Augmented reality student worksheets for learning mathematics during the COVID-19 pandemic
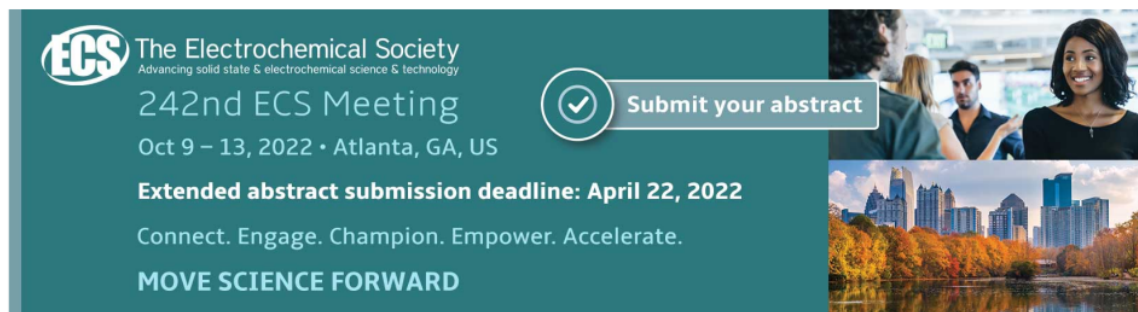
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Augmented reality student worksheets for learning mathematics during the COVID-19 pandemic

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Abstract. In the world of education there are new technologies, one of which is augmented reality. Digital component with real object can be combined, displayed interactively and real time, and it can be applied in space geometry learning. This research directs to design an augmented reality student worksheet for learning mathematics during the pandemic concerning space geometry. This research used a design research method namely the implementation and design stages. The design stage is focused in this research. Based on preliminary study at school, mathematics learning using learning media often assisted by learning management system . This application was designed by showing the user interface to make it easier, the 3D model is designed according to scientific learning for helping student to demonstrate mathematically the real problem featured. The design of problem based learning is creating some problems to encourage students to formulate a hypothesis through small group discussions to get solutions from the given problem, this model is assisted learning management system. Based on the result of the product feasibility test, augmented reality student worksheet is suitable to the use in problem based learning in school.

1. Introduction

The Covid-19 Pandemic has disturbed the learning process in a face-to-face manner [1]. Schools and Higher Education Institutions (HEIs) in Indonesia have been temporarily closed since March 14th, 2020 [2]. Public education institutions leader has implemented alternative methods to continue the learning since they are not possible to come to school [3]. In order to fulfill the right of students to get educational service during the emergency period of Covid-19, Ministry of Education and Culture of Indonesia has determined learning from home or remote learning. Teachers are required to be able to find ways to motivate their students in carrying out remote learning [4]. The establishment of remote learning is a challenge for educators to develop effective learning media for remote learning during the pandemic.

Development in technology have a significant influence in improving the quality of human life. The challenges of industrial revolution 4.0 which demands efficiency, digitalization, and automation, it provides a golden opportunity for those who are able to apply technology in various fields [5]. This development will help problems in various aspects of life, without exception in education. In order to be in line with the times and the character of students who are familiar with technology, teachers must be accustomed to using technology in learning [6]. Augmented reality can help to enhance students' motivation and interest in learning mathematics [7,8]. Augmented reality can be designed in remote learning because the content created can be displayed anytime and by anyone [9].

One of the competency dimension of education unit graduates is skill dimension. Students are required to have creative, productive, independent, collaborative and communicative thinking and acting

skill. To be able to create creative students, new learning innovation in education can be applied, especially learning innovation that have been recommended by education experts in order to meet curriculum demand. The use of learning resource can create children's creativity in learning process. Worksheet is expected to solve the problem faced by students in learning process. Therefore, the worksheet that is developed must attract the attention of students to read it and direct students to find mathematical concept. The Program for International Students Assessment (PISA) is a triennial survey assessment of literacy attainment in reading, science, and mathematics. In PISA 2018 mathematics assessment focuses on students' abilities in formulating, using, and interpreting. According to PISA 2018, Indonesia ranked 72nd out of 78 participating countries. The lack of student literacy skills is the cause of Indonesia's low PISA score. Mathematical literacy ability is the ability of the individuals to formulate, apply, and interpret mathematics in various context [10].

In addition, students also feel uncomfortable or even feel afraid in learning mathematics. This is also the cause of students' low math skills. [11]. The above, causes the low ability of students' mathematical literacy [12]. Therefore, it takes a concept of learning mathematics that is fun and not boring, among them namely learning by problem or so-called problem-based learning. In this learning, students are accustomed to solving real problems so that they are expected to be able to arrange their own knowledge and skill [13]. Digital technology can help teachers in mathematics teaching and learning process [14,15,16]. It is necessary to find out the potential use of technology for problem-based learning model, and to engage student as center of learning and teacher is only as facilitator [17]. Since the pandemic, problem-based learning can't be applied in classroom. So, that was applied in online learning environment or hybrid learning.

Hybrid courses consist of participants who are active in learning, not only passive listeners [18, 19, 20]. The concept of hybrid learning has become a lifelong learning concept or so-called Massive Open Online Courses (MOOC) [21]. This learning is available to all and does not have to come to educational institutions. MOOCs are education with the following characteristics: has a beginning and an end, emphasizes specific content, assignments and assessments, online based, free, and can be used by anyone [22].

In this study, an augmented reality application will be developed in a problem-based learning model. Augmented reality must be integrated with smartphones or other gadgets and to show virtual objects a marker is needed [23]. The problem-based learning model that assisted by augmented reality student worksheet is design to help students visualized the object in augmented reality application. Because of the need to improve students' mathematical literacy skills, interesting media were developed, one of which is augmented reality for problem-based learning. Early stage of development, an augmented reality student worksheet during the pandemic was design.

2. Methods
The method of application development in this study was used ADDIE model. Below are the steps of development.

Figure 1. Steps of development [24]

This study focused on the designing augmented reality student worksheet before they are implemented in schools. This stage consists of analyzing, designing, and developing. the product of this stage is an initial product that is ready to be implemented. The participant of this study were students from Islamic State Junior High School 3 Kebumen. The analysis stage consist of analysis of problem, learning components, and media development. The design stage

consist of determining the name and design of the application. The next stage was development consist of assessment by experts, teacher, and some students. Then, the final design of application can be applied at school. The assessment of the augmented reality student worksheet based on the criteria of Chee and Wong [25].

3. Results and Discussion

3.1 Analyzing of research equipment

At the analysis stage, several results were obtained. First, problem analysis. It was known that students prefer to learn mathematics based on problem. It is proven that students were more interested in learning with a problem-based learning model in space geometry where student can arrange their own knowledge and skill rather than only became passive listener. Then media development analysis, it was known that augmented reality plays an important role in remote learning because it can present manipulative teaching aids virtually at home, usually using physical aids. Students prefer using augmented reality for mathematics learning. Based on the results of analysis, it was known that the use of augmented reality was appropriate for Islamic State Junior School 3 Kebumen during the pandemic.
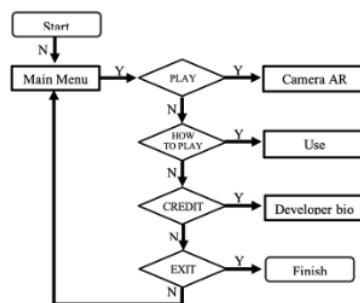
3.2 Designing of the application

Figure 2. Main menu flow chart

The name of this application is Space AR. The main menu consists of PLAY, HOW TO PLAY, CREDIT, and EXIT. The main menu flow chart is shown in Figure 2. In start menu, students can scan the marker contained in worksheet. Marker has designed properly so it can be scanned easily by application. It can show cube, beam, cube net, beam net, cube volume, and beam volume. In how to play menu there is ways to use the application and in the credit menu there is biodata from the developer.
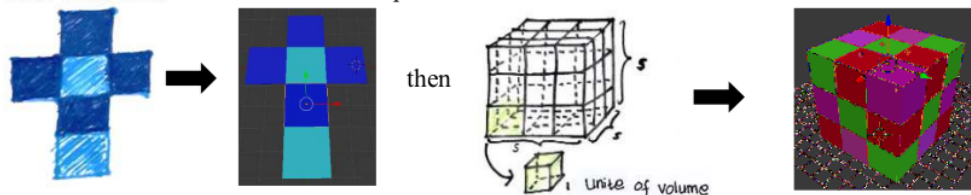

Figure 3. Realization of 3D concept

3D blender software was used to create 3D objects that have been designed according to a scientific approach. Figure 3 show the model to find the surface area and volume of the cube formula. Then the marker design for each 3D model was made different. This is to make it easier for students to scan these markers and minimize scanning errors.

3.3 The Development of the learning instrument
The result of the design that has been made is called the initial product. Unity 3D software is used to develop this application. Figure 4 represents the main menu and augmented reality features.

Figure 4. Display of application

The application as a companion of student worksheet. The student worksheet serves to answer the question related to the result of student observations of the augmented reality student worksheet. To make it more interesting, the student worksheet changed to google form. The augmented reality trial was conducted at Islamic Junior High School, 4 students were taken as the sample from 8I class. Figure 5 show the example of augmented reality worksheet for surface area of cube.
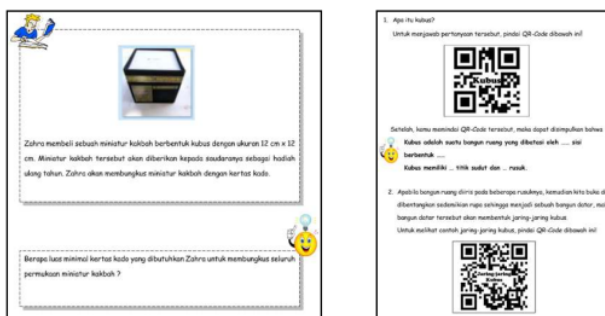

Figure 5. Augmented reality student worksheet

Then, students fill out the assessment to find out their responses about learning using the augmented reality student worksheet. The respondents of this study consist of mathematics expert, media expert, teachers, and 4 students obtained grades for all aspects. After all respondents have responded, the results are recapitulated. The recap results are as below.

Table 1. Assessment

No	Aspect	Score	Category
1	*Appropriateness*	5.00	Very Good
2	*Accuracy, Currency, and Clarity*	4.77	Very Good
3	*Screen Presentation and Design*	4.76	Very Good
	Total	4.84	Very Good

The appropriateness aspect obtains 5.00 means that has a very good rating. The material presented in augmented reality student worksheet is good, it is suitable to core competencies and basic competencies. The indicators are also appropriate with the core competencies and basic competencies chosen. The accuracy, currency, and clarity aspect get 4.77 means that has a very good rating. The use of augmented reality student worksheet suitable with the material chosen that is space geometry, this application is also suitable with the times, which is currently starting to develop the use of smartphones in learning moreover in pandemic. The commands / instructions in the application are also clear. The screen presentation and design aspect get 4.76 means that has a very good rating. This value indicates that the presentation and screen design aspect of the augmented reality student worksheet are very good. The colour composition and accuracy of the background selection in this application looks interesting. From the result of the four responses review, it was found that in application need material/theory for surface area and volume of cube and beam. This application can run well on smartphones with at least 1GB of RAM and an operating system of at least Android Jellybean 4.1.

Due to the Covid-19 pandemic, learning process at Islamic Junior High School 3 Kebumen was carried out online through a platform. In line with the MOOC characteristics there are has a beginning and an end adjusting the stages of problem-based learning, emphasizing specific content that is space geometry, assignments using augmented reality student worksheets, online based using a platform, free, and can be used by anyone. There are five stages in the problem-based learning model. The first is provide orientation about the problem to students through augmented reality student worksheets. The second is organizing students to research problems in the augmented reality student worksheets and being given the opportunity to ask questions. The third is to assist independent or group investigations. At this stage, students try to collect the right information with the help of augmented reality technology contained in the augmented reality student worksheets. In accordance with the theory of Hybrid courses that the participants more active in learning, not only passive listeners. The fourth is developing and presenting the work, students and their groups carry out a mathematical literacy process to solve the problems presented in the augmented reality student worksheet after getting the solution to these problems, students present it through a platform. This fourth stage is the most dominant stage in improving students' mathematical literacy skills because in this stage a mathematical literacy process is carried out which is highly dependent on seven indicators in mathematical literacy. The final stage is analyzing and evaluating the problem-solving process, students who have the same or different solution are welcome to provide feedback, comments, or questions. Then the teacher confirms whether the problem is true or not.

Mathematical literacy skills are measured by mathematical literacy test instrument. assessment is carried out before and after learning (pre-test and post-test). Based on the post-test result, students' mathematical literacy skills using the problem based learning model combined with augmented reality student worksheets reach the completion individually and classically. And based on the N-gain value, it was found that the use of augmented reality student worksheets in problem based learning model can improve students' mathematical literacy skills in the medium category. This is in accordance with the results of previous research that are with augmented reality, students can independently find mathematical concepts and can be used as a learning media to help teacher and students in the learning process of mathematics [26], augmented reality technology able to improve learning outcomes and student interest in the learning process at all age levels [7], and augmented reality can increase student involvement in improving mathematical literacy skills [27].

4. Conclusion

Based on the results and discussion, can be concluded that the augmented reality student worksheet appropriate to be learning media in learning mathematics expecially space geometry. Before augmented reality student worksheets can be implemented in learning activities at school, augmented reality should be revised according to the respondents' suggestions. Based on the post-test result, problem based learning model combined with an augmented reality student worksheet reach completion individually and classically also can improve students' mathematical literacy skills in the medium category.

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FINAL GRADE

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GENERAL COMMENTS

Instructor

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