JURNAL ILMIAH PENDIDIKAN PROFESI GURU
Volume 7 Nomor 3 2024, pp 656-669
E-ISSN: 2621-5705; P-ISSN: 2621-5713
DOI: https://doi.org/10.23887/jippg.v7i3.85085

Interactive Learning Innovation in Archival Material Through the Development of Augmented Reality-Based E-Modules

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Abstrak

Kurangnya bahan ajar yang spesifik dan buku pegangan yang memadai untuk mata pelajaran kearsipan dapat menghambat proses pembelajaran siswa dan mencapai tujuan Kurikulum Merdeka secara optimal. Berdasarkan hal tersebut tujuan penelitian ini yaitu mengembangkan e-modul berbasis AR pada materi kearsipan. Jenis penelitian ini yaitu pengembangan yang menggunakan model pengembangan Alessi & Trollip yang mencakup tahapan perencanaan, desain, dan pengembangan. Subjek penelitian yaitu ahli materi, ahli desain dan ahli media. Subjek uji coba penelitian melibatkan peserta didik. Metode pengumpulan data dilakukan melalui wawancara, survei, dan tes. Instrumen pengumpulan data menggunakan lembar kuesioner. Teknik analisis data menggunakan analisis deskriptif kualitatif dan kuantitatif. Uji efektifitas menggunakan N-gain. Hasil penelitian menunjukkan bahwa e-modul berbasis AR yang dikembangkan sangat valid dengan skor kevalidan sebesar 83% berdasarkan expert review. Praktis dengan skor 80,14% dari uji praktikalitas. Hasil N-gain sebesar 0,67, yang termasuk kategori sedang. Terdapat peningkatan signifikan pada hasil belajar siswa sebelum dan setelah penggunaan E-modul berbasis AR. Disimpulkan e-modul berbasis augmented reality dapat meningkatkan hasil belajar siswa secara signifikan. Implikasi penelitian yaitu e-modul berbasis augmented reality yang dikembangkan dapat digunakan dalam kegiatan pembelajaran pada siswa menengah kejuruan.

Kata Kunci: *Augmented Reality, E-Modul, Kearsipan, Media Pembelajaran, Pendidikan Vokasi*.

Abstract

The lack of specific teaching materials and adequate textbooks for archival subjects can hinder the student learning process and optimally achieve the Independent Curriculum's objectives. Based on this, this study aims to develop an AR-based e-module on archival material. This type of research uses the Alessi & Trollip development model, which includes the stages of planning, design, and development. The research subjects are material experts, design experts and media experts. The subjects of the research trial involved students. Data collection methods were carried out through interviews, surveys, and tests. The data collection instrument used a questionnaire sheet. Data analysis techniques used qualitative and quantitative descriptive analysis. The effectiveness test used N-gain. The results showed that the AR-based e-module developed was very valid, with a validity score of 83% based on expert review. Practical with a score of 80.14% on the practicality test. The N-gain result was 0.67, which is included in the moderate category. There was a significant increase in student learning outcomes before and after using the AR-based E-module. It was concluded that the augmented reality-based e-module can significantly improve student learning outcomes. The research implies that the augmented reality-based e-module that was developed can be used in learning activities for vocational high school students.

Keywords: Augmented Reality, E-Module, Archiving, Learning Media, Vocational Education.

1. INTRODUCTION

Digital transformation has changed the educational landscape significantly. Teachers are now faced with the challenge of designing learning that is not only relevant to technological developments, but also able to meet the diverse learning needs of each student (Hidayati & Irmawati, 2019; Mariono et al., 2021; Prisila et al., 2021).This challenge is further complicated by the digital divide and the demand to continuously develop pedagogical competencies. To overcome this challenge, teachers need strong support in the

History:
Received : August 12, 2024
Accepted : November 03, 2024
Published : November 25, 2024

Publisher: Undiksha Press

form of ongoing training and professional development (Adukaite et al., 2017; Artacho et al., 2020; Beardsley et al., 2021).Modern education has undergone a significant paradigm shift. Critical thinking, creative thinking and problem solving skills have become very important to equip students to be able to face increasingly complex and dynamic global challenges (Septikasari & Frasandy, 2018; Sviangga et al., 2018; Widodo & Wardani, 2020).The digital era has fundamentally revolutionized the world of education. Learning is no longer limited to physical classrooms and textbooks. With the rise of online learning and the use of digital devices, the teaching and learning process has become more flexible, interactive, and personal. This paradigm shift requires adaptation from both educators and students in order to maximize the potential offered by technology (Alamiyah et al., 2021; Antara & Dewantara, 2022; Blaschke & Hase, 2019).

However, the current problem is that many teachers still lack the skills to develop digital-based media. This was revealed in previous research findings which stated that teachers still have difficulty in developing digital media that can facilitate students to learn anywhere (Aristiani & Agung, 2022; Saripudin et al., 2021).Other studies also reveal that the lack of digital media also has an impact on low student motivation (Hapsari & Zulherman, 2021; Juniarsih et al., 2021; Sudirman et al., 2020).The use of monotonous print media and PowerPoint can make students feel bored and fed up. The lack of variation in delivering material can hinder student understanding and reduce interest in learning (Nopiantari & Agung, 2021; Tembang & Suharjo, 2017).Effective learning requires a variety of media and methods to accommodate students' different learning styles (Hidayati & Irmawati, 2019; Mariono et al., 2021; Prisila et al., 2021).The results of observations conducted at SMK Negeri 1 Penukal, found several problems. The problems that occurred were the lack of specific teaching materials and adequate textbooks for the archiving subject which could hinder the student learning process and achieve the objectives of the Merdeka Curriculum optimally. In fact, the archiving system material is important as a provision for students to enter the world of work.

Based on the problems found, the solution offered is to develop Augmented Reality (AR) based learning media on archival material. Referring to previous research that has proven the potential of AR in education, it can increase learning motivation, conceptual understanding, and student skills in implementing archival systems (Sahin & Yilmaz, 2020; Smith & Friel, 2021).The future of education lies in the optimal use of digital technology. By integrating technology into the learning process, teachers can prepare students to face the challenges of the digital era (Bianto & Aprillya, 2022; Peterson et al., 2020).E-module is a digital learning module that can be accessed through various electronic devices. With interactive features and high flexibility, e-module allows students to learn independently, anytime and anywhere (Kristalia & Yerimadesi, 2021; Widiantari et al., 2022).E-modules offer an efficient solution in terms of distribution and storage of learning materials. With e-modules, learning materials can be easily updated and distributed widely without the need for reprinting (Kristalia & Yerimadesi, 2021; Satria Dewi Pendit et al., 2022; F. Wulandari et al., 2021). It can also reduce paper usage and support environmental conservation efforts. The benefits of e-modules include ease of access and a variety of forms, such as text, multimedia, interactive, simulation, game-based, project, course, and augmented reality (Kristalia & Yerimadesi, 2021; Wibisana et al., 2022; Widiantari et al., 2022).

Augmented Reality (AR) is a technology that combines real-world elements with computer-generated digital objects in real-time, creating a unique interactive experience (Sahin & Yilmaz, 2020; Smith & Friel, 2021). Virtual-based AR uses markers as coordinates to display objects that are not visible in real life and can be projected on the mobile screen. AR provides the flexibility to customize the learning experience according to individual needs (Maijarern et al., 2018; Önal & Önal, 2021).With mobile devices, each student can

explore learning materials at different speeds and depths, making learning more personalized and effective. In vocational education, visualization is key to understanding complex concepts. AR is able to present interactive and immersive visualizations, so students can see firsthand how a system or component works. Vocational education with a relevant and flexible curriculum can equip graduates with the skills needed to face challenges. Previous research also revealed that interactive learning can improve the fun learning atmosphere (Harsiwi & Arini, 2020; F. Wulandari et al., 2021).Other research also reveals that the use of E-modules can make it easier for students to learn (Awwaliyah et al., 2021; Kurniawati, 2020; Taqwina et al., 2022).In addition, other research also states that AR media can make it easier for students to understand the material so that it can improve student learning outcomes (Guntur et al., 2020; Susetya & Harjono, 2022). This study is different from previous studies that focused on conventional archiving systems. This study uses augmented reality to visualize 3D objects with explanatory narratives that include text, audio, and images, so that learning becomes more interactive and effective. The application interface displays navigation buttons to move between scenes, including buttons for augmented reality, the main menu, application profile, and exiting the application. Users can view 3D objects and related information directly with the information button that activates additional explanations, and augmented reality provides feedback that helps students understand the material better. Based on this, the purpose of this study is to develop-*AR-based modules on archival materials.*The development of AR-based e-modules on archival material not only improves students' understanding of the material, but can also develop various 21st century skills needed in the world of work.

2. METHOD

This study adopts the Alessi & Trollip development model which is structured in three main stages, namely planning, design, and development. This model was chosen because it is considered very effective in producing interactive and innovative multimedia products, such as Augmented Reality (AR)-based learning media in the archiving system (Alessi & Trollip, 2001).The three stages according to Alessi and Trollip are Planning, Design and Development (Alessi & Trollip, 2001). The research planning stage is one of the most important steps in the research process, so the stages carried out by the developer to determine the goals and direction of the development of Augmented Reality in the archiving system. The design stage in the development of Augmented Reality is a stage related to the initial content development idea, namely describing the introduction of the program, preparing a prototype, and creating a flowchart and storyboard. The development stage in Augmented Reality learning media is an implementation of the design stage. At this stage is a detailed process in creating effective and relevant learning materials.

The Augmented Reality learning media product that is developed will be validated by material experts, design experts and media experts who master their fields using previously prepared instruments. Furthermore, revisions are made according to the input of the two experts. If the material experts, design experts and media experts have approved the revision results, then it will proceed to the beta test.Beta test is conducted after alpha test is given. Beta test consists of two stages, namely beta test 1 and beta test, 2. Beta test 1 is given to a small group of students. In order to avoid bias, this small group test will be tested on class X students who have taken the archiving system material, while beta test 2 is given to a large group of students, meaning it is given to all class X Office Management students of SMK Negeri 1 Penukal as research subjects. After the response instrument of 35 students is obtained, the next step is to process and analyze the data. Data collection methods used observation, interviews, questionnaires, and tests. The observation method was used to

collect data on problems that occurred in schools. The direct interview method with teachers was used to collect data on the development of archiving system materials in schools that were the objects of development research. The questionnaire method was carried out in preliminary study activities carried out by distributing google forms to analyze the needs, characteristics of students, and facilities and infrastructure in schools. This questionnaire includes analysis of the needs of students, educators, validation, and practicality. The test method was used to measure the level of effectiveness of the use of the developed product. Data collection instruments with questionnaire sheets and test questions. The instrument grid is presented in Table 1.

Table 1. The Research Instrument Grid (Practicality Test)

No	Aspect	Indicator
1	Appearance	Attractive Augmented Reality display
		The material presented is easy to understand
		The text used is legible and there are no typos
		The image appears very clear
		The application size is not too big
		The videos shown are clear and easy to understand.
2	Feature	Navigation button function works well
		Clarity of feature instructions is easy to understand
3	Language	The language used in the material is easy to understand
		The terms used in the material are easy to understand.

The data analysis technique in this study was obtained from research instruments in the form of qualitative and quantitative data. Quantitative data was obtained from questionnaires and qualitative data was obtained from responses or suggestions from experts and students after using the Augmented Reality-based E-module.The data from the questionnaire that has been obtained will then be analyzed descriptively and data will be obtained in the form of a percentage of students' needs for augmented reality-based e-module media on the archiving system material.The analysis of test result data was conducted by comparing the learning outcome scores of students during the initial test and the final test completion results by referring to the KKM (Minimum Completion Criteria) score. KKM for the productive subject of the archival element. In the analysis of this test result data, the pretest and posttest were calculated using the formula. To see the increase and comparison of the average score using *N-gain Score*e.

3. RESULTS AND DISCUSSION

Results

This study produces valid, practical, and effective AR-based e-modules to improve vocational high school students' understanding of archival material. This study uses systematic development stages based on the Alessi & Trollip model. The results of the study are as follows. First, planning. Analysis of vocational high school students' needs shows a demand for interactive and interesting learning media. The AR e-module developed in this study successfully meets these needs and provides innovative solutions for archival learning. Identification of the analysis of student needs described above that 95.5% of students have smartphones, at SMKN 1 Penukal allows its students to use smartphones for the learning process. 61.1% of students are interested in using learning media. The learning process at SMKN 1 Penukal is quite good, because some teachers have used learning media as seen from the data above, the percentage result is 61.1%. In the eighth point that teachers are now

required to follow technological developments, the percentage is recorded at 41.7%. Through google forms at the third point, students have difficulty understanding the archival system material, the percentage is recorded at 52.8%. Educators use learning media on the material 38.9% using power point and modules. Students also have various learning methods, but 61.1% of students are interested in using learning media to enjoy the learning process provided by educators. 47.2% of students want learning with augmented reality media in the learning process. Students also need augmented reality 61.1% to understand the archiving system material.

This study utilizes the existence of a computer laboratory, LCD, and student access to smartphones to develop an AR-based e-module that suits the learning needs at SMK Negeri 1 Penukal. By considering the facilities and infrastructure available at the school and the characteristics of student devices, the researcher chose to develop an AR-based e-module that is compatible with the Android operating system. SMK Negeri 1 Penukal has provided a conducive learning environment for the application of AR technology in learning. The existence of a computer laboratory and student access to smartphones allows for the effective integration of AR e-modules in the learning process. The final step in the planning stage is the look and feel of the augmented realty product being developed. The planned look and feel appear in a live view of existing objects and add images, animations, and 3D models. The appearance of the augmented reality application is presented in Figure 1.

Figure 1. Augmented Reality Application View

Second, design. The design stage is carried out by creating a concept for an augmented reality product for an archiving system on an augmented realty product, by creating a flowchart and storyboard. The design stages in this study are as follows: Creating an augmented reality product concept based on an analysis of student characteristics and material characteristics. This product is designed to have 6 main menus in the form of an augmented reality menu, AR simulation, learning objectives, exercises, development profiles, download markers, and materials. The augmented reality menu contains archiving storage system material. Students will be given questions and search for answers on Google from students from each question by seeing and listening to the results of the augmented reality display. The researcher developed a concept that became an augmented reality whose results were depicted. The augmented reality flowchart on the archiving system is presented in Figure 2.

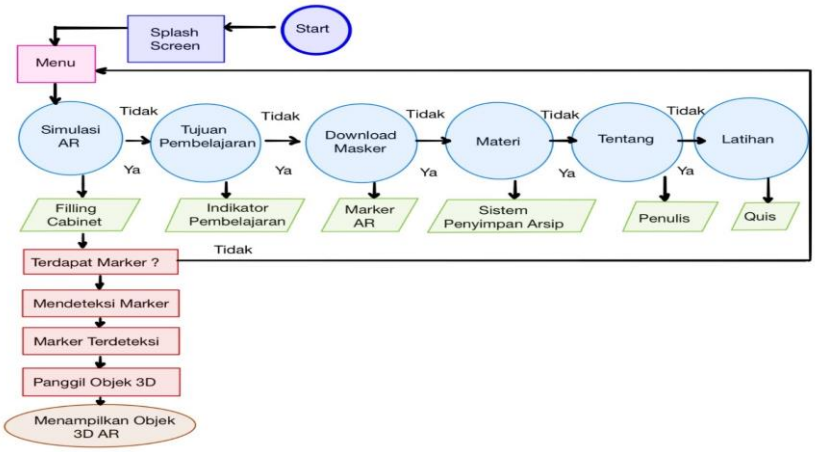

Figure 2. Flowchart Media Augmented Reality Filing System

Third, development. After the product flowchart has been well-conceived, the next step is to carry out the product development process (text, program code, 3D objects, component integration, supporting materials for augmented reality applications) to become an augmented reality application for an archiving system. The next stage is to create a program code for an augmented reality archiving system. This study utilizes the power of Unity 3D and Visual Studio 2012 to create an innovative augmented reality application. Through a structured development process, from resource preparation to final testing, we have succeeded in building an application that can provide an interactive and effective learning experience. The graphic design of the product in this development is in the form of product development stages and also animation in augmented reality. The following are the various stages: First, Creating 3D Objects in Blender 3D. Second, texturing 3D objects in Blender. Third, adding movement or animation to 3D objects. Fourth, adding animation according to the animation of the archive file. Fifth, creating an AR application project in Unity 3D. Sixth, importing 3D Objects. Seventh, Creating an Application Menu. Eighth, Upload the vuforia SDK marker database. Ninth, import the Vuforia marker database. Tenth, AR integration Pairing 3d with markers uploaded with vuforia. Eleventh, build into an apk application. Configure the android project and build into an android package or (.apk) file so that it can be installed on an android smartphone. After the various product components that have been prepared and created are combined into an application. Using the applicable program code, it becomes a series of augmented reality archiving system materials that are ready to be tested alpha and beta. The product evaluation process is carried out in stages, starting from verification of materials, design, media, to language. Input from experts is very valuable to improve the quality of augmented reality products. Alpha test aims to identify product deficiencies and weaknesses so that they can be fixed before further testing. This evaluation includes aspects of materials, design, media, and language. The summary of Expert Validation Results is presented in Table 2.

Table 2. The Expert Validation Results Recapitulation

No	Assessment Aspects	Score
1	Material	80.00 %
2	Product	82.00 %
3	Language	83.67 %
Average		**83.67%**
Category		**Very Valid**

The results of the assessment by material experts showed a value of 80.00% with a very valid category, indicating that the e-module product is suitable for use as an independent learning medium for archiving system material for class X students at SMK Negeri 1 Penukal. Furthermore, the product was validated by experts in the field of educational technology, who gave a value of 89.00% with a very valid category for augmented reality media with archiving system material. Language validation by language experts gave a value of 82.00%, also with a very valid category. In conclusion, the developed augmented reality media is suitable for testing on students, with material expert validation showing a value of 80.00%, indicating that this product is very valid and suitable for use as a learning medium. The results of the alpha test showed that the initial prototype of the product had been assessed as very valid by experts, and several suggestions for improvement had been implemented to produce prototype 1. Evaluation by experts showed that the product had good potential and needed some improvements to produce prototype 1. The beta test phase aims to test the practicality of the product in a real learning environment. Three students with different levels of ability were selected as test participants to ensure that the product can be used by a wide range of students. During the beta test, students were asked to use the augmented reality product independently while being observed by researchers. Data on the ease of use of the product were collected through instruments that measured aspects of design, features, and language. The recapitulation of the Augmented Reality Product Beta Test is presented in Table 3.

Table 3. The Augmented Reality Product Beta Test Recap

Learners	Maximum Value	Practicality	Presentation
RPS	50	45	90.00%
LAC	50	48	96.00%
ABS	50	47	94.00%
Total	**150**	142	93.33%

Based on the results of the practical test, it can be concluded that augmented reality media has a high level of practicality. In addition, the positive response from students to the excitement and appeal of this media shows great potential to increase learning motivation. The trial involving three students showed that augmented reality media has the potential to be an effective and enjoyable learning tool. Students provided positive feedback regarding the design, features, and language used in the media. After going through a series of alpha and beta tests, a field test was conducted which was attended by 36 students of class X MP 2 at SMK Negeri 1 Penukal. At the first meeting, students were given 20 multiple-choice pretest questions. Analysis of the pretest data showed that most students still had difficulty in understanding the basic concepts of the archiving system. Based on these findings, this study aims to develop augmented reality-based learning media that can improve student understanding. The low average pretest score is an indicator that a more innovative learning approach is needed to improve students' understanding of the archiving system material. Augmented reality was chosen as one alternative solution. The recapitulation data of the students' pretest results can be seen in Table 3. The recapitulation of the students' posttest results is presented in Table 4.

Table 4. The Recapitulation of Student Pretest Results

Score Interval	Number of participants	Presentation	Predicate
86-100	1	2.77%	Very good

Score Interval	Number of participants	Presentation	Predicate
71-85	0	0	Good
56-70	1	2.77%	Enough
40-55	19	52.78%	Not enough
0-39	15	41.67%	Very less
Total	**36**	**100%**	

Table 5. Recapitulation of Results *Student Posttest*

Score Interval	Number of participants	Presentation	Predicate
86-100	5	13.89%	Very good
71-85	21	58.33%	Good
56-70	10	27.78%	Enough
40-55	0	0%	Not enough
0-39	0	0%	Very less
Total	**36**	**100%**	

Based on data *posttest* above there is an increase in learning outcomes using augmented reality. The graph results show a comparison between the pretest scores before using augmented reality and the posttest after its use. The comparison table shows that the average pretest score of students before using the augmented reality-based e-module was 39.03, included in the low category, while the average posttest score after using the e-module increased to 80.14, included in the good category. This increase of 6 proves that the augmented reality e-module is effective in improving student learning outcomes. The comparison between the pretest and posttest scores can be seen in Figure 3.

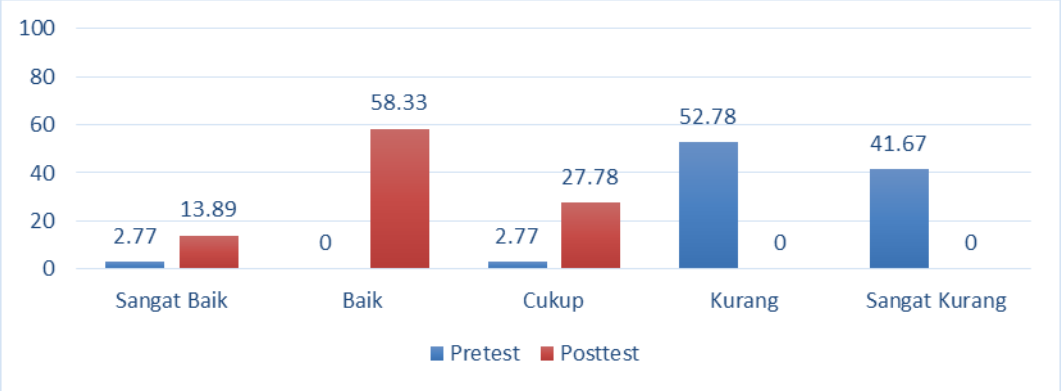

Figure 3. Recapitulation Results Pre-test and Post-test

The effectiveness assessment was measured using N-Gain based on the average value of the pretest and posttest. The N-Gain result of 0.67, which is included in the moderate category, indicates that the use of augmented reality-based e-modules for archiving system materials is effective in improving student learning outcomes. This increase reflects the positive impact of the e-module in the learning process. Based on the questionnaire, students responded well to the e-module because the material was easy to understand and there were additional explanations that increased their knowledge. However, there is a drawback, namely that the e-module cannot display 3D object models in dim light conditions, because the smartphone camera requires sufficient lighting to scan the marker image and display the 3D model.

Discussion

The results of the data analysis show that the augmented reality-based e-module for the archiving system material is effective, valid and has a high level of practicality. The results of the n-gain test also show that the use of augmented reality-based e-modules for the archiving system material is effective in learning. This is due to the following factors. First, the use of augmented reality-based e-modules can improve student learning outcomes. The augmented reality-based e-module media developed has a good impact on learning outcomes, as seen from the increase in students' abilities at the end of the learning process. The use of internet technology as a digital learning resource is an important step in improving the quality of learning (Astini, Suni, 2020; Syahroni et al., 2020; Tempola et al., 2020).Augmented reality products are considered practical because they are equipped with 3D images and objects that make it easier for students to learn (Ali et al., 2021; Chiang et al., 2022; Elmunsyah et al., 2019).The implementation of augmented reality in archiving system learning has succeeded in increasing the effectiveness of learning by providing better visualization and deeper interaction. Well-developed e-modules can help students learn because students can understand the material more easily (Asmah et al., 2022; Kumalasari et al., 2023).Improved learning outcomes after using valid, practical, and effective augmented reality-based e-modules are in line with the need for a digital learning environment, which makes learning more effective, efficient, and interesting for students.

Second, the use of e-modules based on augmented reality can increase students' learning motivation. This study has succeeded in developing innovative augmented reality learning media. The main purpose of developing this media is to answer the challenges in improving the quality and increasing students' learning motivation. Augmented Reality (AR) is a technology that combines the real world with digital elements, such as images, sounds, or other data (Ali et al., 2021; Chiang et al., 2022; Elmunsyah et al., 2019; Haz et al., 2019).With AR, users can see their actual physical environment, but with additional digital elements displayed on top of it (Kiryakova et al., 2018; Riastini et al., 2020).By providing a more engaging and interactive learning experience, augmented reality is able to motivate students to be more actively involved in the learning process (Ali et al., 2021; Carolina, 2023; Chiang et al., 2022; Elmunsyah et al., 2019; Haz et al., 2019). This is in line with the spirit of the Independent Curriculum which emphasizes student-centered learning, as well as encouraging the development of skills and competencies that are relevant to the needs of the world of work (Wijayanti & Ekantini, 2023).This success is supported by the comprehensive characteristics of augmented reality that help achieve learning goals.

Third, the use of e-modules based on augmented reality is very practical, creating a flexible learning atmosphere. The product developed is based on Android which can be accessed anywhere and anytime (Kuncahyono, 2018; Ramadhan et al., 2020).Android-based learning media offers interactivity, complete features such as 3D objects, images, sound, and text, as well as ease of access that allows independent use anytime and anywhere. The use of appropriate digital learning media can increase learning effectiveness, increase student engagement, and create a more dynamic and inclusive learning environment (Kiryakova et al., 2018; Riastini et al., 2020; Seruni et al., 2019).The expected results of learning activities are to provide direction and achieve learning objectives. E-modules include flexibility of access, because the parties can access them anytime and anywhere according to their wishes (Asmah et al., 2022; Kumalasari et al., 2023).E-modules also provide various types of multimedia and 3D (three-dimensional) content that can improve student understanding and engagement. This is what makes learning activities more flexible and interesting. Previous research findings also revealed that the use of augmented reality learning media can be an alternative for teachers in implementing learning (Firdanu et al., 2020; Nurholisa et al., 2022). Other studies also reveal that E-modules can improve student learning outcomes

(Oksa & Soenarto, 2020; Ramadhan et al., 2020; S. Wulandari et al., 2021).The results of the field test showed an increase in student learning outcomes, as seen from the posttest results. Augmented reality-based e-module media met expectations and had several advantages, such as easy access through markers, easy operation, and flexible use in various learning situations. However, its weaknesses include the inability to display 3D models in low light, because the smartphone camera requires sufficient lighting to scan the marker image. In addition, the limitations of this study are that this media only covers one material, not covering all archival materials for Class X.The implication of this research is that the development of e-modules based on augmented reality opens up great opportunities for innovation in the world of education. The results of this study provide a significant contribution to the development of technology-based and student-centered learning media.

4. CONCLUSION

The results of the study indicate that the development of an augmented reality-based e-module for archiving system material in vocational schools has proven effective in improving the quality of interactive learning. By combining attractive visual elements, interactive simulations, and the support of the latest technology, this e-module is able to increase student learning motivation, facilitate understanding of complex concepts, and significantly improve learning outcomes. Validation from material, language, and media experts, as well as field trial results show that this e-module has good quality and can be implemented in the learning process. Therefore, the development of augmented reality-based learning media is a very appropriate step to answer the challenges in today's education world.

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