Research Article

Innovative Learning Media for Interior Design using Augmented Reality at Vocational High Schools

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Abstract: One aspect of the concept of building design development is interior design. The accuracy of the placement of interior materials is very important for (SMK) students majoring in Building Drawing Engineering. However, it may be difficult to present and organize material in real life. This barrier can be caused by a lack of materials or the ability to see objects from multiple angles. To realize the Vocational Center of Excellence and SMK Bisa programs, augmented reality technology is present as a solution in vocational education. Augmented reality is a technology that allows virtual things to be placed in the real world. The reason for choosing this research topic is that users can interact with virtual things in an augmented reality environment providing them with hands-on experiences. Objects that are displayed in the form of interior materials can be in 3D so that they look as close as possible to the original object. Users can interact and change the location of interior materials directly and realistically using augmented reality applications. The method used in this research is the Lee & Owens Development Model starting from Assessment/analysis, Need assessment, front-end analysis, design, development, Implementation, and Evaluation. The application developed only includes some interior design materials, Design markers have a high level of augmentability, so users will be able to immediately see a 3D model when the marker is scanned, The application has been tested on several smartphones and the results are successful.

Keywords: Learning Media; Interior Design; Augmented Reality; Vocational High Schools; 3D Model

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1. Introduction

Education (SISDIKNAS (National Education System in Indonesia) Law No.20 of 2003) is a conscious and planned effort to create a learning atmosphere and learning process so that students actively develop their potential to have religious spiritual strength, self-control, personality, intelligence, noble character, and skills needed by themselves and society. Interior design is an interior planning system that functions as a protector from environmental conditions by creating an atmosphere and image of space that meets the requirements of comfort, safety, and satisfaction of the physical and spiritual needs of its users without neglecting aesthetic factors [1]. Students' ability to design interiors must be developed while at school. Interior design is one part of the concept of architectural design design. Interior design includes activities to determine building concepts, interior design, interior materials, and the beauty of an interior layout [2].

Teachers use media to convey information to students in a way that they can understand. Media is an intermediary or conductor of messages from the sender to the recipient [3]. Media is an instrument to simplify the process of delivering messages and information from the material [4]. Learning is the process of exchanging information between teachers and students carried out during learning activities [5]. Learning is the development of new knowledge, abilities, or attitudes as individuals interact with information and the environment [6]. Learning is a deliberate activity planned by the

teacher to provide learning experiences to students with the aim that students are able to learn independently [7]. Based on this understanding, it can be concluded that learning media can be used by teachers to convey material information to students to stimulate students' thoughts, feelings, attention, and willingness to learn.

Media selection criteria stem from the concept that media is part of the overall instructional system [8]. Some criteria that must be considered in choosing media: (1) Following the objectives to be achieved. (2) Suitable for supporting lesson content in the form of facts, concepts, principles, or generalizations. (3) Good media that is practical, flexible, and durable must be chosen so that it can be used anywhere, anytime, and by anyone. (4) The teacher knows how to use it. Teachers can utilize the media effectively. (5) Target segmentation. Media are not always effective for all groups; for example, media that are effective for large groups are not necessarily effective for small groups. (6) Technical excellence. Several criteria must be considered in choosing media as learning aids. In essence, the media must be effective, efficient, and right on target to ease the burden on teachers and students in teaching and learning activities.

Research conducted in the context of Augmented Reality-based media learning that has been done shows students facilitate learning. Research conducted [9] examines the visualization of 3d home interior furniture using augmented reality with android-based markerless methods whose results are helping to realize their views in determining furniture in a room. Further research [10] supports learning computer tools in 3D which makes it easy to recognize parts of the computer. In line with the research conducted [11] examines the learning model of the sea floor model which is successfully implemented and can facilitate learning in 3D. Previous research on Augmented Reality for interior materials, as well as for other applications has been completed by previous researchers in references [14-25].

To learn theory and practice, vocational students should be provided with learning media that is easy and allows them the freedom to organize and design interior materials. This freedom can be in the form of determining the location of objects and their position on other materials; however, beauty and comfort factors must also be considered. Therefore, students need an environment that allows them to manage objects in a real and direct way. Augmented reality is one type of learning media development that can be used as an interactive and innovative learning solution [12].

Based on the description above, there is a problem that SMK as a vocational school must prepare graduates who are competent in the field of technology following technological developments in interior design. In realizing graduates who are competent in the field of interior design, teachers are needed who can deliver the material well. To be able to convey interior design material introduction material well, learning media is needed that can reach all students.

Advances in technology also have an impact on the evolution of learning media. One of them is augmented reality technology which is developing in the field of education. Augmented reality is created using computer-aided or mobile-aided devices. Augmented reality can be used as an alternative media for learning interior design. Augmented reality is packaged in an application that runs on a smartphone so that it can reach all students who mostly already have a smartphone. AR interior design applications are packaged interactively so that students can interact with learning media and as a result, learn for themselves. The goal to be achieved in this research is to produce the design and performance of augmented reality as a learning media for the introduction of interior materials in vocational schools majoring in Building Drawing Engineering.

2. Method

2.1 System Design

In this research, the method used is the Lee & Owens method. The Lee & Owens method consists of four stages, namely assessment/analysis, design, development and implementation, and evaluation. The following is a cycle of research methods according to Lee & Owens.

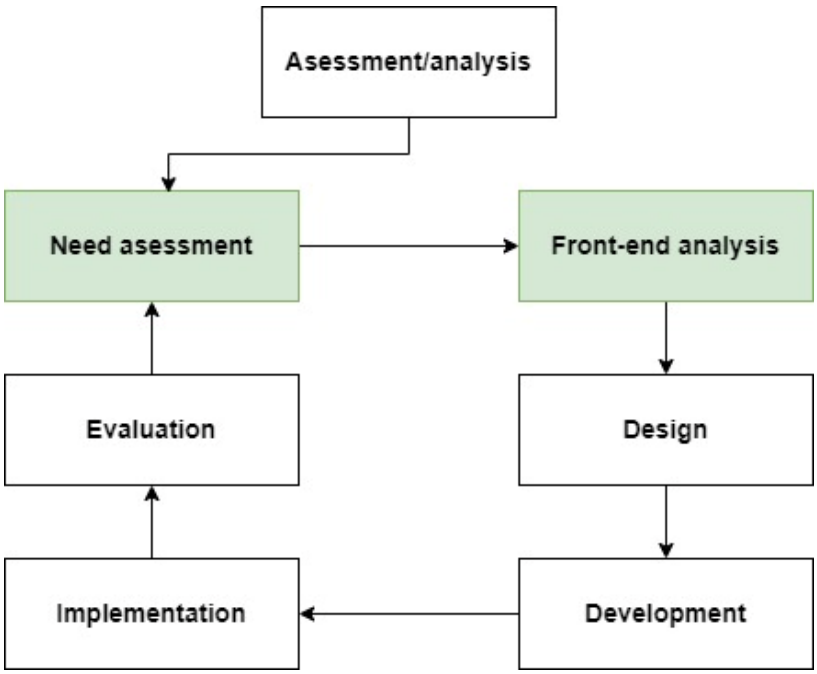

Figure 1. Lee & Owens Development Model

2.2 Assessment/ Analysis

At the analysis stage, more details are presented, namely front-end analysis and needs assessment. Front-end analysis serves to analyze things that can be taken into consideration to choose a solution to solve the problem. Meanwhile, need assessment is used to assess needs so that it can determine the right solution.

2.3 Need Assessment

Learning activities should be equipped with learning media that facilitate students to support student performance. Learning media can be in the form of images, text, audio, video, or 3D forms. Generally, in designing building interiors, students have been facilitated by devices and applications for interior design, but sometimes students need additional media to support imagination in imagining a form of interior material. In addition, the media used should give students the freedom to organize and arrange the location of interior materials and make it easy to see the shape of interior materials from various points of view. In this case, presenting a learning medium is one way to facilitate students in learning. The development of increasingly sophisticated technology also requires prospective designers to present their designs in a more innovative form. This can add to the selling value of a design. Therefore, media is needed that can inspire SMK students majoring in Building Drawing Engineering to be able to present their design designs in a more innovative and sophisticated form by utilizing developing technology.

2.4 Front-end analysis

This analysis consists of audience analysis, technology analysis, task analysis, critical-incident analysis, situational analysis, objective analysis, issue analysis, media analysis, extant-data analysis, and cost-benefit analysis. Technology analysis is an activity to determine the available technology and constraints in using technology. The technology available for product implementation is a smartphone. However, smartphones need to be analyzed further about what specifications support and can be installed by augmented reality applications. In addition, the technology needed for AR product development includes applications to develop AR environments, marker maker applications, 3D object model maker applications, and applications to change images. Media analysis is an activity carried out to determine the availability of media obtained through observations during learning activities. The material developed with AR is material about interior design. This material needs to be added with AR to facilitate students in imagining interior design material objects.

2.5 Design

This stage is the stage of designing the right media based on the needs analysis at the assessment and analysis stage. Some of the activities in this stage are the media specification project team, lesson outline, and control configuration and cycle. Specifications are divided into 2, namely in the form of markers and augmented reality applications. The following media specifications were developed:

1. Marker
    a. Marker design in the form of QR-Code
    b. QR-code measuring 5cm x 5cm
    c. One QR-Code contains one 3D model

2. Augmented Reality Application
    a. Application in the form of APK (Application Package File)
    b. Can be installed on Android smartphones with application system 4.1 or higher
    c. Requires a minimum storage space of 100MB
    d. Minimum 2 MP camera

2.6 Development and Implementation

The development stage is done by developing augmented reality in the developer application. The application developed is an offline application so it does not require an internet connection. The next step is to create the 3D model needed.

At the implementation stage of making AR applications in offline form, there are types of 3D models that are suitable and not suitable. The appropriate type of 3D model is obj. While inappropriate file forms fbx, blend, max, and 3ds. Therefore, considerations in determining the 3D model maker application. Applications that have been developed need to be tried to test reliability. Testing is done on different smartphone specifications.

2.7 Evaluation

Is a stage to determine the feasibility of the application in terms of suitability, suitability, and reliability of the application. At this stage, it is determined to what extent the application will be evaluated and the development of instruments as a standard for application feasibility. The evaluation in this study has been carried out in the discussion of the revision of each stage. Based on this, the evaluation at the implementation stage can be known from the level of validity, and practicality of the developed interior design augmented reality-based learning media.

3. Result and Discussion

Following the development method according to Lee and Owens, the following design results have been carried out.

3.1 System flow and function

In implementing this research, researchers focus more on using the open-source tool Unity, as the main framework for building AR applications. The process flow of the AR application developed can be seen in the flowchart Figure 2. The first stage begins with the selection of the marker model. The marker model is in the form of a multimarker. Then scan the marker with the Android camera. Next, the marker that has been selected is then rendered or the unification of the image with the environment which is then stored in the AR application. The next process is the process of displaying 3D objects. The AR application system flowchart can be seen in Figure 2. Figure 3 is a Function of the AR Application system.

Figure 2. Flowchart of AR Application system

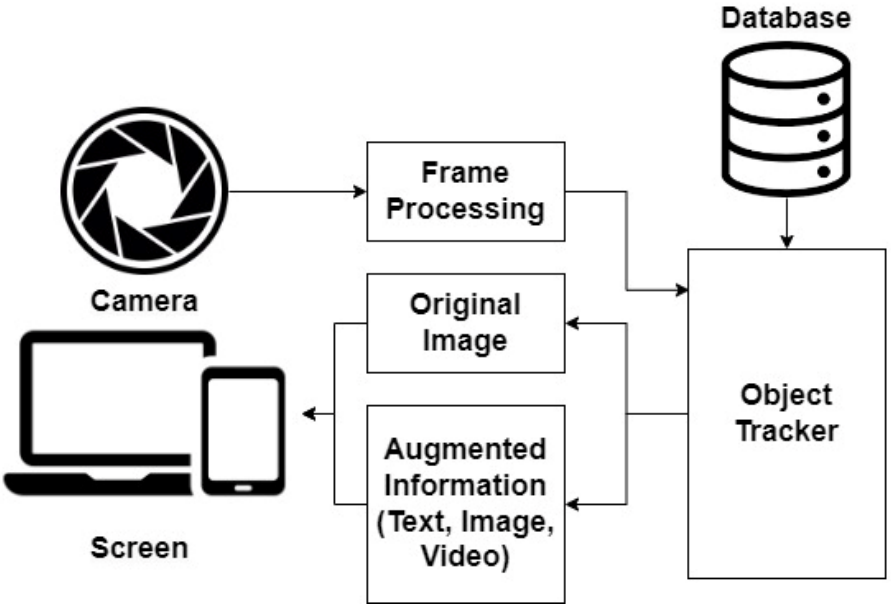

Figure 3. Function of AR Application system

3.2 Marker

Markers that can be used to display 3D models in the form of augmented reality. Users can rotate and place these markers on the interior design plan according to the material that has been designed. Each marker represents one form of a 3D model. The marker is designed with a small size to make it easier to place so that it does not cover other materials or designs. Users can rotate the marker to determine the direction of the material. The conceptualized marker is presented in Figure 4.

Figure 4. Interior material multi-markers

In Figure 4 the use of QR-Code for the marker will aim to increase the augmentable marker so that it accelerates the readability of the marker when scanned with a smartphone camera that has an augmented reality application installed. So that users can more easily recognize each marker, then in the middle of the QR-Code added images related to interior design materials.

3.3 Augmented Reality Application

Augmented Reality (AR) is known as an interactive technology that can project virtual objects into real objects in real-time [13]. The development of AR technology today has made many contributions to various fields. In the field of education, AR can be used as a means of learning media, one of which is to introduce Interior Design. Users can visualize historical objects or objects in 3-dimensional form, to improve user perception and interaction with the real world. In this research AR-based applications using the Marker Based Tracking method (based on markers).

In this study, the developed application is in the form of an Android application with an apk extension. The way to install this application is almost the same as installing an Android application in general, but because this application is installed manually and not from the Google Play Store, it requires application installation settings. The interior design AR application on the initial display has an Open AR Button, How to use, Download Target Marker, then exit if you have completed the operation. This application also gives the impression of "*Have Fun Learning*" learning so that vocational students are more interactive and fun in learning with the teacher. The initial appearance of the application and how to use the developed application can be seen in Figures 5 and 6.

Figure 5. Initial view of the app

Figure 6. How to use the AR Interior App

Interior design is the process of arranging and creating interior elements to become an interrelated unit to achieve certain goals, both in the aesthetic aspect, as well as the safety and comfort of the room. The development of this application using the marker-based Tracking method consists of room markers as well as interior design markers consisting of bedroom markers, dining room/kitchen, bathroom, and living room as the application and marker concept can be seen in Figures 7, 8, and 9.

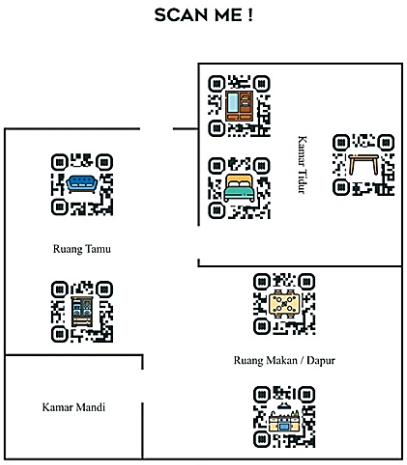

Figure 7. Unreadable marker

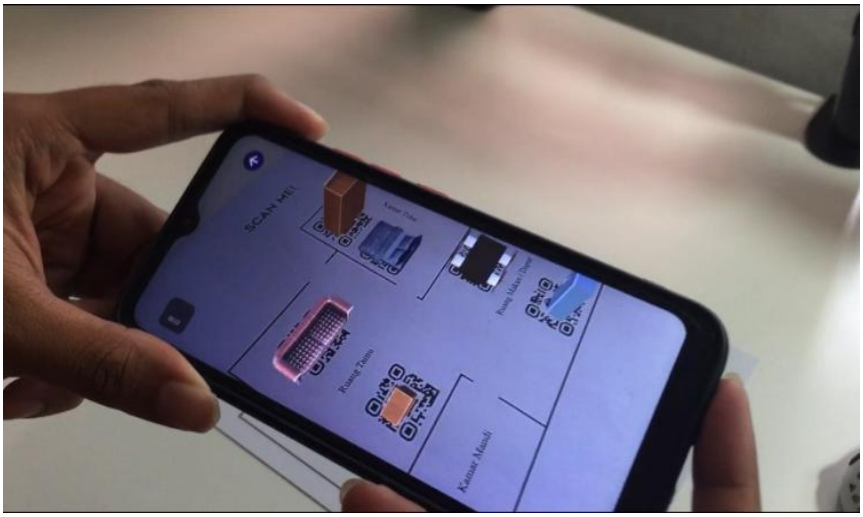

Figure 8. Display when the marker has been read

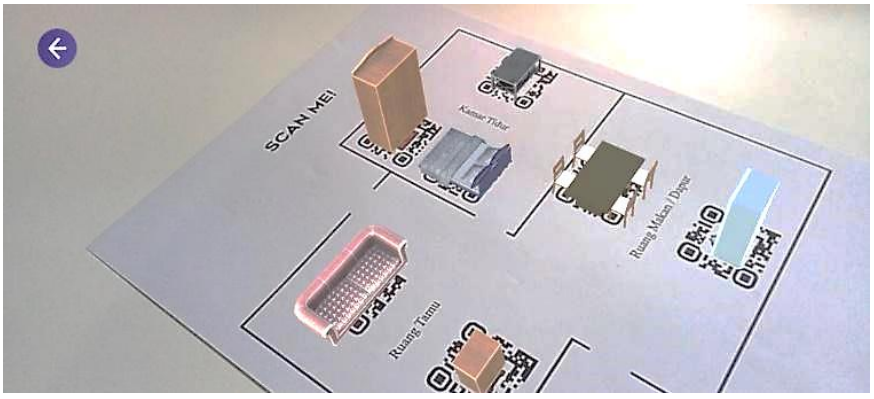

Figure 9. Interior Design 3D Overall View

The use of interior design AR applications using Augmented Reality interactive technology can help vocational students learn the layout and choose furniture-furniture so that they do not need to come directly to the store and do not need to use brochures or magazines to determine furniture without having to go to the interior service provider.

3.4 Testing

Software testing is the process of running and evaluating software to test whether the software has met the requirements or not to determine the difference between the expected results and the actual results. The following will describe several things related to the testing of the Interior Design Augmented Reality marker-based application software.

Field tests were conducted on 63 students of Building Image Engineering Vocational Schools who studied Interior Design. From the results of the field test analysis, it is known that the average percentage of 20 subjects (items) of assessment. this application is included in the criteria is very good because 54 students answered very well, 7 good, and 2 good enough. The level of achievement of the application based on the results of the field test for a good scale is presented in Table 1 and Figure 10.

Table 1. Achievement level of field test results

Criteria for Achievement Level	Percentage (%)	Number of Students
Very good	85,71%	54
Good	11,11%	7
Good enough	3,17%	2
Not good	0	0
Not very good	0	0

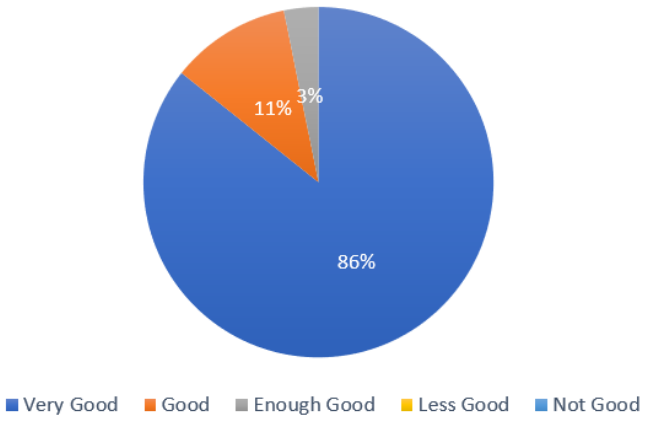

Figure 10. Visualization of the Field Trial

The application that has been developed is then tested on several smartphones to determine its suitability and suitability if installed on smartphones with certain specifications. The following are the results of trials conducted on several smartphones as the smartphone specifications that have been tested can be seen in Table 2.

Table 2. Tested smartphone specifications

No	System Kernel Version	RAM	Rear Camera	Screen Size	Smoothness	Installation
1.	Android 11	6GB	64MP	6.4	Current	Success
2.	Android 10	6GB	16MP	6.5	Current	Success
3.	Android 10	2GB	8MP	6.5	Current	Success
4.	Android 7	3GB	13MP	5	Current	Success

The next test carried out on the application is feature testing. Feature testing tests the function of each button in the application. The tests carried out on the main menu scene are the AR button, marker, about the application, help, and exit. The test can be seen in Table 3.

Table 3. Tested smartphone specifications

No	Testing	Expected results	Testing Results
1	AR Open Button	Running the AR Camera	Successful
2	How to use the button	Displaying How to use	Successful
3	Marker Download Button	Download the marker directed at the link	Successful
4	Exit Button	Exit App	Successful

4. Conclusions

Based on the analysis and testing of the interior design AR application research, it can be concluded as follows [1]. Marker detection runs well and can bring up three-dimensional Interior Design objects with the multimarker-based tracker method. [2]. The utilization of augmented reality technology in this application runs well and follows previous planning, which combines three-dimensional objects with the real environment. [3]. From the results of the limited field test of this interior design augmented reality application, 8 students answered very well, 2 students answered well and 1 student answered moderately, meaning that the interior design AR application can be used as an innovative and interactive learning media that is fun for vocational students. [4]. The results of trials conducted on several smartphones from Android 11, 10 and 7 smartphone specifications that have been tested are successfully installed and smoothly but display 3D less than perfectly.

5. Suggestions

Suggestions that can be given for the development of the application of AR in this interior design Augmented Reality Application based on the results of previous research and discussion, namely: [1] In future research, it is hoped that it can be added with a markerless method that can bring up 3D without using markers and can be added to audio. [2] The scope of material equipped with augmented reality also only includes interior design material. For other materials, it needs to be developed further. [3] It is hoped that there is a solution to minimize the size of AR applications that take up a lot of memory causing smartphones to become hot. Further research to find solutions can minimize storage space on the smartphone used. [4] Application development on the 3D object animation side, so that it can be created by paying attention to aesthetics, clarity, and reality so that it provides a better description of the object. [5]. Provide audio narration of interior design explanations and add animations so that learning is more fun, besides seeing visually, you can also listen to the audio narration.

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