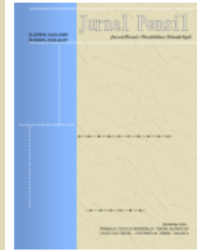


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## DEVELOPMENT OF LEARNING MEDIA OF AUGMENTED REALITY APPLICATION IN BASIC BUILDING CONSTRUCTION LESSON

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### Abstract

An augmented reality is a technology that will be utilized at Basic Building Construction lesson in the Construction and Property Business Expertise Competency at SMK Negeri 1 Cibinong as a learning media to enhance comprehension of building construction material and modify learning media to technology advancements. This research was conducted with Research and Development (R&D) method and the ASSURE model. In this research, the process of developing learning media encompassed various steps, including analysis, determining a learning method, identifying a learning objective, constructing the media and materials, participation, and evaluation and improvement. The research results indicated that: (1) media experts' validation attains an average of 91% (very feasible); (2) material experts' validation attains a percentage of 92% (very feasible); and (3) augmented reality application users' validation attains an average result of 81% (very feasible). The augmented reality application in the Basic Building Construction lesson can be utilized in the Construction and Business Expertise Competency at SMK Negeri 1 Cibinong, as determined by the validity test and the limited user trials.

**Keywords:** Learning media, Augmented reality, ASSURE, Basic Building Construction

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## Introduction

The management of lifestyles is significantly impacted by technological advancements, particularly when it comes to how well students' conceptual comprehension grows throughout the learning process (Fitriyani et al., 2021; Putrawangsa & Hasanah, 2018). The objective of learning is to attain the best possible development in cognitive, affective, and psychomotor aspects (Purba, Tamrin, et al., 2020). One of the breakthroughs to bring learning in accordance with technological advancements is the learning development using technology (Mawaddah et al., 2019). As technology becomes more advanced, teachers are driven to improve their knowledge of technology-enhanced learning, including developing learning media (Firmadani, 2020; Tafonao, 2018). Additionally, the development of learning media that keep up with technological advancements will bring more diversity in learning and boost students' engagement, motivation, and interest, all of which have an impact on the achievement of learning objectives (Belmonte et al., 2019).

Learning media, which can be in the form of hardware and software, is a tool for communication and interaction between teachers and students during the learning process (Abi Hamid et al., 2020; Kustandi & Darmawan, 2020). By utilizing learning media, the learning process can occur in a variety of ways, in a variety of forms and everywhere (Atsani, 2020; Bahasoan et al., 2020; Purba, Tamrin, et al., 2020; Suhelayanti et al., 2020). Learning will perform better and achieve the best learning outcomes when it uses the appropriate learning media and follows up with the times and generations (Purba, Rofiki, et al., 2020). So that learning outcomes can be achieved, it is fundamental to have effective, efficient, and appealing learning media (Dwiyoogo, 2022).

A technology that combines digital and physical information is called augmented reality (López-Belmonte et al., 2020; Madanipour & Cohrssen, 2020). Through the use of computer technology, virtual objects can be projected into the real

world and appear to be tangible objects (Ozdemir et al., 2018). Augmented reality is also a technology that allows its users to access learning via mobile phones (Adedokun-Shittu et al., 2020; Gómez-García et al., 2018). Other than the ease of accessing the media, the use of augmented reality as a learning media will provide a better visual representation than basic photos or figures, which are still in 2D forms (Arslan et al., 2020; Galeh Nur Indriatno Putra Pratama et al., 2022; Garzón et al., 2019; Sumarna et al., 2019).

Students' motivation to learn can be increased by using augmented reality as a learning media (Almenara & Vila, 2019; Flores-Bascuñana et al., 2020; Garzón et al., 2019). Students' understanding of the provided learning material increases as their learning motivation rises (Chen et al., 2017; Garzón et al., 2019; Yuliono et al., 2018). Additionally, student learning outcomes have improved (Moreno-Guerrero et al., 2020; Qorimah & Sutama, 2022; Wen, 2021). Building Information Modeling (BIM) and augmented reality are frequently combined in the construction industry to make it convenient to provide visuals relating to the construction that has been or is currently being executed (Diao & Shih, 2019). Therefore, it is expected that the utilization of augmented reality in the Construction and Property Business (CPB) Expertise Competency will both facilitate students' learning and increase their familiarity with technology.

Needs assessment of 40 students who were enrolled in the CPB was conducted. Approximately 80% of students still struggle to comprehend the lesson on Basic Building Construction. As many as 37.5% of students expressed the learning media the teacher utilized was less appealing. Students need a learning media that can present visuals, such as realistic-looking illustration, in addition to material that is simple to comprehend. Thus, 97.5% of students were in approval of the development of learning media that used augmented reality media.

Software such as Unity 2018, Vuforia, Visual Studio, and Sketchup 2017 are used to develop the augmented reality. Unity 2018 software is used for data processing of 3D objects, audio, and textures. The object to be visualized is displayed using the Vuforia software. Application programming is done using the Visual Studio software. Sketchup 2017 software is used for 3D objects creation. The Syllabus of CPB for Academic Year of 2020/2021 for the Basic Building Construction lesson used as the foundation for the development of the augmented reality.

According to the previously discussed explanation, research titled “Development of Learning Media of Augmented Reality

Application in Basic Building Construction” was carried out. Based on the findings of this research, it is expected that learning media that utilize augmented reality can expand the variety of learning media, deepen students’ comprehension, and enhance learning outcomes.

### Research Methodology

This research was conducted at the CPB at SMK Negeri 1 Cibinong from March to August 2021. This research used the Research & Development (R&D) method and the ASSURE development model. The following figure is a research flowchart based on the ASSURE model.

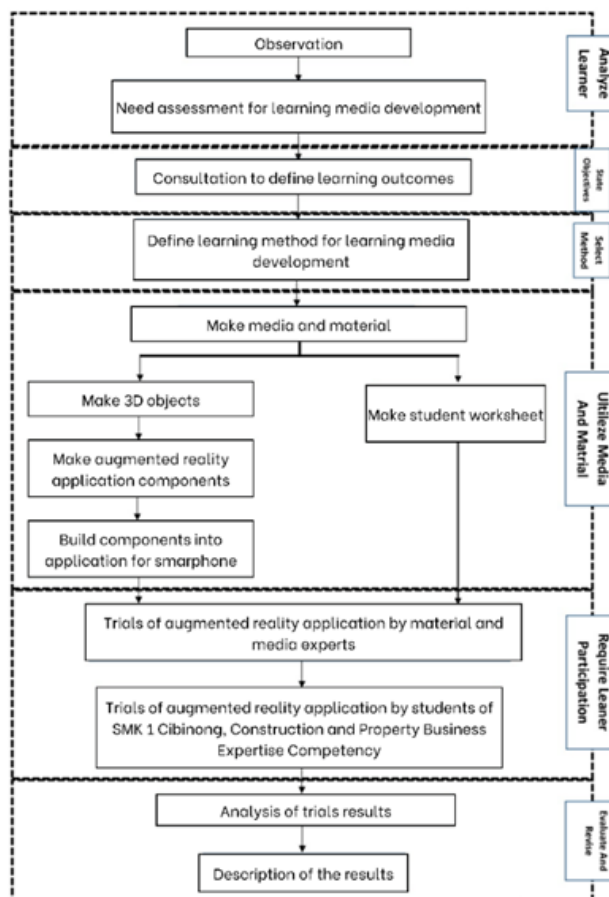


Figure 1. Research Flowchart

Learning media that have been made is validated by media experts and material experts. In addition, learning media will also be tested to limited 50 students of the CPB.

Data obtained from media experts, material experts, and students will be calculated using the following formula.

$$average = \frac{total\ scores\ obtained}{(no.\ of\ questions\ x\ 5)} \times 100\%$$

The average score of the validation is then adjusted to the categories that have been determined as follows.

Table 1. Validation criteria based on Likert scale (Utomo & Ratnawati, 2018)

Attained Percentage	Validation Classification
81 – 100%	Very feasible
61 – 80%	Feasible
41 – 60%	Quite feasible
21 – 40%	Less feasible
0 – 20%	Not feasible

### Results and Discussion

This research developed a product, namely learning media in the form of an augmented reality application for the Basic Building Construction lesson. The learning materials' content had been adjusted to suit the needs of students utilizing Basic Building Construction Syllabus for the 2020/2021 Academic Year. The augmented reality application product that had been developed can be seen in the following figure.

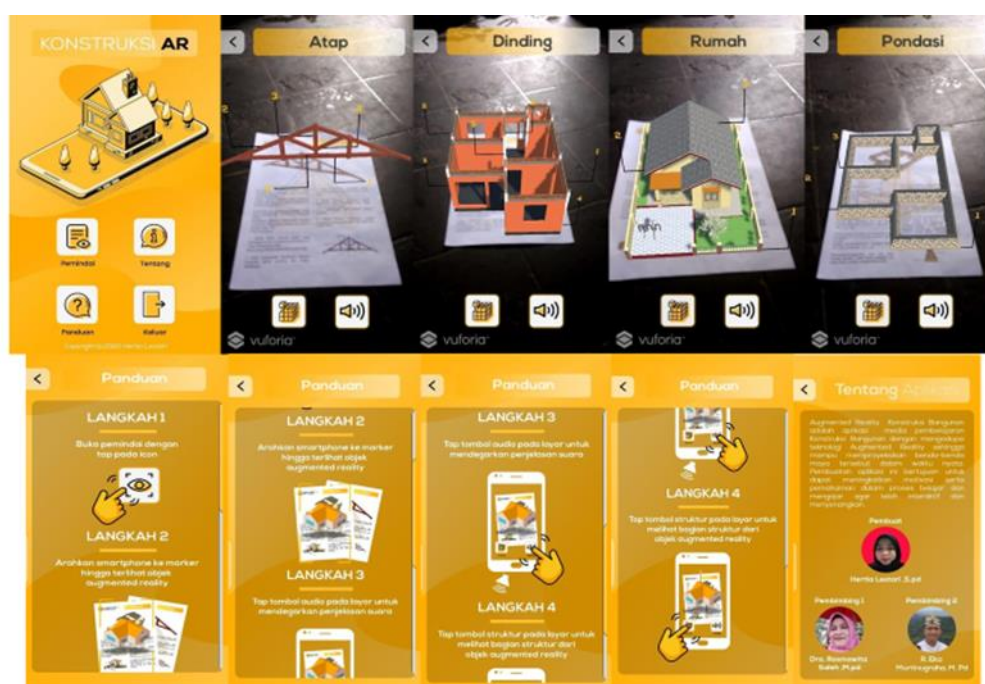


Figure 2. The results of augments reality application made

On the application's main page, there are four menus, namely (1) Scanner Menu, which functions to scan markers and brings up 3D visualizations; (2) About Menu, which contains information about the application and the developers; (3) Guide Menu, which contains a guidance for using the application; and (4) Exit Menu, to exit the application. In addition, this application is equipped with students' worksheets that

can be used to measure students' abilities after learning the lesson.

Validation test by media experts were carried out to determine the quality of the product that had been made in terms of media. In this research, the validation test was carried out by two media experts and assessed based on three aspects, namely the media aspect (13 indicators), the usability aspect (2 indicators), and the material aspect (1 indicator). The results of the validation test can be seen in the following table.

Table 2. Results of validation test by media experts

No	Aspect	Max. Score	Assessment Score		Percentage	
			V1	V2	V1	V2
1	Media	65	55	63	85%	97%
2	Usability	10	9	9	90%	90%
3	Material	5	4	5	80%	100%
Total		80	68	77	255%	287%
<b>Average</b>					<b>91%</b>	

According to the table above, the average results of validation by media experts are 91%. This means that the product made, namely the augmented reality application, is very feasible to use as a learning media in the Basic Building Construction lesson seen from the media aspect, the usability aspect, and the material aspect.

The validation test by the material experts were also carried out to determine the quality of the products that had been made in terms of learning materials. In this research, the validation test was carried out by a material expert and was assessed based on three aspects, namely the material aspect (4 indicators), the material aspect (5 indicators), and the usability aspect (2 indicators). The results of the validation test can be seen in the following table.

Table 3. Results of validation test by material expert

No	Aspect	Max Score	Assessment Score	Percentage
1	Material	20	20	100%
2	Media	25	24	96%
3	Usability	10	8	80%
Total		55	52	276%
<b>Average</b>				<b>92%</b>

According to the table above, the average results of validation by material expert is 92%. This means that the material contained in the product made, namely the augmented reality application, is very feasible to use as a learning media in the Basic Building Construction lesson in terms of material aspect, media aspect, and usability aspect.

In this research, limited trials were carried out, namely validation test and effectiveness test, on 50 students from the CPB at SMK Negeri 1 Cibinong. The effectiveness test was carried out to determine the improvement in learning outcomes before and after using the developed product. The test conducted by doing a pre-test before using the product and a post-test after using the product.

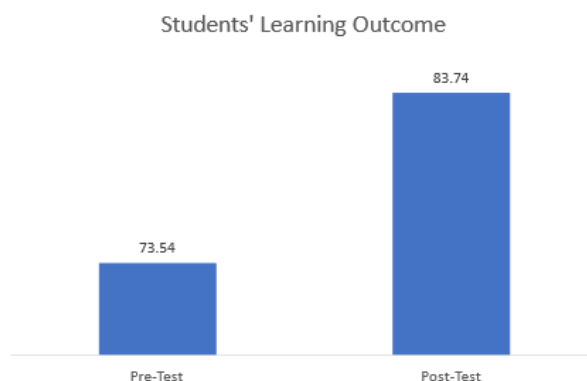


Figure 3. Students' learning outcomes

According to the figure above, there is an increase in the students' learning outcomes for 12.18%. therefore, it can be concluded that the use of augmented reality application as a learning media in the Basic Building Construction lesson can improve student learning outcome.

The validation test was carried out to determine the students' response to the product being developed. In this validation test, there were two aspects that were assessed namely the media aspect (11 indicators) and the learning process aspect (3 indicators). The following table is the results of the validation test that has been carried out.

Table 4. Results of validation tests by students

No	Aspect	Max Score	Assessment Score	Percentage
1	Media	55	45	82%
2	Learning Process	15	12	80%
Total		70	57	162%
<b>Average</b>				<b>81%</b>

According to the table above, the average results of validation obtained by students in limited trials were 81%. This means that the product made, namely the augmented reality application, is very feasible to use as a learning media in the Basic Building Construction lesson both in the media aspect and the learning process aspect.

Based on the results of the validation tests from media experts, material experts, and students, show that the augmented reality application that had been made is very feasible to use as a learning media. This is in line with researches conducted by Arifin et al. (2020), Burhanudin (2017), Lubis & Dasopang (2020), and Syawaludin et al. (2019) where the results of augmented

reality made as a learning media is feasible to use. In addition, research by Wahyudi et al. (2017) also shows an increase in student learning outcomes after using augmented reality in the learning process. The use of augmented reality during learning process at Vocational Schools as a variety of learning media is suitable to use (Gudoniene & Rutkauskiene, 2019; Mustaqim & Kurniawan, 2017). This is because the use of augmented reality in Vocational Schools can fulfill the skills, cognitive, affective, and also psychomotor aspects of students which are also in accordance with the 2013 Curriculum (Mantasia & Jaya, 2016). The use of augmented reality in Vocational Schools is also suitable for long-term use, especially in terms of cost (Solikhatun et al., 2021). To enhance this learning media, it does not

require major refinement which usually done from scratch. It is because the enhancement can be done using software on a computer. In contrast to conventional 3D visual media, if it was damaged, the refinement usually needs to be done as a whole.

This research certainly had limitations that are expected to be a concern for further development. The limitations of this research were that the speed of smartphone devices in displaying 3D objects when scanning was highly dependent on camera quality, camera distance from the marker, and lighting. Smartphone that had higher specifications will have better quality. In addition, in the process of collecting student response data which was carried out through questionnaires, it was not always in accordance with the real intentions because the differences in understanding of each student were different.

## Conclusion

The development of learning media in the form of augmented reality application in the Basic Building Construction lesson can be used as a variation of learning media. Based on the results of the research, the learning media were categorized in the very feasible category in terms of media according to media experts and also material according to material expert. Through a limited trial, which was conducted on 50 students of the CPB at SMK Negeri 1 Cibinong, showed that both the average pre-test and post-test scores were 73.54 and 83.74. This showed that the rate of improvement in learning outcomes obtained after the use of augmented reality application as learning media of 12.18%. Therefore, this learning media is more effective to use during learning process. It can also be concluded that the development augmented reality application can increase knowledge and student learning outcomes in the Basic Building Construction lesson. In this regard, it is feasible to use augmented reality application as a variety of learning media in the CPB Expertise Competency at SMK Negeri 1 Cibinong.

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