Lissa'adah and Widiyatmoko (2023), the Assemblr Edu app is an AR application available for free download on Android and iOS smartphones from the Play Store and App Store.

In line with this, Chairudin et al. (2023) described the Assemblr Edu app as an interactive learning media application designed to enhance student engagement and improve learning outcomes. It creates engaging 3D and AR content, allowing users to select desired topics or subjects and choose content that aligns with the material to be delivered in class. This innovative solution improves the quality of the learning process and student outcomes by enhancing the learning experience.

Supporting this perspective, Agustin & Wardhani (2023) stated that the Assemblr Edu app is a concept that aims to create interactive learning media that provides detailed 3D descriptions on challenging materials, thereby attracting students' interest and improving learning outcomes by enhancing the ability to detect these materials using the five human senses.

Furthermore, Nugrohadi & Anwar (2022) stated that the Assemblr Edu app is an educational application that uses Augmented Reality (AR) technology to create interactive teaching materials. It uses 3D images and animations to pique students' curiosity and encourages creativity. The application helps teachers create a fun and meaningful learning atmosphere, allowing students to focus on activities organized by the teacher. This approach helps students understand the material better and enhances their understanding of the subject matter.

Lestari et al. (2023) added that the Assemblr Edu app is a 3D and AR-based application that enhances learning activities by making them interactive, collaborative, and fun. It can be accessed on smartphones for

free or a fee, and offers an attractive visual display for easy access to its features. This application facilitates interaction with students and teachers, making learning more enjoyable and engaging.

Iskandar et al. (2023) described that Assemblr Edu app is a 3D-based digital learning platform that combines online classes and 3D animation. It provides materials, questions, and educational information to students. Teachers can design creative and interesting learning media for students on this internet-based platform.

Lastly, Aryaningrum et al. (2022) stated that the Assemblr Edu app is a platform that enables interactive and creative teaching for teachers and parents. It offers a variety of educational content, including 3D images and animations, which can be used in class. Users can also use the Editor feature to create their own AR content and add hundreds of 3D objects. This feature allows users to be more creative in developing materials not yet available in the Assemblr Edu app. Teachers can group students into virtual classes based on subjects, allowing them to share materials and collect AR assignments or projects in one place. This platform allows for a more interactive and engaging learning experience for both teachers and students. Next, Chairudin et al. (2023) stated that the Assemblr Edu platform has features that allow us to manage, store and share content that is created, thus facilitating the collaboration process between teachers.

1.2. The features of the Assemblr Edu app

To support the integration of technology in education, the Assemblr Edu app offers a variety of features specifically designed to enhance teaching and learning experiences through Augmented Reality (AR) and 3D visualization. These features enable both teachers and students to engage with educational content more interactively and intuitively.

1) Ready-to-Use Educational Topics

The platform offers over 200 pre-designed educational topics, covering a range of subjects from kindergarten to high school. Each topic is equipped with interactive presentation slides enriched with 3D visualizations, enabling teachers to deliver materials more effectively without needing to create them from scratch. Additionally, Hasanah (2022) demonstrates that this program has a variety of topics of study for language, biology, chemistry, geography, and other subjects. Teachers can use it directly or create lessons in a different room if they desire animated videos.

2) Versatile Editor

The 3D/AR Editor is a versatile tool that allows users to create 3D or AR projects using a simple drag-and-drop method. It features thousands of 2D and 3D assets, allowing users to customize and develop learning materials according to their needs. This versatile editor is ideal for students and teachers to turn ideas into reality.

3) Edu Kits

Assemblr Edu app offers over 6,000 interactive 3D teaching aids through its Edu Kits feature, which includes thousands of ready-to-use 3D and 2D objects in various themes. These aids help explain abstract and complex concepts more concretely and understandably for students, allowing them to visualize human anatomy or molecular structures.

4) Interactivity

Insert animation into the project and hone your creativity. You can create quizzes, mini games, or other interactive projects according to your imagination.

5) Share Projects

Share 3D/AR projects in the form of project links, 3D views, or AR. Present interactive displays however you like.

6) Scan & View

Scan the surrounding environment and view the project in AR view. Teachers can also upload their favorite graphics or images as custom markers and see the project come to life.

7) Flexible Access

The platform offers flexible access and integration with various devices, allowing users to create projects anytime and anywhere so we can create projects easily, anytime & anywhere. It can be accessed via a web browser or mobile application, and can be connected to a

projector or TV for classroom presentations, ensuring clear lesson delivery for all students. Hasanah (2022) said that Students can use their devices to learn using the Assemblr Edu app program. Students can download this program from the Play Store or App Store because it is made for mobile learning.

8) Virtual Classroom for Collaboration

The Assemblr Edu app provides a Virtual Classroom feature that serves as an all-in-one hub for teachers and students to share files, notes, and 3D and AR learning materials. This feature facilitates communication and collaboration between teachers and students in one integrated platform.

9) Immersive AR Experience

After creating a project, users can bring their creations to life through AR experiences. By scanning their surroundings using their devices, students can see and interact with the 3D objects they have created as if they were in the real world. This allows teachers to adapt their teaching strategies to various learning environments and ensures all students can follow lessons conveniently.

1.3. The benefits of the Assemblr Edu app

In addition to its varied features, it is essential to examine the strengths and limitations of the Assemblr Edu app to understand its practical application in educational contexts fully. This section discusses several key

benefits of the Assemblr Edu app based on recent studies and user experiences.

1) Increase students' engagement, motivation, and learning outcomes

   One of the most significant advantages of the Assemblr Edu app is its ability to increase students' engagement, motivation, and learning outcomes. The use of AR and 3D visualization in the classroom has been proven to enhance students' enthusiasm and interest in learning activities. By presenting materials in an interactive and immersive way, students are more eager to participate actively in the lessons (Majid et al., 2023). Hayati et al. (2023) found that the Assemblr Edu application significantly improved learning outcomes in class 5B SDN Buah Gede's science lesson on water cycle material. The application made understanding the material easier, increased student activity, and improved critical thinking skills. Students found the application fun and easy to understand, resulting in increased interest in learning and improved overall learning outcomes. Hasanah (2022) found that using the Assemblr Edu app, learning is designed interactively to encourage students' critical thinking skills. Even 2D and 3D objects can be projected realistically, which makes learning interesting and not boring.

2) Simplify the understanding of abstract and complex concepts

   Another major benefit is that the Assemblr Edu app helps simplify the understanding of abstract and complex concepts. Through 3D

visualizations, students can grasp difficult topics more concretely. For example, scientific structures or biological processes can be visualized in real-time, aiding comprehension and long-term retention of learning materials (Assemblr World, 2024).

3) Flexibility in creating customized learning materials.

   With its built-in Editor 3D/AR feature, teachers and students can easily develop or modify content to suit particular learning objectives and classroom needs. This fosters creativity and supports a more personalized learning experience.

4) User-friendly interface and accessibility

   Furthermore, the platform is known for its user-friendly interface and accessibility. Yasa et al. (2024) argue that the Assemblr Edu App is superior to other AR applications due to its user-friendly 3D objects, allowing users to use it without complex programming knowledge. Assemblr Edu app is designed to be used by a wide range of users, regardless of their programming skills. Its intuitive design allows educators and learners to quickly adapt and take full advantage of its features without requiring advanced technical knowledge (Assemblr World, 2024).

In summary, the Assemblr Edu app is a powerful educational platform that integrates AR and 3D visualization to create engaging, interactive, and meaningful learning experiences. Its comprehensive features, ranging from ready-to-use content, versatile editors, interactive teaching aids, to

collaborative virtual classrooms make it highly effective in increasing student engagement, simplifying complex concepts, and facilitating flexible, customized, and accessible learning processes. Recent studies consistently affirm its positive impact on student motivation, critical thinking, and overall learning outcomes.

2. The concept of students' activeness

2.1 The definition of students' activeness

The teaching and learning process in schools has numerous effects on both students and teachers. Students, as learners, will gain a lot of knowledge, while teachers, as educators, will continue to strive for students to learn. Teachers and students will continue to work actively so that the learning process will provide good results for both; otherwise, both students and teachers will fail. Learning failure is not the fault of the teacher or the student.

Activeness in the learning process is crucial for students to understand and engage with the material. Active students pay attention and try to understand the teacher's teachings, while inactive students may not. Active students are more likely to succeed in learning English, which requires active participation in listening, speaking, writing, and reading skills. Inactive students hinder these skills, making active learning more effective.

To ensure students are active and successful in learning English, teachers must constantly innovate and adapt their teaching methods. However, this process is not easy and requires thorough preparation. The

increasing focus on online learning has made it even more challenging for English teachers to maintain student engagement in learning. Therefore, it is essential for teachers to continuously innovate and adapt their teaching methods to ensure students are active and successful in their English language learning.

Prasetyo & Abduh (2021) define learning activeness as students' active participation in both face-to-face and online teaching and learning activities to develop their potential and achieve learning goals. Rohmah & Hermawan (2025), Student learning activeness is a student's effort to participate in learning activities. This is reflected in student participation in seeking or obtaining information from various sources, such as teachers, books, and other friends.

Molebu (2022) emphasizes that student learning activeness refers to student activity that enhances their emotional abilities and creativity, thereby increasing their abilities and enabling them to master concepts. This activity is crucial during the teaching and learning process, as it indicates a student's desire to learn. Activities that contribute to learning include asking questions, expressing opinions, completing assignments, answering teacher questions, working collaboratively, and being responsible for assigned tasks.

Active learning involves students actively participating in teaching and discussing their ideas and thoughts. It focuses less on transmitting information and more on expanding their skills and ideas. Students engage

in higher-order thinking, such as synthesis, analysis, and evaluation, to solve problems through critical thinking. They participate in activities like writing, reading, and discussion, not keeping silent but actively participating. The greater tension lies in students exploring their values, attitudes, and experiences, making them the center of the classroom.

Muthmainnah (20219) stated that students' activeness can be described as students actively participating in classroom activities and actively completing tasks. Active student participation refers to students working in a respectful partnership with their teacher, often developing courses or assignments for previously taken courses. This activeness is characterized by good cooperation, active task completion, and effective communication with the teacher.

Karim & Karolina (2023) highlight that active student learning involves students actively participating in the teaching and learning process. Key indicators include openness to express personal interests, motivation, creativity, and freedom from pressure from teachers or other parties. Students should be open to expressing their needs and problems, participating in all stages of learning, asking questions, sharing information, conducting group discussions, and training themselves in solving similar questions or problems. These indicators help identify behaviors that occur during the teaching and learning process. Students should be given the freedom to do this without pressure from teachers or other parties.

In essence, student activeness involves active engagement in learning activities, both physically and mentally, characterized by curiosity, participation, problem-solving, and communication. It is vital for mastering language skills, particularly in English learning, and requires consistent teacher effort to foster.

2.2 Kinds of students' activeness

Prasetyo & Abduh (2021) state that student activeness in learning includes participation in assignments, problem-solving discussions, seeking clarification from peers or teachers, and presenting report results, indicating their active involvement in the learning process.

Karim & Karolina (2023) note that teachers' learning style can significantly influence students' learning success. Activeness during the learning process is a key indicator of success, as students who are active in their physical, mental, intellectual, and emotional dimensions are more likely to understand and achieve optimal learning outcomes. Successful learning involves not only receiving knowledge but also developing their skills, behavior, and values. Student learning activity is crucial for the success of the learning process, as it increases students' activeness and creativity through various experiences and interactions. Activeness involves physical and mental action, such as doing and thinking in cycles. Good learning results require a combination of physical and psychological activity. Physical activity involves using body parts actively, while psychological activity involves functioning well mentally during studying.

Putri et al. (2019) affirm that student learning activeness in the learning process has a major impact on the results obtained in learning.

Nafis & El-Yunusi (2024) state that student activeness can also increase their motivation to learn, so that it can help them in dealing with various obstacles experienced during the learning process. Therefore, it is important for educators to create a learning atmosphere that can encourage and facilitate student activity so that the desired learning outcomes can be realized optimally.

Paul B. Diedrich in Nisak & Aisyah (2024) categorizes student activeness into:

a) Visual activities involve paying attention to drawings, reading, experiments, and demonstrations.
b) Oral activities involve speaking, asking questions, giving questions, discussing ideas, and giving opinions.
c) Listening activities involve listening to discussions and having a conversation.
d) Writing activities include writing essays, stories, questionnaires, and reports.
e) Drawing activities involve drawing, maps, and making graphs.
f) Motor activities involve conducting experiments, construction, and playing.
g) Mental activities involve responding, remembering, analyzing, solving problems, and making decisions.

h) Emotional activities involve feelings of interest, boredom, excitement, and calmness.

Sudjana (in Prasetyo and Abduh, 2021) outline indicators of students' learning activeness, including active participation in teaching and learning activities, willingness to solve problems, asking for help when needed, seeking necessary information, conducting group discussions, assessing their abilities and results, practicing problem-solving, and applying learned knowledge in completing tasks or problems. These indicators demonstrate students' willingness to seek help when needed, actively seek information, and follow the teacher's instructions. They also encourage students to assess their abilities and the results they have obtained, practice problem-solving, and apply their knowledge in completing tasks or problems.

Rikawati & Sitinjak (2020) identified student activeness indicators as enthusiastic participation in learning, willingness to ask questions, answer questions, and present understanding results in front of the class.

Through these indicators, teachers can measure student activeness in the classroom during learning. Not only that, teachers can also see the significant impact of activeness in learning, namely understanding the material and achieving learning objectives. This understanding can be shown through student learning outcomes at the evaluation moment or a formative test that is carried out. This aligns with the findings of Nurwahyunita & Suwasono (2012), who suggest that activity affects the quality of learning, which in turn impacts learning outcomes.

Student activeness encompasses various categories, including physical, mental, emotional, and social activities such as reading, writing, discussing, experimenting, problem-solving, and expressing emotions. It plays a crucial role in improving learning outcomes and must be supported by creating engaging, dynamic, and inclusive learning environments.

3. The concept of learning outcomes

3.1 The definition of learning outcomes

Each individual has different potential in understanding information, influenced by various factors such as psychological conditions and environmental factors. Therefore, educators need to recognize the unique characteristics and needs of each learner to adapt the learning process to their preferred learning styles. As stated by Amrulloh et al. (2024), students employ different approaches and methods in acquiring knowledge, making it necessary for educators to implement various teaching strategies to help students achieve their learning outcomes according to their abilities and needs.

Putri et al. (2019) state that student learning outcomes include changes in the affective, cognitive, and psychomotor domains related to the learning process experienced by students. In line with this, Irawati et al. (2021) state that learning outcomes refer to the behavioral changes resulting from a person's learning process, which can indicate their comprehension of the material being taught.

Adam (2006) defines learning outcomes are statements of what a learner is expected to know, understand, and demonstrate after a period of learning. They are explicit statements about the outcomes of learning and are typically defined as a combination of knowledge, skills, abilities, attitudes, and understanding achieved through successful higher education experiences. They also represent a methodological approach for expressing and describing the curriculum, levels, cycles, subject benchmarks, and the Bologna qualifications frameworks.

According to the Malaysian Qualification Agency in Aziz et al. (2012), learning outcomes are statements that outline what students should know, understand, and do after completing a study period. These outcomes serve as references for standard and quality, and guide curriculum development. Learning objectives describe the intended purposes and expected results of teaching activities, establishing a foundation for assessment. Learning outcomes are considered benchmarks for identifying and evaluating educational aspirations for balanced and excellent graduates. Therefore, objectives and learning outcomes should be developed for each course and subject.

Kennedy (2006) notes that the definitions of learning outcomes are consistent, with each focusing on what the student has achieved rather than the content of the lesson. They also emphasize what the student can demonstrate at the end of a learning activity.

Moreover, Anderson et al. (2001) in their revision of Bloom's Taxonomy emphasized that learning outcomes are expressed in measurable behavioral terms, allowing educators to assess the extent to which students achieve the intended instructional objectives. These outcomes typically cover cognitive, affective, and psychomotor domains, reflecting the holistic development expected through education.

Learning outcomes are measurable statements about what students should achieve after participating in a learning process. These outcomes cover knowledge, skills, attitudes, and understanding, expressed through cognitive, affective, and psychomotor domains. They function not only as indicators of academic achievement but also as essential references for curriculum development, learning evaluation, and educational quality assurance.

3.2 The importance of learning outcomes

Amrulloh et al. (2024) highlight that learning outcomes are a crucial indicator of educational success, encompassing not just exam scores but also students' ability to apply their acquired knowledge and skills in everyday life. It reflects the integration of learning into practice and the utilization of knowledge for success in various aspects of life. Education is a long-term investment to develop empowered, creative individuals who can adapt to changing times.

Toohey (1999) suggests that learning outcomes are valuable because they clarify the educational purpose, aid in designing other aspects of the

program, guide learning and assessment activities, express the teacher's educational purpose to students, helping them focus on the course's importance, and help teachers reconceptualize their educational purpose from the student's perspective. In a constructively aligned course, learning outcomes guide learning and assessment activities, ensuring students understand the course's offerings and expectations.

Jenkins and Unwin (2001) suggest that learning outcomes help teachers communicate expectations to students, enhance learning, design materials effectively, and clarify the goals of courses or lectures. They also assist in selecting appropriate teaching strategies, such as lectures, seminars, group work, tutorials, discussions, peer group presentations, or laboratory classes, and communicate the objectives of activities to colleagues. They also assist in setting examinations based on delivered materials and ensure the use of appropriate teaching and assessment strategies. Overall, these outcomes contribute to better student outcomes and effective learning.

Aziz et al. (2012) state that learning outcomes inform students about the knowledge and skills they will gain through a course or program, map relationships between courses, programs, and degrees, map knowledge and skill development at each level, communicate performance standards, provide a structure for evaluating teaching and learning, and inform curriculum design and pedagogic practice.

Harefa et al. (2023), learning outcomes are crucial in the learning process as they provide teachers with information about students' progress towards achieving their learning goals. These outcomes are output values in the form of numbers or letters obtained from tests or exams, providing insight into students' understanding of the subject matter. Teachers can use these outcomes to gauge their students' progress in understanding the material.

The importance of learning outcomes can be seen from the benefits.

a) Students have a clear understanding of what they will learn from the course/program.
    - Learning outcomes guide students in selecting relevant courses and programs.
    - Clear learning objectives prevent wasting time.
    - Reduce unneeded stress for students.
    - Learning outcomes provide students with a clear understanding of what they will learn and achieve at the end of each lesson before it begins.
    - The learning outcomes highlight what students need to know to attain their goals in the course.
    - Achieving learning outcomes demonstrates completion of the course.
b) Teachers can easily plan a lesson.
    - Learning outcomes assist teachers in lesson planning.

- Outcomes provide guidance on what and how much to teach, allowing for effective planning.
- Learning outcomes assist teachers in designing more effective teaching materials.
- Learning outcomes guide teachers in selecting effective teaching tactics.
- Learning outcomes save teachers time by reducing the need for additional instruction.

c) Assistance in Writing Assessments and Evaluations

- Effective learning outcomes facilitate assessment mapping.
- Learning outcomes allow for midway modifications.
- Learning outcomes encourage independent study and preparedness in class.
- Learning outcomes assess the unit's efficacy.
- Marking question papers is heavily influenced by learning results.

d) Support Academic Advisors and Advisees

- Learning outcomes guide advisers in determining what students should learn and how to teach it effectively.

e) Support in obtaining accreditation

- Accreditation authorities use learning outcomes to determine if a course or program aligns with the institution's mission and aims.
- Learning outcomes provide insight into course structure and evaluation methods.

- Learning outcomes serve as evidence, such as rubrics, charts, or graphs, to support summative learning goals.
- Learning outcomes assist Accreditation Agencies in determining whether targeted objectives are accomplished.

Adam (2004) highlights the advantages of learning outcomes in four main areas: course and module design, quality assurance, students, and mobility. Course and module design help ensure consistency in delivery across modules and programs, aid curriculum design by clarifying overlaps, and enable course designers to determine key purposes and align curricula. Quality assurance enhances the transparency and comparability of standards, holds greater credibility than traditional qualifications, and serves as a key reference for establishing and assessing standards. Students receive comprehensive statements outlining what they will achieve upon successful completion of their studies, as well as clear information to inform their choice of module and program. These statements also provide clear information for employers and higher education institutions. Mobility contributes to the mobility of students by facilitating the recognition of their qualifications, improving transparency, simplifying credit transfer, and providing a common format for lifelong learning. Overall, learning outcomes contribute to better education and student outcomes.

Learning outcomes hold a strategic role in education, from planning and implementation to assessment and program accreditation. They serve not only as measures of student achievement but also as fundamental

references for curriculum development, teaching strategies, and assessment systems.

3.3 Types of learning outcomes

Amrulloh et al. (2024) note that learning outcomes in schools cover both academic and non-academic aspects, which can be measured through exams as well as participation in extracurricular activities, leadership, and social skills. Achyanadia (2013) adds that learning outcomes, measured academically and non-academically, together form a comprehensive picture of students' readiness to face challenges and achieve success in various areas of life.

Learning outcomes focus on students and their learning experiences, not just how they are achieved. Ruhland and Brewer (2001) argue that these outcomes should capture cognitive and affective development changes resulting from college experiences. To achieve good learning outcomes, understanding how to relate course content to students' types and make the course meaningful to their needs and life experiences is crucial.

Mahajan & Singh (2017) demonstrate that learning outcomes are determined by factors such as knowledge, cognitive skills, practical skills, and generic skills. 1) Knowledge refers to familiarity with a subject, acquired through experience or education. 2) Cognitive skills involve applying knowledge to actions and problem-solving. 3) Practical skills involve designing and carrying out experiments, often using words like demonstrate and implement. 4) Generic skills, such as problem-solving

techniques and analysis, are key to learning and should be analyzed and compared.

Kennedy (2006), Learning outcomes typically involve knowledge, comprehension, application, analysis, synthesis, and evaluation in the cognitive domain, followed by the affective domain (attitudes, feelings, values) and the psychomotor domain (physical skills).

Hartati (2015) Learning outcomes are the final stages of a learning process, influenced by the student's efforts to complete the learning activities. These outcomes are observed and measured in terms of knowledge, attitudes, and skills, and are often interpreted as improvements and better development. Bloom's classification of learning outcomes into cognitive, affective, and psychomotor domains is used to assess these outcomes. The categorization of learning outcomes is divided into skills and habits, knowledge and understanding, attitudes and ideals, and verbal information, intellectual skills, cognitive strategies, attitudes, and motor skills.

Learning and learning outcomes are interrelated, as learning is a process of activity or change, and learning outcomes result from this process. Student learning outcomes are essentially changes in behavior that include cognitive, affective, and psychomotor fields. Thus, learning outcomes are changes in student behavior after experiencing a learning process, which can be observed through cognitive, affective, and psychomotor aspects.

Cognitive learning outcomes involve intellectual skills and knowledge-based competencies. Bloom (1956) categorized the cognitive domain into six levels: knowledge, comprehension, application, analysis, synthesis, and evaluation. Anderson and Krathwohl (2001) revised this taxonomy into Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating. This research measures cognitive learning outcomes through achievement tests assessing students' comprehension and mastery of English learning materials after using the Assemblr Edu app as an interactive learning medium. The study aims to understand the importance of cognitive skills in achieving learning outcomes.

As education increasingly incorporates digital technology, new categories of learning outcomes relevant to 21st-century competencies have emerged. According to Ng (2012), Digital Literacy Outcomes involve the ability to effectively, critically, and responsibly use digital technologies for learning, communication, and problem-solving.

Similarly, Johnson and Johnson (2019) highlights the importance of Collaborative Learning outcomes, which encompass skills in teamwork, communication, and conflict resolution in digital and face-to-face settings. Additionally, Trilling and Fadel (2009) propose Creativity and Innovation Outcomes, which involve generating novel ideas and solutions in various learning contexts.

These contemporary outcomes are particularly relevant in educational technology tools such as the Assemblr Edu app, which require students to engage actively, think creatively, and collaborate through digital platforms.

This research aims to assess various learning outcomes to evaluate the impact of using the Assemblr Edu app as an interactive learning medium in English language teaching. These outcomes measure the comprehensive impact of Assemblr Edu's use in teaching English.

C. Conceptual framework

Varpio et al. (2020) define a conceptual framework as a research justification that outlines the state of knowledge, identifies gaps in understanding a phenomenon or problem, and outlines the methodology of the research project. It aims to answer questions about the research's importance and potential contributions to existing knowledge. Miles & Huberman (1994) noted that it also serves as the foundation for research, illustrating the relationship between variables and clarifying how the study is organized and conducted. In this study, the conceptual framework is designed to explain how Assemblr Edu influences students' learning outcomes and activeness in English language learning at the 12th grade of UPT SMA Negeri 2 Parepare.

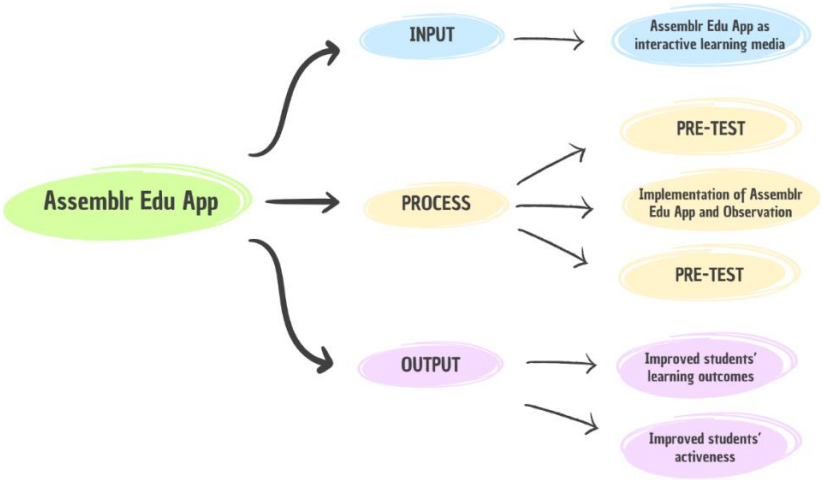


Figure 1 Conceptual Framework

The conceptual framework is constructed based on three components: Input, Process, and Output, as follows:

a. Input

The input refers to the resources and elements introduced at the beginning of the learning process. In this study, the input is Assemblr Edu, an interactive learning application that utilizes Augmented Reality (AR) and 3D objects, designed to support educational activities.

b. Process

The process involves implementing learning activities using Assemblr Edu during English lessons. This stage includes delivering materials through the Assemblr Edu app, students' engagement with interactive content, and real-time classroom activities that promote active participation. The activities are designed to stimulate cognitive, affective, and psychomotor learning outcomes and encourage students' activeness through interactive exploration and collaborative tasks (Wigati et al., 2023).

During this phase, three research instruments are employed:

- A test to assess students' learning outcomes.
- An observation checklist to evaluate students' activeness during lessons using Assemblr Edu.
- A teacher's note to strengthen data validity, provide a richer picture, and explain the "why" behind the numbers in the observation results.

c. Output

The output refers to the measurable results obtained after the learning process. In this study, the outputs are the improvement of students' learning outcomes in English and the increase in students' activeness during learning activities.

It is expected that integrating Assemblr Edu as interactive learning media will positively impact these two areas, as interactive media have been proven to enhance engagement, motivation, and comprehension.

D. Hypothesis

Based on the previous findings and the problem statements, the research states the following hypothesis as follow:

1. The Null Hypothesis (H_0) : There is no significant effect of using Assemblr Edu as an interactive learning media on students' activeness at the 12^{th} grade of UPT SMA Negeri 2 Parepare.
2. The Alternative Hypothesis (H_1) : There is a significant effect of using Assemblr Edu as an interactive learning media on students' activeness in the 12^{th} grade of UPT SMA Negeri 2 Parepare.

CHAPTER III

RESEARCH METHOD

This chapter outlines the research method and design that will be employed in this study.

A. Research design

The research method employed in this study is a mixed-methods approach, specifically the Convergent Parallel Mixed-Method Design. The mixed-methods approach integrates both quantitative and qualitative methods in a single study to provide a comprehensive and in-depth understanding of the research problem. According to Creswell and Plano Clark (2017), mixed methods involve the collection, analysis, and integration of quantitative (numerical) and qualitative (textual or visual) data in one study. This integration is designed to capitalize on the strengths of each data type to more completely explain complex research issues.

In line with this, Sugiyono (2013) emphasizes that mixed-method research is a research strategy that combines quantitative and qualitative data to obtain more comprehensive, valid, reliable, and objective findings. In this study, the Convergent Parallel design is employed, where both types of data are collected simultaneously, analyzed independently, and finally merged to form a well-rounded interpretation of the impact of the Assemblr Edu app on both students' learning outcomes and their classroom activeness.

Unlike the Explanatory Sequential Design, which collects and analyzes quantitative data first and follows with qualitative data to elaborate on those

findings, the Convergent Parallel Design enables the researcher to conduct both strands concurrently and independently, thereby saving time and allowing for direct comparison and corroboration of data sets. This design is especially effective when researchers aim to triangulate findings, compare different perspectives, or validate outcomes through multiple sources of data (Fetters, Curry, & Creswell, 2013).

The quantitative component of this study is employed to measure students' learning outcomes through the administration of pre-tests and post-tests before and after the use of the Assemblr Edu application. Simultaneously, the qualitative component uses an observation checklist to assess students' activeness during the teaching and learning process. These two data sources are then compared and interpreted to identify whether the results converge, diverge, or complement each other.

This convergent approach has been effectively utilized in previous educational research. For instance, Akçayır and Akçayır (2017) explored the use of Augmented Reality (AR) in education and found that the integration of quantitative tests and qualitative classroom observations enhanced the reliability of their conclusions. Similarly, Lin et al. (2017) employed a convergent design to investigate students' perceptions of technology-rich science classrooms, demonstrating that combining survey results and interview data provided richer insights into student activeness.

Therefore, by applying the Convergent Parallel Mixed-Method Design, this study aims not only to assess the effectiveness of Assemblr Edu in improving

students' English learning outcomes but also to capture their learning behaviors and levels of activeness during the learning process, offering a holistic and multidimensional perspective.

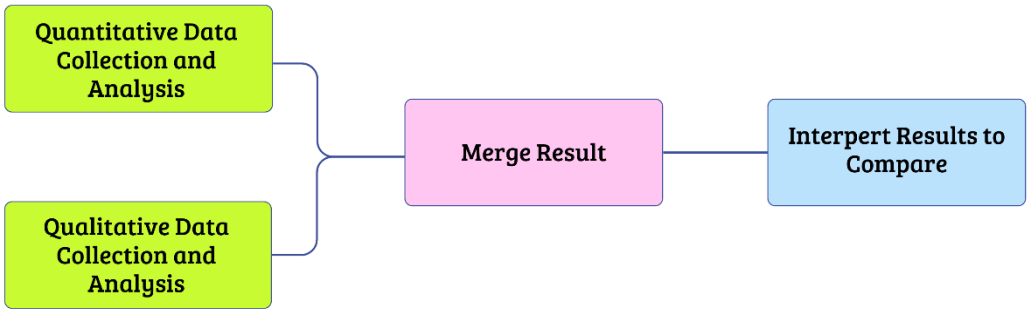


Figure 2 The Convergent Parallel mixed method design by Cresswell & Cresswell 2018

B. The research variable

This research includes two main types of variables: the independent variable and the dependent variable. These variables are determined based on the research objectives and questions, and they serve as the foundation for both data collection and analysis in this convergent parallel mixed-method study.

The independent variable is the use of Assemblr Edu, an augmented reality (AR)-based application implemented as an interactive learning medium. This tool presents digital learning materials in three-dimensional (3D) formats and allows students to engage with content using AR features. Assemblr Edu is applied during the teaching of analytical exposition texts to improve students' understanding and make the learning experience more engaging and interactive.

The dependent variables include students' learning outcomes and students' activeness. Students' learning outcomes represent their level of understanding and mastery of the material, which the researcher measures through pre-tests and post-tests. These tests focus on students' ability to comprehend the generic

structure, language features, and purpose of analytical exposition texts. This variable reflects the cognitive aspect of the learning process.

Students' activeness refers to their level of engagement during classroom activities while using Assemblr Edu. This includes how students participate in discussions, ask and answer questions, give opinions, interact with the digital tools, and complete classroom tasks. The researcher gathers this information using a structured observation checklist that captures behavioral indicators of active learning. This variable reflects the behavioral and affective aspects of the learning process.

By analyzing these variables, the researcher aims to understand not only whether Assemblr Edu improves students' learning outcomes but also how it influences their activeness and participation. This dual focus allows the study to offer a more complete picture of the effectiveness of AR-based learning tools in the context of English language education.

C. Population and sample

1. Population

   The population of this research is the 12th grade of UPT SMA Negeri 2 Parepare for the academic year 2025/2026. There are 11 classes, which consist of 381 students.

2. Sample

   The sample of the research uses random sampling, and the sample for this research is class 12th Excellent C3, which consists of 34 students.

D. Instrument of the research

The instrument of the research is a tool used to collect, measure, and analyze data related to the research interests. The instrument of this research uses data collection, namely students' English learning test to find out the result of their understanding of the subject, and an observation checklist to determine their participation or activeness during the class using the Assmblr Edu application.

1) English Learning Test (Pre-Test and Post-Test)

   The English learning test will be used to assess students' learning outcomes of the subject matter before and after the implementation of the Assemblr Edu app as an interactive learning media. The test consisted of multiple-choice. The pre-test will be conducted before the use of Assemblr Edu, while the post-test will be given after the learning activities to measure students' learning outcomes.

2) Observation Checklist

   The observation checklist will be used to assess students' activeness during the learning process using the Assemblr Edu app. It included several indicators such as students' participation in asking and answering questions, engagement with learning activities, interaction with the media, enthusiasm during class activities, and collaboration with peers. This instrument helped the researcher observe and record students' behaviors during the learning process in a structured and systematic way.

E. Technique of collecting data

In this research, data were collected through two types of techniques corresponding to the mixed-method design employed, namely quantitative data collection and qualitative data collection. The data collection techniques applied in this research are as follows:

1. Quantitative Data Collection

   The quantitative data will be obtained through the administration of pre-test and post-test aimed at measuring students' learning outcomes before and after the use of the Assemblr Edu app as an interactive learning media in English language learning.

   a. Pre-test

      A pre-test will be administered to measure students' initial learning outcomes before the implementation of the Assemblr Edu app in the teaching process. The pre-test consisted of multiple-choice questions related to the learning materials taught in the 11^{th}-grade English.

   b. Post-test

      After the treatment (use of the Assemblr Edu app in the learning process), a post-test will be administered using a set of multiple-choice questions equivalent in level and content to the pre-test to evaluate the improvement in students' learning outcomes.

   The results of the pre-test and post-test were then compared to determine whether there was a significant improvement in students' learning outcomes after utilizing Assemblr Edu.

2. Qualitative Data Collection

The qualitative data were collected through non-participant classroom observation by employing an observation checklist to measure students' activeness during the learning process using Assemblr Edu. The observation was conducted during the implementation of the teaching and learning process in the classroom, focusing on various indicators of students' activeness such as: participation in discussions, attention to instructions, initiative to use the media, collaboration with peers, and enthusiasm in completing tasks.

F. Technique of data analysis

The data analysis techniques used in this study were divided into two parts, in line with the explanatory sequential mixed-method design: quantitative and qualitative data analysis.

1. Quantitative Data Analysis

The quantitative data obtained from students' learning outcomes (pre-test and post-test scores) were analyzed using both descriptive and inferential statistical analysis.

Descriptive analysis was used to describe the mean, standard deviation, minimum, and maximum scores of both the pre-test and post-test. This helped provide a clear overview of the central tendency and variability of the data before and after the intervention.

Inferential analysis was employed to test the research hypothesis. Since the same group of students was tested before and after the treatment

(one-group pretest-posttest design), a Paired Sample t-Test was selected to compare the means of the pre-test and post-test. However, after checking the assumptions of normality using the Shapiro-Wilk test, it was found that the data were not normally distributed ($p < 0.05$). Therefore, the Wilcoxon Signed-Rank Test, a non-parametric alternative to the paired t-test, was used instead. The hypothesis for this test is formulated as follows:

- H_0 (Null Hypothesis) : There is no significant improvement in students' learning outcomes and students' activeness after using the Assemblr Edu app.
- H_1 (Alternative Hypothesis) : There is a significant improvement in students' learning outcomes and students' activeness after using the Assemblr Edu app.

The significance level (α) is set at 0.05. The decision rule is:

- If p-value ≤ 0.05, then H_0 is rejected and H_1 is accepted.
- If p-value > 0.05, then H_0 is accepted.

The analysis was conducted using a one-tailed test because the research objective was specifically to determine whether the post-test scores were significantly higher than the pre-test scores. The statistical analysis was performed using IBM SPSS Statistics version 22.

2. Qualitative Data Analysis

In this research, the qualitative data obtained from the observation checklist were analyzed using Miles and Huberman's Interactive Model of Data Analysis (1994). This model consists of three concurrent activities:

data reduction, data display, and conclusion drawing/verification. This analysis process is iterative and continuous, meaning that the researcher moves back and forth between the components during the data collection and analysis phases.

a. Data Reduction

Data reduction refers to the process of selecting, focusing, simplifying, abstracting, and transforming raw data into a more manageable form. According to Miles and Huberman (1994), data reduction is an analytical step that sharpens, sorts, discards, and organizes data to enable meaningful conclusions.

In this study, data reduction was performed after classroom observations were conducted using the observation checklist. The researcher began by organizing the checklist data and identifying which indicators of students' activeness were demonstrated in each session. The frequencies and patterns of student actions were coded (e.g., A = Asking Questions, D = Participating in Discussions, R = Responding to Questions), and any inconsistent or irrelevant data were filtered out.

The indicators used in the observation checklist were developed based on expert educational theories and adapted to suit the current research context, which investigates the use of the Assemblr Edu app as an interactive learning medium for 12th grade students at UPT SMA Negeri 2 Parepare. The indicators are explained as follows:

1. Paying Attention to the Teacher's Explanation: This indicator reflects students' visual learning activity, such as observing and focusing on the teacher's instruction. It is aligned with Paul B. Diedrich's theory as cited in Nisak and Aisyah (2024), which classifies learning activity into visual, oral, and motoric types.
2. Asking Questions: This measures the students' curiosity and initiative to deepen their understanding. It is supported by Karim and Karolina (2023), who state that active learners are characterized by their engagement through questioning and exploring.
3. Answering Questions: This shows student participation by responding to teacher or peer questions. As explained by Sudjana in Prasetyo and Abduh (2021), an active student interacts verbally and contributes during class.
4. Participating in Discussions: This indicator highlights students' involvement in collaborative learning through discussion. It is grounded in Bonwell and Eison's (1991) theory of active learning and further supported by Karim and Karolina (2023), who emphasize its role in enhancing critical thinking and engagement.
5. Completing Tasks Using Assemblr Edu: This reflects students' ability to carry out learning tasks through the app. Research by Majid et al. (2023) and Anjali et al. (2024) confirms that AR-based tools like Assemblr Edu boost student motivation and creativity.

6. Expressing Opinions: This measures students' willingness to share personal views or reflections. Muthmainnah (2019) states that expressing opinions is a key feature of active learning environments.
7. Using Assemblr Edu Features Actively: This evaluates how students explore and engage with Assemblr Edu's tools, such as 3D models and AR scanning. Hasanah (2022) and Yasa et al. (2024) note that students' interaction with digital features is essential in 21st-century learning.

In summary, each indicator in the observation checklist was systematically selected from the literature and tailored to meet the current research objectives, aiming to measure student activeness in an accurate and contextually appropriate way.

b. Data Display

Miles & Huberman (1994) emphasize the importance of well-organized and condensed data displays in qualitative analysis because they facilitate the recognition of patterns, trends, and relationships. In this research, observation data will be presented in tables, highlighting the occurrence and frequency of each activeness indicator per meeting. Summary descriptions were written to explain students' behaviors about the indicators, and charts or matrices were used to present patterns in students' activeness across multiple lessons.

c. Conclusion

The final stage of a research study involves conclusion drawing and verification, where the researcher interprets data, identifies patterns, and makes sense of the findings. In this study, the researcher utilized Assemblr Edu to infer the learning behavior of active students, comparing qualitative findings with quantitative data to determine if higher activeness correlates with improved learning outcomes.

3. Data Merge

In a Convergent Parallel Mixed-Method Design, data merging is a crucial step that follows the separate analysis of both quantitative and qualitative data. This process helps the researcher understand whether the two types of data are convergent (supporting), divergent (contradicting), or complementary to each other. The aim is to provide a more complete answer to the research questions by connecting numerical outcomes with observed classroom behaviors.

In this study, quantitative data are derived from students' pre-test and post-test scores, which measure their learning outcomes before and after using the Assemblr Edu app. At the same time, qualitative data are collected through classroom observations using an observation checklist, which records students' activeness, including participation, engagement, and interaction with the learning media.

After analyzing both data sets separately, the researcher merges them using a side-by-side joint display technique, as suggested by Creswell

and Plano Clark (2017). This technique presents the results of both data types in a single table or matrix to compare and relate them. The researcher aligns data based on individual students or specific indicators to observe trends, similarities, or differences.

For example, if a student shows an increase in post-test scores and also receives high marks on the observation checklist, the result is convergent. It means the Assemblr Edu app supports both learning outcomes and classroom activeness. If a student performs well on the test but shows low activeness, the result is divergent. It suggests that learning outcomes improve despite low behavioral involvement. Suppose a student is active but shows no improvement in test results. In that case, the result is complementary, meaning the activeness does not directly affect the learning outcomes, but may support other aspects of learning.

This merging process allows the researcher to connect cognitive performance (quantitative) with affective and behavioral responses (qualitative). It also helps validate the results through triangulation, which increases the trustworthiness and accuracy of the findings. According to Fetters, Curry, and Creswell (2013), data integration through joint displays strengthens the explanation and allows researchers to make more meaningful conclusions.

In this research, data merging gives a full picture of how Assemblr Edu impacts students. It shows not only whether learning outcomes improve but also how students behave and respond to the learning process

(students' activeness). The combination of both data types makes the findings more reliable and supports a deeper understanding of the effects of technology-enhanced learning.

4. Interpretation of Merge Results

After the researcher analyzes both quantitative and qualitative data sets independently, the next step is to interpret the results together. This process, known as meta-inference, aims to answer the research questions by considering the combined meaning of both data sets. In a convergent parallel mixed-method design, this interpretive phase is essential for drawing comprehensive and meaningful conclusions.

This research investigates whether the use of Assemblr Edu, an augmented reality (AR)-based learning tool, improves students' learning outcomes (measured through test scores) and classroom activeness (measured through observation checklists). The integration of these findings helps the researcher explore the relationship between the activeness and learning outcomes.

When both data sets align, meaning students who are more active during class also achieve higher post-test scores, the findings are said to converge. This convergence strengthens the conclusion that Assemblr Edu supports both cognitive and behavioral improvements. If the data show divergence, such as students who engage actively but do not improve their test scores, the researcher investigates possible reasons. These may include

technical difficulties, limited content coverage, individual differences in learning pace, or challenges with digital literacy.

In some cases, the findings may offer complementary insights, where one data set enhances the understanding of the other. For instance, students may demonstrate high motivation and participation due to the AR features of Assemblr Edu, even if this does not immediately translate into improved learning outcomes scores. This complementarity still holds value because it shows the affective and motivational impact of the tool.

According to Fetters, Curry, and Creswell (2013), the strength of mixed-method research lies not only in collecting multiple types of data but also in how the researcher interprets the integrated results to generate valid, well-rounded conclusions. The merged interpretation in this study allows the researcher to understand how Assemblr Edu affects both learning outcomes and student activeness, providing a clearer picture of the tool's effectiveness.

This step is essential because it transforms raw data into theoretical insights and practical implications. It helps validate whether the Assemblr Edu can serve as an effective digital media for English language learning, especially in encouraging both improved learning outcomes and active classroom behavior.

CHAPTER IV

FINDINGS AND DISCUSSION

This chapter presents the findings of the study and their discussion. The findings are based on data collected from tests and observations, which are then analyzed to answer the research questions.

A. Findings

This section explains the results of the study on the use of the Assemblr Edu App at UPT SMA Negeri 2 Parepare. The findings are divided into two parts: the results of the pre-test and post-test, which measured students' learning outcomes, and the results of classroom observations, which measured students' activeness. The test results were analyzed using quantitative methods to answer the first research question, while the observation data were analyzed qualitatively to answer the second. Together, these findings give a complete picture of how the Assemblr Edu App affected both students' learning outcomes and their activeness.

1. The Improvement of Students' Learning Outcomes Using the Assemblr Edu in English Learning

a) The percentage of students' pre-test

The pre-test was conducted to see the students' ability before using the Assemblr Edu App. The results are shown in the table below.

3. Score	Classification	5. F	6. %
7. 86 – 100	8. Excellent	9. 14	10. 41%
11. 71 – 85	12. Good	13. 6	14. 18%
15. 56 – 70	16. Fair	17. 3	18. 9%
19. < 55	20. Poor	21. 11	22. 32%
23. Total		**24. 34**	**25. 100%**

Table 1 Students' Pre-test Result

The result of the pretest shows that students have different levels of achievement before using Assemblr Edu. From 34 students, 14 students (41%) are in the “Excellent” category with scores 86–100, and 6 students (18%) are in the “Good” category with scores 71–85. Then, 3 students (9%) are in the “Fair” category (56–70), while 11 students (32%) are in the “Poor” category with scores under 55.

This result means that although some students already have high scores, many students still get low scores. It shows that students need support and new learning media to help them improve their results. The Assemblr Edu is expected to give this support and make learning outcomes better.

b) The percentage of students’ post-test

After learning with the Assemblr Edu App, the students took a post-test. The results can be seen in the following table.

26. Score	**7. Classification**	**28. F**	**29. %**
30. 86 – 100	31. Excellent	32. 26	33. 76%
34. 71 – 85	35. Good	36. 4	37. 12%
38. 56 – 70	39. Fair	40. 0	41. 0%
42. < 55	43. Poor	44. 4	45. 12%
46. Total		**47. 34**	**48. 100%**

Table 2 Students' Post-test Result

After treatment using the Assemblr Edu app, the posttest results show that most students improve after learning with Assemblr Edu. Of 34 students, 26 students (76%) are in the “Excellent” category with scores 86–100, and 4 students (12%) were in the “Good” category with scores 71–85. None of the students were in the “Fair” category, and

only 4 students (12%) remain in the “Poor” category with scores under 55.

This result means that after using the Assemblr Edu app, the number of students with “Excellent” scores increases a lot, while the number of students with low scores or the “Poor” category decreases. It shows that Assemblr Edu has a positive impact on students’ learning outcomes, it helps improve students’ learning outcomes significantly. Most students become more successful after using this learning media.

c) The mean score of students’ pre-test and post-test

The mean scores of the pre-test and post-test were compared to determine the improvement. The result is presented in the table below.

Descriptive Statistics

	N	Mean
Pretest	34	69.97
Posttest	34	86.53
Valid N (listwise)	34	

Table 3 The Mean Score of Students' Test

The descriptive statistical results reveal that the mean score of the students’ pretest is 69.97, whereas the mean score of the posttest is 86.53. This demonstrates an improvement of 16.56 points between the two tests. The increase in the mean score suggests that the implementation of Assemblr Edu as a learning media contributes positively to students’ learning outcomes, as the posttest scores are considerably higher than the pretest scores.

d) Hypothesis testing

To check whether the improvement was significant, a hypothesis test was conducted. The result is shown in the table below.

Test Statistics[a]

	Posttest - Pretest
Z	-3.608[b]
Asymp. Sig. (2-tailed)	.000

Table 4 Hypothesis Testing

Based on the results of the hypothesis testing using the Wilcoxon Signed Ranks Test, the value of Z = -3.608 with Asymp. Sig. (2-tailed) = 0.000 is obtained. This significance value is smaller than the significance level of $\alpha = 0.05$. The basis of decision-making in hypothesis testing is:

- If the significance value (Asymp. Sig.) ≤ 0.05, then H_0 is rejected and H_1 is accepted.
- If the significance value (Asymp. Sig.) > 0.05, then H_0 is accepted and H_1 is rejected.

Since the result shows that $0.000 \leq 0.05$, it means that H_0 is rejected and H_1 is accepted; therefore, it can be concluded that there is a significant difference between the pretest and posttest scores. This finding suggests that the use of the Assemblr Edu app in English learning has a significant impact on improving students' learning outcomes.

2. Students' Activeness During the Use of the Assemblr Edu in English Learning

In this study, besides aiming to see the improvement of student learning outcomes, this study also aims to observe student activeness in learning after using the Assemblr Edu application in the material. During the implementation of the application, researchers conducted observations. Data from the observation checklist collected from 34 students, 12th grade of UPT SMA Negeri 2 Parepare, showed that 18 out of 34 students (53%) are in the "Very Active category", indicating that the use of Assemblr Edu significantly enhanced students' activeness. The results of the observations that have been carried out can be seen in the following table:

Total Score	Category	F	%
6–7	Very Active	18	53%
4–5	Active	9	26%
2–3	Less Active	4	12%
0–1	Not Active	3	9%
Total		**34**	**100%**

Table 5 Students' Activeness Category

Based on observations, student activeness during the learning process using the Assemblr Edu App was generally high. This is evident from the data distribution, where more than half of the students, or 18 (53%), fell into the "Very Active" category, demonstrating nearly all indicators of activeness, from paying attention to teacher explanations to maximizing the app's features. Nine (9) students (26%) were in the "Active" category, demonstrating consistent activeness across 4–5 indicators, specifically paying attention, completing assignments, and occasionally asking or

answering questions. Meanwhile, 4 students (12%) were in the "Less Active" category, with limited engagement across only 2 – 3 indicators, typically involving attention or using the app without much verbal interaction. 3 students (9%) were in the "Not Active" category, demonstrating very low participation, demonstrating only 0 – 1 indicator of activeness.

These findings indicate that overall, the use of Assemblr Edu successfully encouraged the majority of students to be active in learning. The high number of students in the "Active" and "Very Active" categories (79%) confirms the app's effectiveness in increasing student activeness. However, the presence of a small number of students in the “Less Active” and “Not Active” categories indicates the need for additional strategies, such as technical assistance, motivational support, or simpler discussion methods, so that all students can achieve an optimal level of activity.

Based on the categorization data, the majority of students are in the “Active” and “Very Active” categories, indicating that the use of the Assemblr Edu App successfully created a learning environment that encouraged active participation. If we examine each activity indicator in more depth, the patterns that emerge will strengthen these findings. An explanation of each activeness indicator and teacher note can be seen in the following table:

49. Indicator	50. Teacher's Notes	51. Explanation	52. F	53. %

54. Paying Attention (PA)	55. M1: Focus on app usage. M3: Focus on subject matter.	56. A high quantitative result is validated by notes showing a qualitative shift from procedural attention (how to use the tool) to conceptual attention (the English lesson itself), indicating deep activeness.	57. 29	58. 85%
59. Asking Questions (AQ)	60. M1: Technical questions. M3: Content-related questions.	61. The high percentage reflects a classroom buzzing with inquiry. The teacher's notes show a crucial evolution: curiosity moved from the medium (the app) to the message (Analytical Exposition text), signifying successful integration of technology into learning.	62. 26	63. 76%
64. Answering Questions (AN)	65. M1: Only some students. M3: More students participated.	66. The increase in willingness to answer questions, as per the notes, correlates with the solid 68% score. It suggests growing confidence and understanding, moving from a passive to a more responsive classroom environment.	67. 23	68. 68%
69. Participating in Discussion (PD)	70. M1: No discussion. M3: Small-group discussions emerged.	71. The moderate score is given context by the notes: collaboration started from zero and grew organically. This indicates that AR stimulated natural collaboration as students explored together, but structured whole-class	72. 20	73. 59%

		debates were not the primary outcome.		
74. Expressing Opinions (EO)	75. M1: None. M3: Only a small portion.	76. This is the only indicator where both data sources align perfectly on a challenge. The notes confirm that, despite high activity elsewhere, articulating personal opinions remained a significant hurdle, often due to language anxiety and the cognitive demands of the task.	77. 17	78. 50%
79. Completing Tasks (CT)	80. M2: Most completed tasks. M3: Near-perfect completion.	81. The high score is powerfully supported by the notes showing a trajectory to near-universal task completion. This demonstrates that the app was not just a fun distraction but an effective medium for achieving tangible learning outcomes.	82. 29	83. 85%
84. Using Assemblr Edu Features (UF)	85. M1: Enthusiastic, trying. M3: Independent mastery.	86. The near-perfect score is brought to life by the notes. They show a journey from initial excitement and experimentation to confident, independent use. This indicates excellent usability and that students quickly became comfortable with the technology.	87. 31	88. 91%

Table 6 Students' Activeness Per Indicator and Teacher Note

Teacher notes for the Paying Attention (PA) indicator highlighted a meaningful shift: students initially focused on procedural aspects such as

how to operate the app, but over time, their attention moved toward conceptual understanding of the lesson itself (analytical exposition text). This finding is strongly supported by the quantitative data, which shows that 29 out of 34 students (85%) were observed paying attention. This transition illustrates how AR technology (Assmblr Edu), when integrated with teacher guidance, can reduce distractions from the medium and channel attention toward the core learning objectives. Such a pattern aligns with Mayer's (2009) Cognitive Theory of Multimedia Learning, which emphasizes that well-designed visual media can direct learners' cognitive resources toward understanding content more deeply.

The Asking Questions (AQ) indicator also showed significant development according to teacher notes: At first, most questions were technical in nature, reflecting curiosity about the Assemblr Edu application/platform itself. However, by the third meeting, students increasingly asked content-related questions. This evolution toward deeper cognitive engagement is reflected in the data, with 26 students (76%) actively asking questions. This progression echoes findings by Makransky and Petersen (2021), who explain that immersive media initially attract attention through novelty but, with proper scaffolding, can sustain inquiry and direct it toward meaningful knowledge construction.

For the Answering Questions (AN) indicator, teacher notes described a positive change in the classroom atmosphere, where more students gradually gained the confidence to answer questions. This pattern

of growth is corroborated by the fact that 23 students (68%) were observed answering questions. This suggests that repeated interaction with Assemblr Edu lowered students' anxiety and created a more responsive classroom environment, a finding consistent with results reported by Mursyida et al. (2023), who found that AR use in English classes reduced students' hesitation and fostered greater willingness to respond verbally.

In contrast, teacher notes for Participating in Discussion (PD) explained that collaboration started from zero in the first meeting and grew gradually into small-group discussions, but structured, whole-class debates were still limited. This qualitative challenge is reflected in the quantitative result, which shows that only 20 students (59%) participated in discussions. This reflects the challenge of moving from behavioral activeness to higher-order, critical engagement.

Similarly, teacher observations for Expressing Opinions (EO) confirmed a significant obstacle, noting that expressing personal opinions was especially difficult due to language barriers and the cognitive demands of analytical exposition texts. This was the least demonstrated indicator, with only 17 students (50%) observed expressing their opinions. These findings align with those of Saidin et al. (2025), who emphasize that AR effectively stimulates participation but does not automatically guarantee deeper, dialogic activeness without teacher support.

On the other hand, teacher notes for Completing Tasks (CT) confirmed a trajectory of strong progress, with most students completing

tasks in the second meeting and achieving near-perfect completion by the third. This is powerfully demonstrated by the high number of students, 29 (85%), who were observed completing their tasks. This shows that Assemblr Edu was not just a fun distraction but an effective medium for achieving.

Finally, teacher notes for Using Assemblr Edu Features (UF) detailed a journey from initial enthusiasm and experimentation to confident, independent mastery of the application's functions. This excellent usability and activeness are mirrored in the highest score among all indicators, with 31 students (91%) actively using the Assemblr Edu features. This finding is in line with Johnson-Glenberg (2023), who argues that embodied interaction with digital objects strengthens both activeness and conceptual understanding of tangible learning outcomes.

The observations show that Assemblr Edu effectively built a strong foundation of behavioral activeness, as students paid attention, explored Assemblr Edu features, and completed tasks enthusiastically. Over time, this engagement developed into cognitive activeness, with students asking more content-focused questions and showing greater willingness to answer. However, higher-order verbal engagement, such as expressing opinions and active discussion, remained limited. These findings indicate that while Assemblr Edu successfully stimulates attention, curiosity, and participation, teacher guidance is still essential to transform this activeness into deeper, critical, and communicative learning.

3. The Effect of Using Assemblr Edu on Students' Learning Outcomes and Activeness

To better understand how the Assemblr Edu App impacts students, the researcher combined the results of the pre-test and post-test with the observation checklist of students' activeness. From this merged data, three patterns appeared: convergent, divergent, and complementary.

Based on Creswell and Plano Clark (2017), these patterns can be explained as follows. Convergent findings occur when test results and classroom observations show the same pattern, for example, students who were active in class also achieved good scores, while less active students showed lower outcomes. Divergent findings appear when the two results do not match, such as when students are very active but their test scores do not improve, or when students have high scores but low activeness. Complementary findings happen when the two results do not fully align but still support each other, with observation data helping to explain or enrich the test results. Together, these three patterns provide a more complete picture of how the Assemblr Edu App influences both learning outcomes and activeness. To make the explanation clearer, the distribution of students' results based on convergent, divergent, and complementary patterns is presented in the following table.

Category	F	%
Convergent	26	76%
Divergent	3	9%
Complementary	5	15%
Total	34	100%

Table 7 Merging Data Result

The analysis shows that most students (26 students or 76%) were in the convergent category. This means that their learning outcomes were consistent with their activeness in class. Students who were very active when using Assemblr Edu also gained good improvement in their post-test scores. On the other hand, less active students tended to show lower improvement. This suggests that students' activeness with the app supported better learning outcomes.

There were also 3 students (9%) in the divergent category. In this group, learning outcomes did not match their activeness. For example, some students were very active, but their scores did not improve, while others had high scores but were not very active in class. This indicates that being active in class does not always guarantee better scores, since other factors like prior knowledge, learning style, or test conditions may influence the results.

In addition, 5 students (15%) were categorized as complementary. In this case, one aspect was stronger than the other. For example, some students maintained high scores even though their activeness was only moderate, while others were very active, but their scores did not increase. These findings show that the Assemblr Edu App still encouraged participation and activeness, even if the academic improvement was not always visible.

To enrich these results, data from teacher notes during three meetings provide deeper insights into the nature of students' activeness. The notes confirmed that behavioral activeness, such as Paying Attention (PA)

and Using Assemblr Edu Features (UF), was consistently high from the first meeting and reached near-perfect levels by the third meeting. Task Completion (CT) also showed strong progress, with students demonstrating enthusiasm and responsibility in finishing assignments. Moreover, cognitive engagement gradually improved: Asking Questions (AQ) shifted from technical queries about the app to more content-focused questions, and Answering Questions (AN) became more frequent as students grew more confident. However, higher-order activeness, Participating in Discussions (PD) and Expressing Opinions (EO) remained the lowest, although they showed gradual improvement. This indicates that while Assemblr Edu effectively built enthusiasm, curiosity, and focus, teacher scaffolding was still necessary to foster deeper critical engagement.

Overall, the findings indicate that the Assemblr Edu App had a positive impact on both students' learning outcomes and activeness. The majority of students showed a convergent pattern, where both aspects improved together, supported by teacher observations of growing curiosity and responsibility. However, the presence of divergent and complementary cases, along with limited progress in verbal-expressive activeness, suggests that technology alone is not sufficient. Its effectiveness depends on teacher strategies that can channel behavioral activeness into deeper collaboration and critical communication.

B. Discussion

This section presents a comprehensive discussion of the research findings presented in the previous section, intending to interpret the research results in relation to the research objectives, relevant theories, and previous research findings. This discussion is structured to examine the effect of the use of 3D/AR-based learning media, the Assemblr Edu app, on student learning outcomes and activeness, as well as the relationship between learning outcomes and student activeness when the application is implemented in the learning process. Through this analysis, this study is expected to provide a deeper understanding of the effectiveness of augmented reality-based learning media in improving learning outcomes and student activeness in the classroom.

1. The Improvement of Students' Learning Outcomes Using the Assemblr Edu in English Learning

Learning outcomes are a reflection of how well students understand the lessons delivered by the teacher. The success of teaching is often measured by the quality of students' outcomes (Sudargini & Purwanto, 2020). According to Harefa et al. (2023), learning outcomes represent both the results of the learning process and students' achievements, while also providing teachers with important feedback regarding their progress. Kandia et al. (2023) further emphasize that learning outcomes reflect the development of students' abilities, competencies, and skills, although in practice, they do not always meet expectations since improvement is not automatically guaranteed.

In this study, learning outcomes in the cognitive domain were measured through pre-test and post-test results, focusing on students' understanding of the generic structure, language features, and social function of analytical exposition texts. The findings revealed a significant improvement: the mean score increased from 69.97 (pre-test) to 86.53 (post-test), and hypothesis testing confirmed that this difference was statistically significant, meaning the null hypothesis (H_0) was rejected and the alternative hypothesis (H_1) accepted. Moreover, the percentage of students in the "Excellent" category increased from 41% to 76%, while those in the "Poor" category decreased from 32% to 12%. These results demonstrate that Assemblr Edu not only strengthened the performance of higher-achieving students but also helped lower-achieving students catch up with their peers.

This improvement can be explained by the immersive and interactive features of Augmented Reality (AR). According to Mayer's Cognitive Theory of Multimedia Learning (2009), students learn better when information is presented through both words and visuals. In line with this, Makransky and Petersen's (2021) Cognitive Affective Model of Immersive Learning highlights that immersive environments create a sense of presence and control, which in turn increases focus and motivation. Moser and Lewalter (2024) also stress the importance of generative processing, where learners actively select, organize, and integrate new knowledge with existing schemas, while Johnson-Glenberg et al. (2023) underline embodied cognition, whereby physical interaction with 3D

content strengthens conceptual understanding. For example, when students manipulated 3D models of analytical exposition texts in Assemblr Edu, abstract concepts such as “thesis,” “arguments,” and “recommendations” became more concrete and easier to process.

The big shift in achievement from 41% to 76% in the “Excellent” category and from 32% down to 12% in the “Poor” category shows that the improvement went beyond memorization. The app provided lower-achieving students with more personalized and accessible learning paths. Asadi and Ebadi (2024) similarly argue that AR apps enable differentiated learning by allowing students to study at their own pace and style. Importantly, this improvement also reflects a shift from declarative knowledge (knowing what the parts of a text are) to procedural knowledge (knowing how to identify and use them) (Anderson et al., 2001), which is essential for deeper learning.

These findings align with recent research. Hikam et al. (2024) reported that students using Assemblr Edu achieved significant gains in vocabulary mastery due to the app’s engaging and visual design. Hayati et al. (2023) demonstrated that the app enhanced science learning and improved critical thinking, while Asadi and Ebadi (2024) confirmed its role in supporting diverse learners. The present study contributes by extending these benefits into the domain of English language learning, which has been less explored compared to STEM fields. This novelty lies in showing that

AR can effectively support not only concrete scientific concepts but also abstract linguistic structures.

Nevertheless, some limitations must be noted. This study measured only short-term improvement and focused on a single text genre, namely analytical exposition. Therefore, the results cannot be generalized to other genres or to long-term retention. Future studies should examine whether the positive effects of Assemblr Edu are sustainable over longer periods and whether they can be replicated in other text types such as narrative, report, or descriptive texts. Additionally, further research could expand to other literacy skills, such as writing and speaking, to gain a more comprehensive view of AR's role in English education.

In conclusion, the use of Assemblr Edu significantly improved students' English learning outcomes by fostering both higher achievement and deeper understanding. Beyond test scores, the app promoted meaningful learning by reducing cognitive load, increasing motivation, and transforming abstract concepts into concrete, embodied experiences. These results confirm that 3D/AR-based tools like Assemblr Edu are effective and reliable media for advancing multidimensional learning in 21st-century education.

2. Students' Activeness During the Use of the Assemblr Edu in English Learning

The observational data revealed that the implementation of Assemblr Edu successfully fostered a highly active learning environment, with a combined 79% of students categorized as "Active" or "Very Active." This activeness showed across multiple dimensions, reflecting both the strengths of the application and areas requiring further pedagogical support.

The observed activeness can be systematically categorized based on the framework by Paul B. Diedrich (in Nisak & Aisyah, 2024) and theories of engagement (Fredricks, Blumenfeld, & Paris, 2004):

a) Visual Activities (Paying Attention: 85%)

Teacher notes indicate a meaningful shift in student focus: from a procedural focus in the first meeting (M1, where students' attention was primarily on learning how to use the tool itself) to a conceptual focus by the third meeting (M3, where students' attention was successfully directed toward the learning content). This teacher's note of deeper activeness is strongly supported by the frequency and percentage of students' activeness indicator, which shows that 29 out of 34 students (85%) were consistently paying attention during lessons. This finding supports Mursyida et al. (2023), who found that AR effectively sustains student focus and minimizes passive reception.

b) Motor Activities (Using Features: 91%, Completing Tasks: 85%)

Teacher notes described a clear progression in student activeness with the app's functionalities: from an initial phase of "enthusiastic trial" in the first meeting to a state of "independent mastery" in later sessions. The notes also highlighted that nearly all students showed responsibility and persistence in completing the assigned tasks. This evidence of strong psychomotor activity is powerfully corroborated by the frequency and percentage of data. For the 'Using Features' indicator, 31 out of 34 students (91%) were actively manipulating 3D objects, scanning AR markers, and exploring the interface. Similarly, for 'Completing Tasks', 29 students (85%) successfully finished their assignments. This was the strongest dimension of activeness. By interacting with the interface, students shifted from being passive listeners to active participants in their learning. These findings confirm that Assemblr Edu stimulates Psychomotor activity by encouraging exploration and hands-on learning (Liono et al., 2021).

c) Oral Activities (Asking Questions: 76%, Answering Questions: 68%, Expressing Opinions: 50%)

Teacher notes provide crucial insights into the evolution of students' verbal activeness: they show that student questions shifted from technical issues about the app usage in the first sessions to content-focused inquiry in later ones, illustrating a clear growth in curiosity and cognitive engagement. The notes also recorded that willingness to answer questions increased over time, indicating growing confidence.

However, the notes clearly indicated that expressing personal opinions remained a significant challenge for students. These teachers' notes and observations are strongly reflected in the observation checklist data across the three indicators. For 'Asking Questions', 26 students (76%) were observed engaging in inquiry. For 'Answering Questions', 23 students (68%) participated. Meanwhile, 'Expressing Opinions' was indeed the weakest oral indicator, with only 17 students (50%) able to do so. This limitation was primarily due to language anxiety and the higher cognitive demand of analytical exposition texts (Karim & Karolina, 2023), consistent with Mursyida et al. (2023), who found AR reduces hesitation in English classes but may not fully overcome deeper expressive barriers.

d) Mental and Emotional Activities (Participating in Discussion: 59%)

Teacher notes recorded notable progress in student interaction patterns: from no discussion occurring in the first meeting to the emergence of small-group discussions in later sessions. While this shows a positive trend, the notes also highlight that AR technology (Assemblr Edu app) alone cannot guarantee rich, dialogic interaction. This teacher's observation showing limited but growing discussion activeness is directly reflected in the observation checklist, finding that 20 out of 34 students (59%) were observed participating in discussions. This result aligns with Saidin et al. (2025), who similarly note that while Assemblr Edu effectively fosters exploration and initial engagement,

meaningful discussion still requires deliberate teacher scaffolding to develop fully.

The high behavioral and psychomotor activity can be explained by the novelty and interactivity of AR technology. Previous studies (Huang et al., 2016; Alalwan et al., 2020) confirm that AR enhances motivation by making learning more immersive, especially for Generation Z digital natives (Cilliers, 2021). Teacher notes also suggested that students often experienced a state of "flow," where they were fully absorbed in completing tasks, which is consistent with findings by Majid et al. (2023) and Anjali et al. (2024).

Beyond behavioral aspects, Assemblr Edu also produced affective and psychomotor outcomes. Positive emotions such as enjoyment and curiosity supported intrinsic motivation, in line with Pekrun's Control-Value Theory of Achievement Emotions (2023). Psychomotor activity extended to technology-based skills, where students effectively manipulated 3D objects and navigated features, reinforcing cognitive understanding through multi-sensory learning (Saidin et al., 2024).

While AR in this study is the Assemblr Edu app successfully stimulated curiosity, attention, and task completion, higher-order engagement, particularly in expressing opinions and critical discussion, remained limited. This shows that technology alone provides the "raw material" for activeness (Muthmainnah, 2019), but meaningful learning outcomes require teacher facilitation. Asadi and Ebadi (2024) similarly

emphasize that AR is most effective when combined with pedagogical strategies such as debates, guided reflection, or peer teaching.

In summary, Assemblr Edu effectively promoted behavioral and psychomotor activeness, gradually stimulated cognitive engagement, and fostered positive emotions. Yet, verbal-expressive activity was the weakest domain, showing that while the Assemblr Edu app can transform classrooms into more student-centered spaces, teacher scaffolding remains essential to move students toward critical, communicative, and collaborative learning

3. The Effect of Using Assemblr Edu on Students' Learning Outcomes and Activeness

The merged findings of this study clearly show a strong relationship between students' activeness and their learning outcomes. From the integration of quantitative (test scores) and qualitative (observation) data, it was found that 76% of students fell into the convergent category. This means that most students who were more active during learning with Assemblr Edu also showed higher improvements in their test results. This pattern strongly supports the main hypothesis of this study: that Assemblr Edu improves learning outcomes by increasing student activeness.

This result is consistent with the modern framework of Embodied Constructivism (Johnson-Glenberg, 2023), which explains that learning is most effective when cognitive construction is supported by physical interaction, as the kinesthetic experience of manipulating AR objects deepens conceptual understanding. With Assemblr Edu, students were not

passive recipients of information but active explorers who manipulated virtual objects, discovered information, and solved tasks. This activeness directly supported the process of understanding and internalizing the lesson material. Similar findings have been highlighted by Molebu (2022), Majid et al. (2023), and Anjali et al. (2024), who reported that learning activeness leads to stronger conceptual mastery and creativity.

While the merged findings confirm a clear link between activeness and learning outcomes, the data also reveal variations that cannot be explained by a single pattern. To better understand these differences, the discussion is divided into three categories: convergent, divergent, and complementary, which together illustrate the diverse ways Assemblr Edu shaped student learning.

a) The Convergent Pattern

The convergent cases (76%) strongly support modern theories of generative learning (Moser & Lewalter, 2024), which explain that meaningful learning happens when students actively select, organize, and connect information. In this study, students who were active in using 3D models, exploring Assemblr Edu features, and discussing their findings were not only "doing activities" but also building mental models of the analytical exposition text. This process helped them understand the material more deeply and was reflected in the improvement of their post-test scores. Teacher notes strongly reinforce this finding, describing how students who consistently paid attention,

eagerly interacted with Assemblr Edu features, and collaborated during class discussions also demonstrated significant gains in their performance. For instance, students who manipulated 3D models to separate thesis, arguments, and recommendations were later able to recall and apply these structures more effectively in their post-test responses. Taken together, these findings provide strong evidence that Assemblr Edu supports the principle of active learning, where student activeness in the process directly translates into measurable improvements in outcomes.

b) The Divergent Pattern

The divergent cases (about 9%) demonstrate that being active in class does not always guarantee better learning outcomes. Some students were highly active during the lessons, but their test scores did not show much improvement. This reflects the “hands-on, minds-off” phenomenon, where students enthusiastically engaged with the technology but did not fully connect it to the lesson content. According to Cognitive Load Theory (Sweller, 2024), excessive focus on technical features can divert attention from the core material, resulting in superficial activeness rather than deep understanding.

Conversely, other students with strong prior knowledge still achieved high scores even though their visible activeness in class was only moderate. This suggests that while activeness plays an important

role, additional factors such as prior knowledge, learning style, and test-taking ability also significantly affect learning outcomes.

Teacher notes reinforce these findings, highlighting cases where students eagerly interacted with Assemblr Edu features but treated the 3D objects more as “play” rather than tools for analyzing the text structure. As a result, their test results did not improve substantially. On the other hand, some quieter students who appeared less active during classroom discussions demonstrated strong mastery of the material in their written post-test answers.

Similar results have been reported in previous studies. Akçayır & Akçayır (2022) found that some students became distracted by the novelty of AR and failed to connect it with the learning objectives. Likewise, Saidin et al. (2025) emphasized that while AR can effectively boost motivation and participation, without careful teacher scaffolding, this activeness may remain surface-level and fail to lead to meaningful learning. Together, these findings strengthen the conclusion that technology-based activeness alone is insufficient; effective learning requires both proper teacher guidance and student readiness to engage cognitively with the content.

c) The Complementary Pattern

Beyond the convergent and divergent cases, another group of students reflected a more subtle yet equally important outcome. These complementary cases (about 15%) demonstrate that learning

gains cannot be measured solely through test scores, but also through affective and motivational outcomes. Some students who were very active in class but showed only moderate score gains nonetheless benefited in other crucial ways, such as developing stronger motivation, greater confidence, and a deeper interest in learning English. On the other hand, a few students who were less active during the lessons still achieved high scores, suggesting that they were able to process and internalize information efficiently with minimal outward participation.

These outcomes are well explained by the Control-Value Theory of Achievement Emotions (Pekrun & Goetz, 2024), which argues that interactive and playful environments such as AR foster positive emotions, enjoyment, curiosity, and satisfaction while reducing negative ones like anxiety by strengthening students' sense of control and the value they place on tasks. Teacher notes further support this perspective, recording how some students who were initially shy or hesitant became more confident once they engaged with the 3D features of Assemblr Edu. Even though their test scores did not rise sharply, they showed more willingness to ask questions, participate, and explore the material independently. Conversely, some students remained relatively quiet during classroom discussions but produced strong written answers in the post-test, indicating that meaningful learning took place in less visible ways.

This variation highlights that learning is highly individual and that technology affects students differently depending on their prior knowledge, confidence, and learning approaches. In short, the complementary cases show that the success of Assemblr Edu cannot be fully captured by score improvements alone, but also lies in its ability to shape attitudes, reduce anxiety, and inspire long-term activeness with English learning.

Together, these three patterns, convergent, divergent, and complementary, illustrate that the relationship between activeness and learning outcomes is complex and multifaceted. The convergent pattern (76%) clearly demonstrates the effectiveness of Assemblr Edu in linking active participation with improved learning outcomes, supporting constructivist theories of generative learning (Moser & Lewalter, 2024) and embodied cognition (Johnson-Glenberg, 2023). Teacher notes further confirmed that students who consistently paid attention, eagerly interacted with Assemblr Edu features, and collaborated in discussions also showed significant gains in their post-test performance. For example, students who manipulated 3D models to distinguish between the thesis, arguments, and recommendations of analytical exposition texts were later able to recall and apply these structures more effectively in their written assessments. This shows that Assemblr Edu enables students to connect their activeness in the learning process with tangible improvements in outcomes. However, the divergent cases (9%) highlight that activeness does not always guarantee

higher achievement. Some students were very active in class but showed little improvement in test scores, a phenomenon explained by Cognitive Load Theory (Sweller, 2024), where attention was diverted toward technical features rather than the lesson content. Conversely, students with strong prior knowledge achieved high outcomes despite being only moderately active. Teacher notes confirmed this by observing that while most students were captivated by Assemblr Edu, a few became distracted by its novelty and failed to link their enthusiasm to deeper learning. Beyond these, the complementary cases (15%) emphasize that learning gains are not only about test scores but also about affective and motivational growth. Some students who remained active but scored moderately still showed improved confidence, reduced anxiety, and stronger motivation to engage in English learning. Teacher observations documented previously quiet students who, through Assemblr Edu interactions, became more willing to ask questions, share opinions, and explore material independently. On the other hand, students who appeared less outwardly active but still achieved high test results suggest that meaningful learning also occurred internally. These outcomes align with the Control-Value Theory of Achievement Emotions (Pekrun & Goetz, 2024), which posits that interactive and supportive environments foster curiosity and enjoyment, strengthening students' persistence in learning.

These findings are in line with earlier studies that reported the positive impact of Assemblr Edu on student activeness and outcomes. For

example, Hayati et al. (2023) demonstrated that Assemblr Edu improved science learning outcomes by helping students visualize complex material, while Kurniawan et al. (2024) confirmed that AR not only enhanced academic performance but also promoted positive emotions such as enjoyment and confidence. At the same time, the divergent cases align with Alkhattabi (2022), who cautioned that AR's novelty could sometimes distract students from core objectives, leading to only superficial activity. Thus, this study both confirms and nuances prior research: it affirms that the Assemblr Edu app supports activeness and outcomes, while also revealing variations that depend on prior knowledge, learning styles, and teacher scaffolding.

Despite these promising results, this study has several limitations. It was limited to one genre of text analytical exposition, so the findings cannot yet be generalized to other genres, such as narrative or report texts. The outcomes were measured only in the short term, so long-term retention and transfer of knowledge were not assessed. Furthermore, the study was conducted in a single school context, which limits external validity. These limitations echo the recommendations of Wang et al. (2023) and Saidin et al. (2025), who stressed the importance of longitudinal research and more diverse samples in AR-based studies.

The novelty of this study lies in its integration of quantitative test results, observational checklists, and teacher notes into a single analysis. Unlike many earlier studies that measured outcomes or activeness

separately, this research provides a nuanced picture by identifying three patterns: convergent, divergent, and complementary, simultaneous within the same classroom. This contributes to the literature by showing not only that AR works, but also how and for whom it works best, bridging the gap between behavioral activeness, affective outcomes, and academic outcomes in English language learning.

Looking forward, future research should investigate whether the convergent pattern holds across other text genres and literacy skills, such as writing, speaking, and listening. It should also examine long-term retention and explore how AR supports self-regulated learning strategies, as suggested by Kurniawan et al. (2024). Furthermore, integrating Assemblr Edu into collaborative and project-based tasks could transform behavioral activeness into sustained critical thinking and communicative competence. Expanding the study to larger and more diverse classrooms would also provide stronger evidence for its generalizability across different contexts.

In conclusion, the merged findings of this study demonstrate that Assemblr Edu is a powerful tool for fostering both student activeness and learning outcomes. The dominant convergent pattern confirms its effectiveness as a medium for active learning. At the same time, the divergent and complementary cases highlight the importance of teacher support, prior knowledge, and individual learning styles. Rather than reporting uniformly positive effects, this study offers a more multidimensional perspective, showing that Assemblr Edu works best when

paired with structured pedagogical strategies. By combining activeness, outcomes, and teacher insights, this research strengthens the position of Assemblr Edu as a valuable innovation in English language education and contributes new depth to the growing body of AR literature.

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Beyond these pedagogical insights, this study also identified a technical limitation in the web-based version of Assemblr Edu. The researcher observed that the application does not support multiple windows for displaying or managing projects simultaneously. Instead, when a new project is opened, it automatically replaces the existing one in the same window. Consequently, to access two or more projects at once, users must repeatedly return to the homepage and reopen each project individually.

Although this limitation did not directly affect students' activeness or learning outcomes, it posed a challenge for multitasking, particularly for teachers or learners who needed to compare, reference, or work across multiple projects at the same time. Addressing this issue in future updates could significantly improve the usability and flexibility of Assemblr Edu, thereby enhancing its potential as an effective educational tool.

CHAPTER V
CONCLUSION AND SUGGESTION

This chapter presents the conclusions and suggestions based on the findings and discussions from the previous chapters. The conclusions are formulated to summarize the answers to the research questions, while the suggestions are intended for teachers, future researchers, and other stakeholders interested in the development of learning based on Augmented Reality (AR) technology through the Assemblr Edu application.

A. CONCLUSION

This study set out to examine the effect of using Assemblr Edu on students' learning outcomes and activeness in English learning at UPT SMA Negeri 2 Parepare. The findings provide several important conclusions. First, Assemblr Edu significantly improved students' learning outcomes. The mean score increased from 69.97 (pre-test) to 86.53 (post-test), with hypothesis testing confirming the improvement was statistically significant. The percentage of students in the "Excellent" category rose from 41% to 76%, while those in the "Poor" category dropped from 32% to 12%. These results demonstrate that Assemblr Edu successfully supported both higher-achieving and lower-achieving students, enabling more equitable learning progress.

Second, Assemblr Edu effectively enhanced student activeness. Teacher notes confirmed that student activeness progressed from surface-level procedural engagement to deeper cognitive engagement with the lesson content. This finding is strongly supported by observational data, which showed that

79% of students were in the "Active" or "Very Active" categories, with especially strong activeness in specific indicators: paying attention (29 students, 85%), completing tasks (29 students, 85%), and using Assemblr Edu features (31 students, 91%). However, teacher observations also noted that higher-order verbal activity remained challenging for students. This is reflected in the observational data showing weaker performance in expressing opinions (17 students, 50%) and participating in discussions (20 students, 59%), indicating that Assemblr Edu alone was insufficient for fostering critical and communicative learning without teacher support.

Third, the merged findings revealed that three interaction patterns between activeness and outcomes are convergent (76%), divergent (9%), and complementary (15%). The convergent pattern confirmed that active participation through Assemblr Edu directly translated into better test performance, supporting constructivist theories of generative learning (Moser & Lewalter, 2024) and embodied cognition (Johnson-Glenberg, 2023). Divergent cases highlighted that activeness does not always guarantee achievement, as explained by Sweller's (2024) Cognitive Load Theory, where some students were distracted by the novelty of AR. Complementary cases revealed that activeness also generated affective benefits, such as confidence and motivation, aligning with Pekrun & Goetz's (2024) Control-Value Theory of Achievement Emotions. Together, these three patterns enrich the understanding of how Assemblr Edu influences both cognitive and affective aspects of learning.

These findings are consistent with previous research showing Assemblr Edu's positive impact on activeness and outcomes (Hayati et al., 2023; Hikam et al., 2024; Kurniawan et al., 2024). However, this study adds nuance by demonstrating that AR's impact is not uniform: it depends on prior knowledge, individual learning styles, and teacher scaffolding. Thus, while this research supports prior studies, it also extends them by explaining variations in students' responses.

Despite these contributions, this study has limitations. It was conducted in a single school context, focused only on one text genre (analytical exposition), and measured outcomes only in the short term. These limitations mean the results cannot yet be generalized to other contexts, text types, or long-term learning. Moreover, an additional technical limitation was identified in the web-based version of Assemblr Edu: the application does not support multiple windows for displaying or managing projects simultaneously. When a new project is opened, it automatically replaces the previous one in the same window. As a result, users who wish to access two or more projects at once must return to the homepage and reopen each project individually. Although this did not directly affect students' learning outcomes or activeness, it posed a challenge for multitasking, especially for teachers or learners managing multiple projects. Addressing this limitation in future updates could greatly enhance the usability and flexibility of Assemblr Edu.

The novelty of this study lies in its integrated approach, which combines quantitative test scores, observation checklists, and teacher notes to identify

convergent, divergent, and complementary patterns simultaneously. This multidimensional analysis contributes to the growing AR literature by showing not only that AR works, but also how and for whom it works best in English language learning.

For future research, it is recommended to extend the analysis to other text genres and broader literacy skills (speaking, writing, listening), to investigate long-term retention, and to explore how AR, particularly Assemblr Edu, can support collaborative and project-based learning. Expanding the study across larger and more diverse student populations would also strengthen the generalizability of the findings.

In conclusion, Assemblr Edu has proven to be a powerful medium for enhancing both learning outcomes and activeness. It works most effectively when integrated with structured pedagogical strategies that channel behavioral activeness into critical, communicative, and collaborative learning. This study affirms the promise of AR as an educational innovation in English learning while contributing a nuanced perspective that enriches both theory and practice in technology-enhanced education.

B. SUGGESTION

Based on the findings and conclusions above, this section presents several suggestions aimed at both teachers and future researchers. These recommendations are intended to serve as practical guidance as well as a foundation for further studies in developing AR-based learning that is more effective and sustainable.

1. For Teachers

   Teachers are encouraged to use Assemblr Edu as a supportive tool to introduce complex or abstract topics, making learning more visual and interactive. To maximize student activeness and learning outcomes, AR exploration should be combined with collaborative activities such as group discussions, presentations, and peer teaching. Teachers should also provide technical guidance and motivate less active students through encouragement and structured questions. Finally, differentiating instruction to suit students' varying prior knowledge and learning styles can help each student gain the most from the app.

2. For Students

   Students are advised to actively engage with the AR content, exploring, manipulating, and interacting with learning materials to deepen understanding. Participation in collaborative activities, sharing opinions, and working with peers can strengthen verbal, social, and critical thinking skills. Students are also encouraged to develop self-regulated learning habits by setting personal goals, monitoring progress, and reflecting on their understanding. While enjoying the interactive features, they should ensure that exploration is purposeful and connected to the lesson objectives.

3. For Future Researchers

   Future studies are suggested to use Assemblr Edu or similar AR platforms in other text genres and broader literacy skills, such as speaking, writing, and listening. Research can also be expanded to different subjects,

grade levels, and school contexts so that the findings can be more widely applied. Long-term studies are needed to see whether the positive effects of AR on learning outcomes and motivation can last over time. In addition, future research should pay attention to teacher readiness, digital literacy, and training needs so that AR can be integrated effectively in the classroom. It is also important to examine not only academic results but also affective and psychomotor outcomes, such as students' confidence, creativity, and collaboration skills. Comparing different AR platforms may also help to identify which features are most effective for certain learning goals. Finally, using AR in collaborative or project-based learning is recommended to see how student activeness can develop into deeper critical thinking and communicative competence.

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