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DEVELOPMENT OF AUGMENTED REALITY IN UNDERSTANDING THE NETS AND RIBS OF SPATIAL BUILDINGS

Sondang Purnamasari Pakpahan[1], Andy Sapta [2*], Uliya Khoirun Nisa [3]
[1,3] Elementary School Teacher Education, Universitas Terbuka
[2] Educational Technology, Universitas Terbuka
email: andy.sapta@ecampus.ut.ac.id

Abstract: Technology-based learning media is currently widely developed in accordance with the 21st-century learning model. Many subject matters are better delivered when using technology-based media. One of the media that can be used is Augmented Reality. Based on this, the purpose of this study is to develop Augmented Reality in conveying the material of nets and ribs in Build Space. Augmented Reality is developed using 3D modeling, rigging, and animating methods, which are then combined using Unity. The results of the development of Augmented Reality applications in understanding the nets and ribs of this building space have been validated by experts and users. The validation results of this Augmented Reality application are rated Very Good.

Keywords: augmented reality; nets; ribs; spatial building.

Abstrak: Media pembelajaran berbasis teknologi saat ini banyak dikembangkan sesuai dengan model pembelajaran abad 21. Banyak materi pelajaran yang lebih baik disampaikan bila menggunakan media berbasis teknologi. Salah satu media yang dapat digunakan adalah Augmented Reality. Berdasarkan hal tersebut, tujuan penelitian ini adalah untuk mengembangkan Augmented Reality dalam menyampaikan materi jaring-jaring dan rusuk pada Bangun Ruang. Augmented Reality ini dikembangkan dengan menggunakan metode 3D modeling, rigging dan animating, yang selanjutnya digabungkan dengan menggunakan Unity. Hasil pengembangan aplikasi Augmented Reality dalam memahami jaring-jaring dan rusuk dari bangun ruang ini telah divalidasi oleh ahli dan user. Hasil validasi aplikasi Augmented Reality ini dinilai Sangat Baik.

Kata kunci: augmented reality; bangun ruang; jaring-jaring; rusuk.

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INTRODUCTION

Learning is an activity that aids provided by educators to convey knowledge and build character and attitudes in students [1],[2]. Learning activities at school are one way of conveying knowledge from teachers to students. In carrying out learning activities, teachers should prepare various things needed to support learning so that learning activities can be carried out properly. Teacher skills in preparing learning activities need to be considered. One of the things that must be considered is the preparation of learning media [3],[4].

Learning media is one of the most important components of learning activities at school [5],[6]. Learning media is very important because the role of media in learning is very large. Learning media can even attract students' attention so that students' attention can be more focused on the learning that takes place [7],[8]. In addition, learning media also helps make it easier for students to understand the material being taught [9],[10]. However, keep in mind that the learning media used must, of course, be in accordance with the needs and material to be delivered.

Learning media needs to be prepared and developed by adjusting the development of students. In addition to the development of students, technological developments also need to be considered in preparing learning media. However, learning media has yet to be developed [11]. Teachers still use learning media that is already available. This is due to the limited time to make and the limited funds to provide media. Because of the lack of media used, learning is still centered on the teacher using the lecture method only. Students are also still passive because they have yet to be given space in the learning process.

The use of learning media really helps the implementation of a good learning process, especially in materials that are considered difficult by students [12],[13]. One of the materials that require media to facilitate the delivery of material to students, especially elementary school students, is geometry material. Geometry material is considered difficult because of the limitations of students in imagining how geometric shapes can be formed and what are the elements that make up geometry [14],[15]. In teaching geometry material, teachers usually use objects as learning media. However, this media has yet to be able to visualize geometry interestingly especially for elementary school children in the present.

Technological developments certainly affect various aspects of life, including learning media. Increasingly sophisticated technology demands the development of increasingly sophisticated learning media to attract the attention of students and maintain the usefulness of the material. One of the developments in learning media that is being done today is Augmented Reality-based learning media [16]-[20].

Based on the conditions described earlier, a learning media is needed that can visualize various geometric shapes. To realize this, they compiled Augmented Reality-based learning media on geometry material in elementary school. Therefore, this study aims to develop Augmented Reality-based geometry learning media.

METHOD

In developing this Augmented Reality using using several stages. These stages include problem analysis, observation, design, implementation, and evalua-

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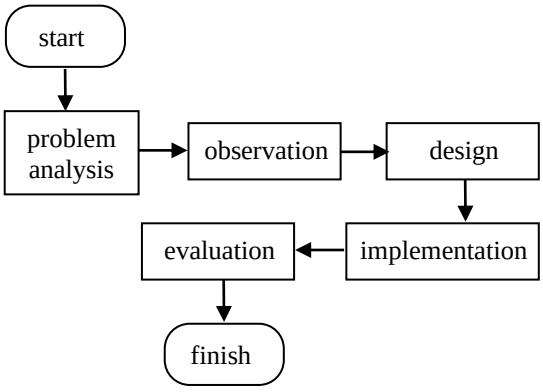

Image 1. Flow of Application Development

Problem Analysis
Problem analysis is done to find and know the problems that occur during learning. The problems studied are mainly related to the material of the nets and ribs of the Space Buildings. The problem is associated with the use of Augmented Reality as one of the learning media.

Observation
Observation of the results of the problem analysis was conducted on 40 teachers. The teacher served in elementary schools in three places, namely Medan, Asahan, and Pematang Siantar. All these areas are in the province of North Sumatra. Observations were conducted to find out more in-depth about the learning of nets and ribs of Spatial Buildings carried out in schools.

Design
From the results of observations, Augmented Reality design is carried out regarding the nets and ribs of Building Spaces. The design is developed using 3D modeling, rigging, and animating. When the development of 3D objects has been completed, the next is the process of combining 3D objects in Unity software with Augmented Reality.

Implementation
Applications that have been developed at the design stage are then compiled on a smartphone device so that they can be used. Furthermore, the model developed as a card when using Augmented Reality is printed. The card used will trigger the appearance of a 3D image display when Augmented Reality is used.

Evaluation
Software testing is done with two methods, namely functional testing, and non-functional testing. Functional testing is done using black box testing to test the features and functionality of the software that has been built. Non-functional testing is done in the form of compatibility and usability testing.

RESULT AND DISCUSSION

The development of this Augmented Reality application for Building Space starts with a needs analysis. Needs analysis is done by distributing questionnaires to elementary school teachers in North Sumatra. Sample selection is done randomly, using cluster random sampling. Cluster selection by considering the district or city of the samples.

Application Implementation
After obtaining accurate data, further in-depth observations were made in three cities, namely Medan, Asahan, and Pematang Siantar. After obtaining data that is considered sufficient to develop Augmented Reality to recognize building space, it is poured into the storyboard to facilitate the creation of applications at the implementation stage.

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Furthermore, the existing storyboard is developed into a flowchart. A flowchart on the development of Augmented Reality is shown in Image 2.

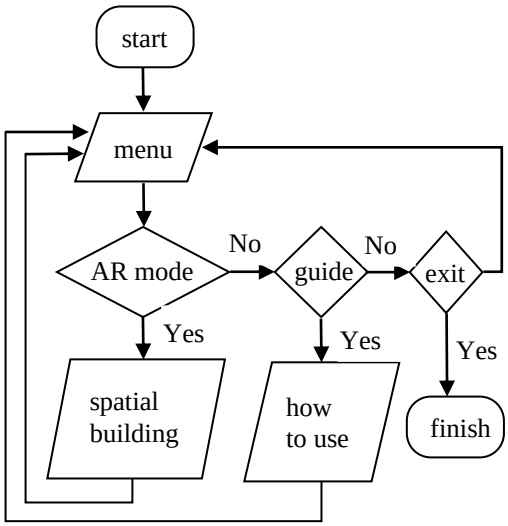

Image 2. Application Flowchart

At the implementation stage, some sessions must be carried out to obtain maximum results from the design that has been designed. The design derived from the results of the needs analysis will certainly facilitate the implementation process. The development of this Augmented Reality application uses the marker-based tracking method [21], as shown in Image 3.

The process of using Augmented Reality by providing markers that have been developed to display 3D objects. The card detection process begins by pointing the smartphone camera at the card that has been developed. When the position is appropriate, the camera will detect the card. The process of reading the card can be affected by the light intensity, the distance between the camera and the card, and the detection of objects that may block the card. If the camera does not detect the card, then the user must adjust the camera position or card position so that it works. This Augmented Reality application is declared successful if the card displays a 3D object of flat buildings drawn on the card.

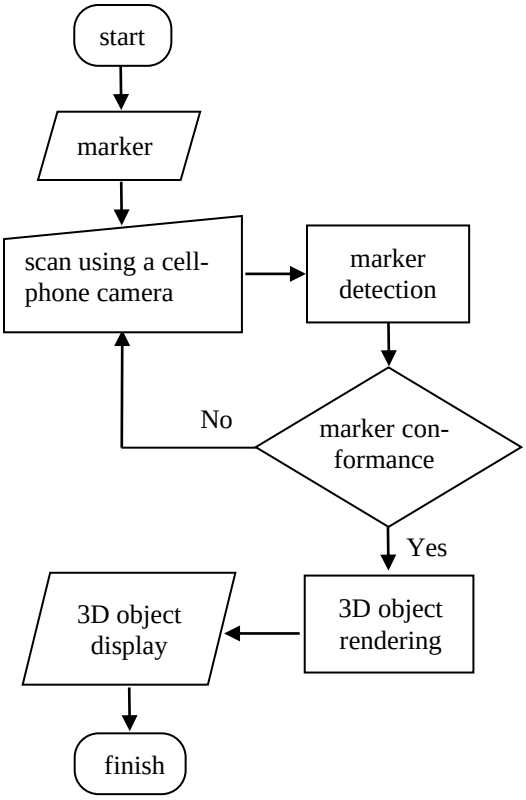

Image 3. Flowchart of Application Work Process

The results of the development of Augmented Reality to recognize these space buildings are that there are several menus, namely the main page and the 3D object page. The main page of this Augmented Reality has a "scan", "guide", and "exit" button, as shown in Image 4. The first user can learn how to use the application from the "guide" menu. Users who scan the card that has been developed can directly press the "scan" button. The results of the scan on the card are shown in Image 5.

On the 3D object page, there are several options, including the types of spaces, nets, and ribs. In the choice of spaces, there are several choices, namely

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Cube, Cuboids, Pyramid, Prism, and Cylinder. The next 3D object option is the rib option, as in Figure 6, and various forms of nets from the selected building space, as in Figure 7.

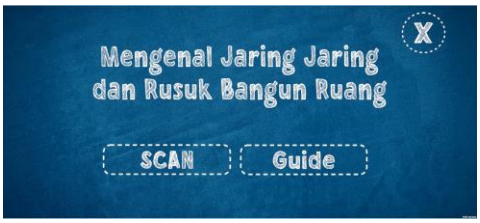

Image 4. Main Page

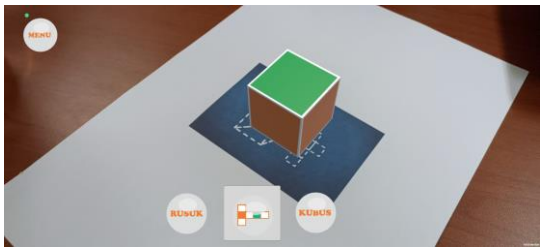

Image 5. Scan Display on The Card

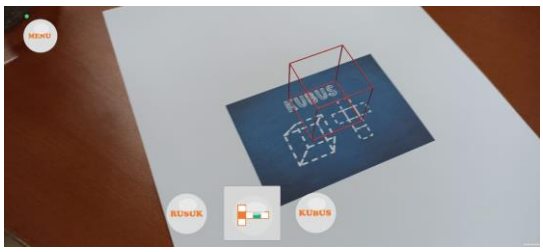

Image 6. 3D Object Display for Rib Shape

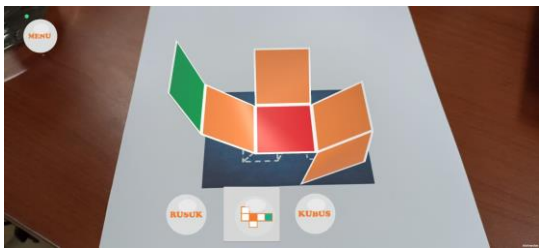

Image 7. 3D Object Display for Net Shape

Program Testing

Program testing is done to determine the shortcomings and suitability of the application against the initial design that has been designed. Augmented Reality mental Build Space is first tested using blackbox testing. Testing is done focusing on the resulting output. This blackbox test focuses on the function of a system that has been developed. The results of blackbox testing are contained in Table 1. The blackbox test results show that all menus can run well.

Expert Validation Test

To obtain application validation from experts, an expert validation test was conducted. Testing is done by three experts who are competent in their respective fields. Experts who test Augmented Reality applications know this

Table 1. Blackbox Test Results

No	Menu/Feature	Test Case	Expected Result	Test Result
1	Play AR	Click the play AR button	Enter the main page	Valid
2	Guide	Click the “Guide” button	Enter the “Cara Penggunaan Aplikasi” menu	Valid
3	Scan	Click the “Guide” button	Enter the camera menu on the smartphone to scan the card	Valid
4	Menu	Click the “Menu” button	Return to the main page	Valid
5	Exit	Click the “X” button	Exit the application	Valid

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Space Building includes Mathematics, Computer, and Educational Technology.

For Mathematics experts is a doctorate from Al-Wasliyah Nusantara Muslim University. For computer experts is a doctorate from Makassar State University. The Educational Technology expert is a Professor from Lambung Mangkurat University. The interpretation results of the three experts stated that the application of Augmented Reality recognizes the wake of Space is declared Very Good.

User Acceptance Test

The next test is carried out in the form of a User Acceptance Test (UAT). UAT aims to get responses and information from teachers about Augmented Reality, knowing the Space Buildings developed. UAT testing was given to three elementary school teachers from Yogyakarta.

From the results of UAT obtained information that overall, the respondent's response to Augmented Reality knows the Space Buildings developed obtained an average value above 4 on a scale of 5. This can be interpreted that Augmented Reality knows the Space Buildings developed got a very good response from respondents with an overall average of 85% of the three aspects of the assessment. However, respondents hope that there will be improvements to the media developed because on some devices, Augmented Reality recognizes Space Buildings is too large to exceed the width of the smartphone so that there are some images that are cut off and buttons that are difficult to select.

CONCLUSION

From the results of the development of Augmented Reality Knowing Space Buildings, it can be concluded that the Augmented Reality Knowing Space Buildings application was successfully developed. This is evidenced by the results of expert validation, which gives very good results, and the User Acceptance Test, with an average questionnaire value of 85% or very good. However, Augmented Reality recognizes that the Space Buildings that are developed still need improvement for use on some devices.

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