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Mobile Application for Simulation of Camera Shot Angles Using 3D Environment Virtual Reality

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ABSTRACT

This paper addresses the challenges faced by Telkom University in online learning, specifically in practical courses that require hardware. One such course is Videography in the Communication Science Study Program, which aims to equip students with theoretical knowledge and practical techniques for shooting from specific angles or positions using camera devices. To overcome this challenge, the study focuses on developing an Android mobile application that simulates the practical exercises in the Camera Shot Angles course. The application utilizes a virtual 3D environment and offers a VR (Virtual Reality) mode, allowing students to immerse themselves in realistic shooting experiences from various positions and angles. It also includes a comprehensive set of questions to evaluate students' understanding of the course material. The testing results indicate that the application is compatible with mobile devices with a minimum of 4GB RAM and has received positive scores for user experience aspects such as attractiveness, perspicuity, and efficiency. This paper discusses the development process, features, and evaluation of the application, highlighting its potential to enhance the practical learning experience for students in the Communication Science Study Program at Telkom University. By providing a virtual platform for practicing camera shot angles, this application offers a solution to the hardware limitations faced during online learning, enabling students to gain practical skills and knowledge effectively.

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1. Introduction

The utilization of advanced information and communication technology in educational institutions, including universities, has significantly increased to enhance the teaching and learning processs [1]. Ongoing research in learning technology aims to improve learning quality in terms of both content and student outcomes. Telkom University has introduced an online learning platform based on the Learning Management System (LMS), enabling the transition from traditional classroom models to a multimedia system accessible by lecturers and students anytime and anywhere. This facilitates students' independent development of learning materials due to the availability of resources on the e-learning platform [2].

To enhance the implementation of motor-based learning materials, an interactive application that effectively simulates laboratory or studio activities is required [3]. Videography (COH2M4) requires practical motor skills, particularly in understanding camera angles. However, due to restricted study hours, expensive equipment requirements, limitations in the laboratory, and constrained shooting locations, students' comprehension of this material is hindered, thereby preventing the lecturer's comprehensive evaluation of their motor skills [4].

This research focuses on developing a mobile application as digital learning media to simulate learning materials related to Camera Shot Angles. The proposed digital media incorporates Virtual Reality (VR) technology and utilizes 3D objects as a user interface environment [5][6], creating an immersive experience that replicates real-world scenarios [7]. It could be especially suitable for groups with reduced mobility [8]. This digital media is also integrated as a digital content component within the LMS platform, serving as an essential software to achieve the learning outcomes of the Videography course [9][10].

2. Method

The development of digital module applications based on Virtual Reality technology uses a multimedia development method called MDLC (Multimedia Development Life Cycle). MDLC is a systematic approach used to develop multimedia applications. It consists of several stages, including concept, design, material collecting, assembly, testing, and distribution, emphasizing capturing user requirements and ensuring high-quality multimedia content [11]. It uses a structured methodology for the development of multimedia applications. It comprises several essential stages for successfully creating and deploying multimedia projects [12]. Figure 1 shows the flow of the MDLC method.

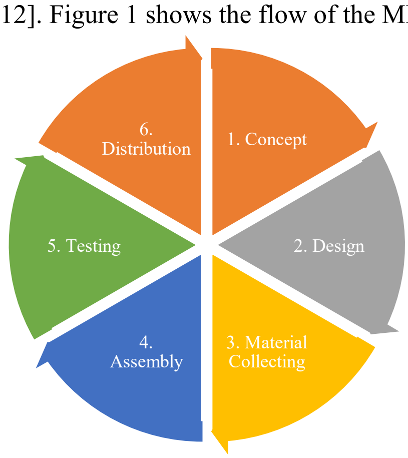

Figure 1 MDLC Method [12]

The first stage of MDLC is the concept phase, where the requirements and objectives of the multimedia application are determined. This involves understanding the target audience, their needs, and the application's desired functionality. The concept phase is the foundation for developing a digital module in Videography, encompassing functional and non-functional requirements. It involves gathering user data to achieve learning objectives effectively [13].

In the design phase, the conceptual and visual aspects of the multimedia application are developed. This includes creating a sitemap, designing the user interface (UI), user experience (UX), and planning the overall structure of the project [14]. The design phase also defines multimedia elements such as images, audio, video, and animations. Figure 2 is the result of the application sitemap design that has been developed.

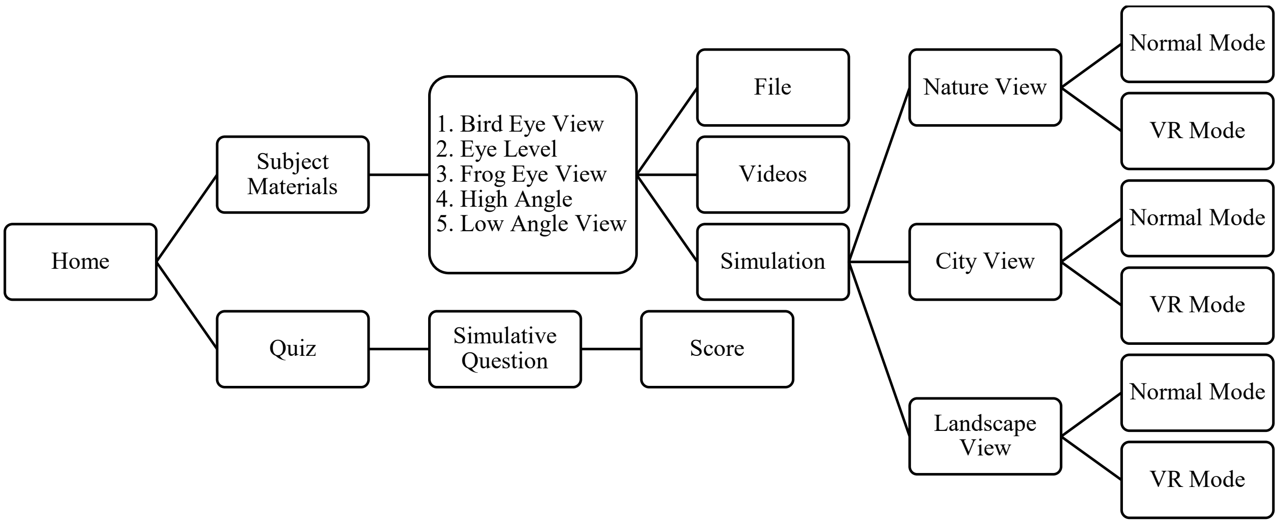

Figure 2 Sitemap of Digital Module Application

Once the design is finalized, the material collecting phase begins. This phase collects the materials for the digital module application, such as learning materials (composition of images and camera angles), virtual environments, 3D objects (people, cameras, trees, buildings), images/icons, audio, and video, to facilitate learning objectives. The required materials should be able to display easily and clearly on specific mobile device specifications, particularly regarding 3D objects and environments. This is crucial because specific devices available on the market may have limited specifications that could affect multimedia content performance [15].

After all the materials have been collected, the next phase is the assembly or development. This stage involves implementing the design and integrating the multimedia materials into the application. Multimedia developers use various tools and programming languages to create interactive and engaging multimedia content [16]. After the development phase, thorough testing ensures the multimedia application functions properly and meets the specified requirements. Testing involves checking the application's functionality, usability, performance, and compatibility across different devices and platforms.

3. Assembly Result

The development of the application resulted in a digital module application designed for the Android operating system. The application primarily simulates camera angle shooting, offering standard screen and VR modes. Users can use a VR Box device to enhance their experience in VR mode.

3.1. Main Menu

The main menu page serves as the initial screen upon opening the application. It features a visual representation of a camera image, representing the essence of the Videography course and the course identity. Additionally, this page includes two buttons, Topics and Quiz, accompanied by an Information button. Figure 3 displays the main menu interface.

Figure 3 Main Menu Interface

3.2. Material Page

After selecting the Topics button on the main page, users will be directed to a page where they can choose from five camera angle topics related to the learning content of the Videography course. These topics serve as references for shooting angles. Figure 4 shows the topics page interface.

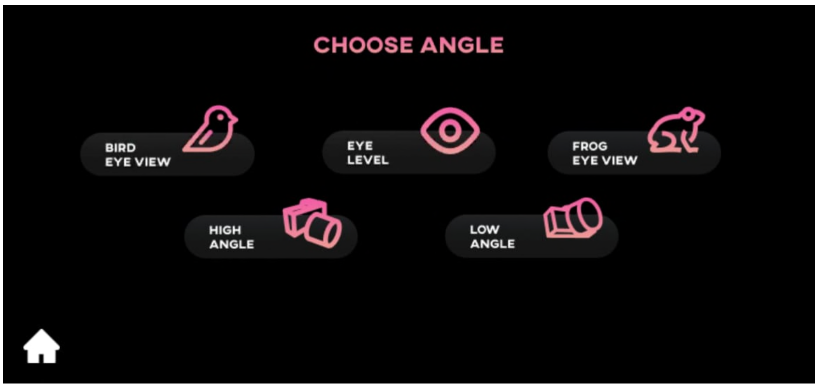

Figure 4 Topics Page Interface

3.3. Simulation Page

Upon selecting the simulation content, users will be directed to a simulation page that presents a 3D environment view. In this interactive simulation, users can directly experience camera angles and choose from three different environments: urban, forest, and landscape. Navigation buttons allow users to switch between these environments. A VR (Virtual Reality) Mode button is available on this page, enabling users to transform the screen into a split-view mode, compatible with a VR box device. Through this feature, users can immerse themselves in a simulated environment. Figure 5 displays several simulation views in normal mode, while Figure 6 showcases several VR ones.

Figure 5 Simulation Page Interfaces in Normal Mode

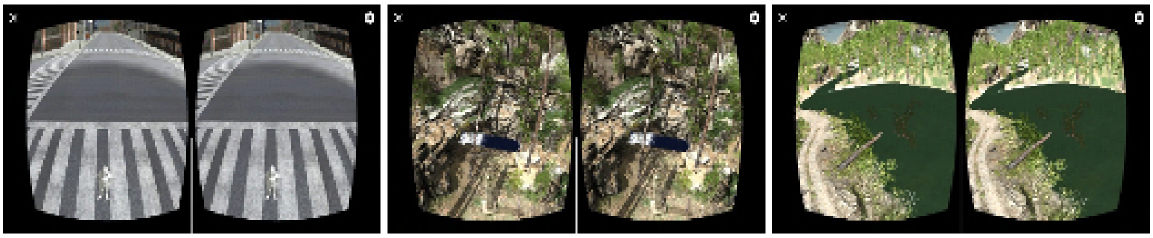

Figure 6 Simulation Page Interfaces in VR Mode

3.4. Evaluation / Quiz Page

The evaluation feature, a quiz, is utilized to assess user comprehension following the simulation of the previous camera shot angles. The application prompts users to practice capturing pictures from specified positions within this feature until they achieve the correct outcome. Figure 7 illustrates the interface of the material evaluation page, displaying the results.

Figure 7 Evaluation page interfaces

4. Testing

Testing is conducted to ensure that the application meets the performance and functionality requirements of the users. This application performs two types of tests: performance testing on various mobile devices and user experience testing [17]. The performance testing involved conducting five functional tests on ten different Android devices with varying brands and specifications to determine the minimum requirements for running the VR simulation application. On the other hand, user experience testing was carried out to evaluate the level of comfort and immersion of the content, considering the application's utilization of VR technology and a 3D environment, along with the use of an additional device, the VR Box, for its operation.

4.1. Performance

Performance testing was conducted to measure the specific functions of the device while it was in standby mode [18]. These functions encompassed digital content that required superior RAM (Random Access Memory) performance compared to other content. The assessment was carried out using a 4-point scale, ranging from 4 (very smooth) to 1 (stop) [19]. Table 1 displays the performance test results for the following functions:

1. Initial display,
2. Videos playback,
3. Simulation in Normal Display,
4. Simulation in VR Display.
5. Gyroscope response

Table 1 Performance testing

No	Device	Android Version	RAM (GB)	Functions					Average Score
				Initial Display	Video	Normal Display	VR Display	GPS Response	
1	Samsung Galaxy S21 Ultra (2021)	11	12	4	4	4	4	4	4
2	Xiaomi Mi 11 (2021)	11	8	4	4	4	3	3	3,6
3	Samsung Galaxy A52 (2021)	11	12	4	4	4	3	3	3,6
4	Oppo Find X3 Pro (2021)	11	12	4	4	4	4	4	4
5	Samsung Galaxy S8 (2018)	9	4	4	4	3	3	3	3,4
6	Oppo A54 (2021)	10	4	4	4	3	3	3	3,4
7	Asus Zenfone 8 (2021)	11	6	4	4	4	3	3	3,6
8	Vivo Y20s (2020)	10	4	4	4	3	3	3	3,4
9	Xiaomi Redmi Note 10 (2021)	11	4	4	4	4	3	3	3,6
10	Realme 8 Pro (2021)	11	6	4	4	3	3	3	3,4
			Total Score						3,6

The performance testing results revealed ten devices from various brands and types with RAM specifications ranging from 4GB to 12 GB. All devices demonstrated smooth performance without issues when running the application during the initial display. However, only two devices with 12GB RAM could run the VR mode and GPS response smoothly. Additionally, all features were successfully executed on all tested devices without interruptions or application crashes (score 1), scoring 3.6 out of 4. These findings indicate that the digital module application is lightweight and can be run on Android mobile devices with a minimum RAM specification of 4GB and Android version 8.0 or higher.

4.2. User Experience

Virtual reality technology offers users a unique and immersive experience. This application used the UEQ (User Experience Questionnaire) method to evaluate user experience [20]. The testing phase involved 39 students from a Communication Science class. The UEQ method consists of 26 statements with 7-point scoring options, assessing six measurement aspects: attractiveness, efficiency, perspicuity, dependability, stimulation, and novelty [21]. Table 2 shows the raw data from the results of completing the questionnaire by 39 respondents.

Table 2 Data from The UEQ Questionnaire

No	Question																									
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
1	7	7	2	2	3	5	6	4	4	4	5	2	6	6	4	5	2	3	2	6	2	6	2	3	2	4
2	5	5	4	7	3	2	2	6	6	3	4	3	6	4	6	4	2	4	1	4	2	6	4	6	4	6
3	6	6	1	2	3	5	4	4	4	2	4	1	3	3	4	4	2	3	2	4	2	3	3	2	3	4
4	5	2	3	3	2	5	5	5	2	3	5	3	5	5	3	5	2	4	2	5	3	5	4	3	3	3
5	6	6	5	1	2	6	6	4	2	3	5	1	6	6	4	6	2	3	2	6	3	6	2	2	2	3

No	Question																								
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
6	7	7	2	1	1	7	7	3	1	1	7	1	7	7	5	7	1	2	1	7	1	7	1	1	1	7
7	7	7	3	2	3	6	6	6	2	4	5	1	6	6	4	6	2	4	1	7	2	6	2	2	3	4
8	7	7	3	1	1	4	4	7	7	7	4	1	5	7	1	7	1	5	1	7	1	7	1	1	1	4
9	6	6	6	2	2	3	2	5	2	6	4	2	6	4	2	6	3	5	2	3	2	6	6	3	3	4
10	7	7	1	1	1	7	7	4	1	1	7	1	7	7	7	7	3	4	1	7	1	7	1	1	1	7
11	5	7	5	5	6	5	5	6	6	4	7	1	6	6	6	6	7	2	1	6	3	5	2	4	3	5
12	4	7	5	6	6	6	2	7	3	3	5	3	7	6	5	5	2	2	3	6	1	7	1	3	3	4
13	6	6	3	2	2	5	6	5	5	4	5	2	4	5	2	6	2	2	2	5	5	6	5	2	2	5
14	6	6	2	2	4	4	6	4	4	2	4	3	4	4	5	4	4	4	2	6	2	4	2	4	4	5
15	7	6	7	5	7	7	7	7	1	7	7	1	7	6	6	6	1	1	1	4	4	4	1	1	1	4
16	5	7	3	1	3	5	5	3	1	3	4	4	7	4	5	4	1	3	1	7	1	7	3	5	4	5
17	2	1	5	5	4	3	3	4	5	5	2	6	2	1	3	2	5	5	4	1	2	5	3	4	3	6
18	7	7	1	1	1	6	6	4	2	1	6	2	6	7	7	6	3	4	1	7	1	6	4	2	2	6
19	6	6	4	6	3	4	5	5	2	4	6	2	6	6	6	6	2	4	2	6	2	6	2	3	2	4
20	6	6	2	2	2	5	5	6	1	2	4	2	6	6	6	6	2	2	2	7	2	6	2	2	2	7
21	4	3	4	5	2	6	6	6	3	6	4	3	4	5	3	5	2	3	2	6	3	6	6	4	4	3
22	5	6	3	3	2	5	5	4	2	3	5	2	5	5	6	5	3	3	3	6	2	6	2	3	3	6
23	7	7	1	1	1	7	7	4	1	2	7	1	7	7	7	7	1	1	1	7	1	7	1	1	1	1
24	1	5	3	5	4	5	4	4	4	5	2	6	4	1	4	1	4	7	5	4	4	4	4	4	7	4
25	2	5	5	4	2	4	3	3	1	2	5	2	6	5	5	5	5	4	2	7	2	7	3	2	2	5
26	7	7	1	1	1	7	7	4	1	1	7	1	1	7	7	7	1	1	1	7	1	7	1	1	1	1
27	6	6	4	2	2	6	6	5	3	2	5	4	7	6	5	5	2	4	3	6	2	6	1	2	2	5
28	6	7	2	1	1	6	5	6	4	3	6	1	3	7	5	6	3	2	1	7	1	7	1	2	1	6
29	7	7	4	1	1	7	7	4	1	1	7	1	7	7	7	7	1	4	1	7	1	7	3	2	1	7
30	6	7	1	1	1	5	5	4	1	3	5	1	7	7	6	7	1	3	4	7	1	7	1	1	4	6
31	5	6	5	2	2	4	5	5	2	2	3	3	4	6	6	7	2	3	2	7	3	6	5	4	3	6
33	4	6	4	2	3	4	4	7	2	4	4	5	6	4	3	5	2	4	3	5	2	6	6	3	3	4
34	7	7	2	1	1	7	7	3	4	2	6	1	7	7	4	7	1	4	1	7	1	7	1	1	1	5
35	2	2	3	3	2	5	4	3	2	2	4	2	6	5	6	1	2	4	2	5	2	7	3	3	4	7
36	4	6	4	2	1	4	5	6	2	3	7	1	6	6	4	6	2	3	1	7	2	6	2	4	2	4
37	7	7	6	4	7	7	7	7	1	7	7	1	7	7	4	7	2	2	2	2	1	7	7	3	3	3
38	7	7	1	1	1	7	7	7	1	1	7	1	7	7	7	7	1	1	1	7	1	7	1	1	1	1
39	6	7	2	3	1	6	7	4	2	2	6	1	7	6	6	7	3	3	2	6	2	6	1	2	2	6

From the data in Table 2, every score from each respondent then transformed into half positive values and half negative values randomly using the formula in Equation 1 [22]:

$$x = n - 4 \qquad \text{Equation 1}$$

The n indicates the value of the statement. Then the Mean and Variance values are calculated for each aspect. The Mean value indicates the respondents' average satisfaction level for each measured aspect in the UEQ questionnaire. A higher Mean value indicates a higher level of satisfaction of respondents towards the measured aspect. The Mean value can be calculated using the formula in Equation 2 [22]:

$$\text{Mean} = \frac{(\sum x)}{n} \qquad \text{Equation 2}$$

Σx is the sum of all scores given by respondents, and n is the total number of respondents. The Variance value describes the extent to which respondents' scores vary for each statement. A higher Variance value indicates a greater variation among respondent scores, suggesting significant differences in user experience within the measured aspect. The formula in Equation 3 can be used to calculate the Variance value [22].

$$\text{Variance} = \frac{\left(\sum (x-\bar{x})^2\right)}{n} \qquad \text{Equation 3}$$

Where Σ is the symbol for summation, x is the score given by respondents for each statement, $\bar{x}$ is the mean (average) of all scores given by respondents, n is the total number of respondents.

Using these formulas, the Mean and Variance values are obtained for each aspect, as Table 3 and 4 show the final results for each scale.

Table 3 Recapitulation of Each Question

No	Score		Scale / Aspect	Mean	Variance
	1	7			
1	annoying	enjoyable	Attractiveness	1,5	2,7
2	not understandable	understandable	Perspicuity	2,0	2,4
3	creative	dull	Novelty	0,8	2,7
4	easy to learn	difficult to learn	Perspicuity	1,4	3,1
5	valuable	inferior	Stimulation	1,5	2,9
6	boring	exciting	Stimulation	1,3	1,7
7	not interesting	interesting	Stimulation	1,3	2,3
8	unpredictable	predictable	Dependability	0,9	1,7
9	fast	slow	Efficiency	1,4	2,7
10	inventive	conventional	Novelty	0,8	3,1
11	obstructive	supportive	Dependability	1,2	2,0
12	good	bad	Attractiveness	1,9	2,0
13	complicated	easy	Perspicuity	1,6	2,4
14	unlikable	pleasing	Attractiveness	1,6	2,4
15	usual	leading edge	Novelty	0,9	2,5
16	unpleasant	pleasant	Attractiveness	1,5	2,5
17	secure	not secure	Dependability	1,7	1,7
18	motivating	demotivating	Stimulation	0,8	1,7
19	meets expectations	does not meet expectations	Dependability	2,1	1,0
20	inefficient	efficient	Efficiency	1,8	2,3
21	clear	confusing	Perspicuity	2,1	1,0
22	impractical	practical	Efficiency	2,1	1,0
23	organized	cluttered	Efficiency	1,4	3,0
24	attractive	unattractive	Attractiveness	1,4	1,6
25	friendly	unfriendly	Attractiveness	1,5	1,7
26	conservative	innovative	Novelty	0,7	2,7

Table 4 Recapitulation of Each Scale

Scale	Mean	Variance	Result
Attractiveness	1,583	1,57	Good
Perspicuity	1,757	1,04	Good
Efficiency	1,671	1,04	Good
Dependability	1,474	0,67	Above Average
Stimulation	1,224	1,02	Above Average
Novelty	0,796	1,36	Above Average

From the final calculation results of each aspect in Table 4, it can be visually observed using a bar chart, as shown in Figure 8. Only the calculation results of the Mean (average) values are used to determine the level of user satisfaction and experience.

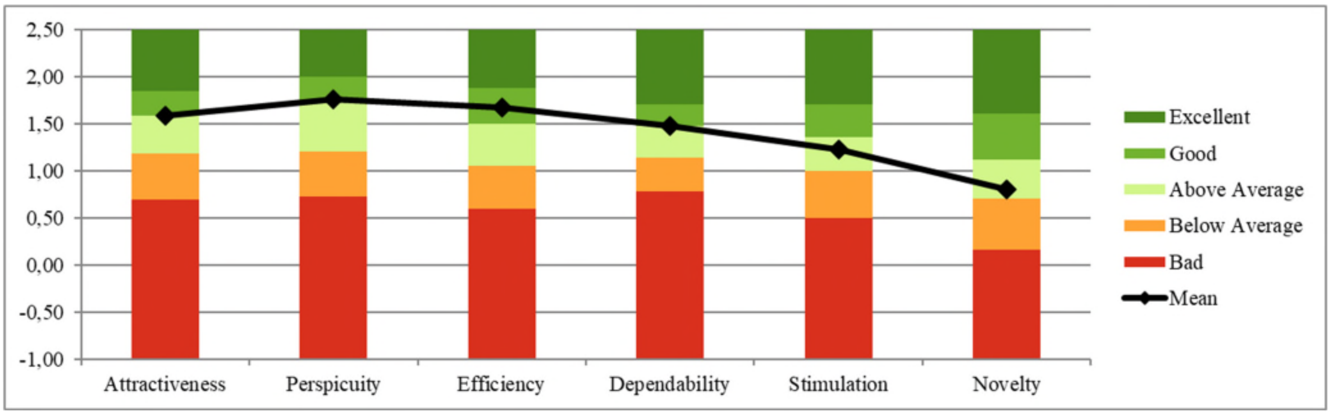

Figure 8 Final UX Testing for Each Scale

Figure 8 illustrates that from the user experience testing using the UEQ method, the developed VR application is well-received by all users, with all aspect scores above average. However, from these results, every aspect has yet to achieve a perfect score (Excellent) in the eyes of the users.

5. Conclusions

The development of a mobile application for a simulating camera shot angles using Virtual Reality technology resulted in a digital learning module that facilitates simulated image capture by utilizing 3D objects in a virtual environment. The application offers two screen modes for users: normal screen mode and VR mode. Users can also evaluate the materials within the application.

The application's performance was tested using ten different Android mobile devices with varying RAM specifications ranging from 4GB to 12 GB. The performance testing showed that all devices could run the application well, with a minimum requirement of 4GB RAM and Android version 8.0. The overall performance testing results obtained a 3.6 out of a maximum score of 4.

The application was also evaluated in terms of user experience using the UEQ (User Experience Questionnaire) method, involving 39 students as respondents. The UX testing results indicated that the application's attractiveness, perspicuity, and efficiency were rated as "GOOD". In contrast, the users rated the aspects of dependability, stimulation, and novelty as "ABOVE AVERAGE".

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