Augmented reality application: What are the constraints and perceptions of the students during the covid 19 pandemic’s 3D geometry learning process?

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Abstract. The Covid 19 epidemic has altered the interplay of the classroom learning process. To facilitate the learning process of 3D geometry, secondary school teachers adopt several technology items. Augmented reality technology is one of those technological goods. This study therefore aims to explain the constraints and perceptions of secondary school students during the COVID-19 pandemic, during the 3D geometry learning process. This study used a qualitative research design descriptive of it. The number of participants to this study was five, namely 3 male students and two female students. Techniques for collecting data using sheets of observations and interviews. Although data analysis by Miles and Huberman [1] adopts data analysis, which consists of data selection, data reduction, data presentation and conclusions or verification processes. Study results show that there are still many challenges faced during the learning process using augmented reality technologies, namely: (a) Constraints when downloading the program on the cellphones of the instructor and the pupil. (b) Marker constraints pertaining to AR identification. (c) Constraints on the student's smartphone requirements. (d) Limit and network restrictions for accessing the Resources section. (e) Students found too many constraints on appraisal questions on the test checklist. While several challenges do remain, the majority of the students have a good understanding of the learning experience using augmented reality technologies.

1. Introduction

The Covid 19 epidemic is motivating teachers to integrate technology into the learning process [2]. Teachers use many of the technological products starting from mobile or online [2], digital learning [3] and using WhatsApp Group [4]. Not all technology items, however, can be implemented and applied to help teach those materials, particularly material with 3D geometry. The Augmented Reality (AR) technology is one of the digital-based learning, which can help teach 3D geometry during the COVID-19 pandemic.

AR technology has been used in the learning process of education [5]. There are three characteristics of the AR technology system, namely 1) combining physical and virtual objects; 2) interactive, and 3) can bring up animated 3D objects [6]. Furthermore, the benefits of AR technologies will promote cooperation between teachers and students in the learning process [7], develop spatial skills [8], increase student learning outcomes and attitudes [9], [10], enhance student comprehension of 3D geometry
concepts [11], and prospective mathematics teachers [5], [12]. Thus, AR technology is able to bridge teachers and students' learning experiences, especially in learning 3D geometry.

Researchers such as [13] who highlighted the effect of using AR on the mathematical efficiency, motivation and anxiety of the students during the learning process conducted recent studies on the use of AR in learning. Also a study [14] uses AR in studying the 3D geometry. In the meantime, [15] the effect of using AR on achievement in mathematics and visual perception was studied. However, there is no research that focuses on studying 3D geometry to explain the limitations and experiences of secondary school students.

The constraints in using AR technology are defined in the context of this study, beginning from the constraints of planning, implementation, and assessment. Meanwhile, students' views of the students' expectations of AR application content, the method of using AR apps, and AR applications-assisted assessment were shown.

2. Methodology
This research qualitatively explains the limitations and experiences of high school students during the learning process of 3D geometry. The research participants were 5 students from one of Indonesia's private schools. Three male students and two female pupils aged 13-14. Five students involved in this study agreed and volunteered to take an active part in the learning process of 3D geometry. Using observation sheets during planning, installation and assessment, to document the limitations encountered by students when using the augmented reality program. In this study, data collected by observation and questionnaires were evaluated through the method of coding by which the results. The reduced data is then viewed, summarized or re-checked [1]. The interface architecture for AR applications as shown in Figure 1.

![Figure 1. Augmented Reality Application Menu](image)

3. Result and Discussion
a. Result
Constraints During the Learning Process
This research concerned students and teachers using the AR application. The Augmented Reality Software can be used and accessed by downloading teacher and student owned smartphones on each. Based on the results, it would appear that when the teacher uses the application, there are no major hurdles. Except that, the challenges that were faced when the AR application was installed on the teacher's smartphone. This is because the AR application is still not submitted to the Playstore. The
installation phase of the AR application starts from the application file as format (Apk) sent through the WhatsApp number of the teacher. The files which were sent are then downloaded and stored in the memory of the smartphone. This will be mounted on the smartphone as it is stored in the new smartphone memory. Based on the findings of the interview, it was discovered that the teacher argued that the use of AR applications in studying geometry, especially cubes and blocks, was very useful and very interesting in helping to express mathematical concepts, although there were difficulties in the implementation process.

Another thing is that any student interested in this study already has a smartphone, so they don't find the smartphone challenging to use. Much as the teacher had faced challenges during development on the smartphone. It was shown at the first meeting where learners were already puzzled and this was the first time that the application was used in studying. Students are confused to use the menu on offer. Some students press on the AR tab straight away, others immediately press on the evaluation menu. If students start to get confused, the teacher aims to illustrate and explain how the menus function. The students are asked to try using the program once they understand the teacher's description. When a document in the shape of an AR marker was presented by the teacher. There was one student, though, who was uncertain about the current markers being identified. This is because the student does not concentrate on the camera being aimed at the dot. This causes that the animation of the 3D geometry entity does not occur in the AR menu. Additionally, some students are constrained to open the long-connected AR menu to the marker object.

Students were welcomed back to open the material menu found in the application at the next meeting after the teacher explained the 3D geometry material. Since the usage of this application has to be linked to the internet network, therefore, we must have quotas so there is no wifi. This is a challenge since most students do not have the quota to open an overview of the YouTube content that is linked from the AR application's content menu. Another challenge is the clarification of the content on the application's information menu, the sound is very small while the volume is complete. As a consequence, we have to put our smartphone closer to the ear, it doesn't concentrate on describing the picture shown by the application. Furthermore, since the sound is very weak in the material explanation, and the surroundings of the class are not silent, it results in not concentrating on listening to the material explanation. Other challenges are due to the missed network on some cellular cards aside from being limited by quotas. This results in a long charging period when the content is opened in the AR application.

At the last meeting students were asked to open the evaluation menu on the AR framework at the evaluation stage. The teacher presents the evaluation menu with guidance and details, but some students are still restricted to selecting the content to be completed by students. Students do not realize in the test menu that there is a time and ranking provided after students can answer multiple-choice questions from A to D. In comparison, with the amount of questions on the test menu, students are limited to managing time. Students assume that there are so many questions answered, whereas the time given is just around 60 minutes. This is what makes a lot of students do not perfectly do the issues.

Perception by Students

Interviews (W) of five students were performed to see the experiences of students using scientists. However, owing to some reasons two students were able to be interviewed, namely one male (L) student and one female (P) student. The subject of the interview is aimed at explaining student expectations related to student expectations of the AR application content, the method of using AR apps, and assessment using the AR application. Excerpts from the interview are below:

1. Male Student (M)
   W : Have you ever learned to use applications for AR?
M : I've never learned using AR apps. Learning only from the WhatsApp Group class during COVID 19.

W : Have you expressed an interest in the menu content of the AR application?
M : I think this program is cool, since it explicitly shows objects.
W : Can the learning process help you understand the principle of 3D geometry using AR applications?
M : I understand a bit, it's just that I have issues accessing video content in the material menu in my quota.
W : Does the appraisal menu in the AR program help you test your ability to understand the principles of 3D geometry?
M : I think the problem is already young at the beginning, but at the end, it gets harder. The period is limited, and is also missing.
W : Does it inspire you to study 3D geometry using AR applications?
M : The technology will hopefully be used for other products.

2. Female Student (F)
W : Have you ever learnt to use mobile for AR?
F : Previous teachers have never used maths research apps.
W : Has the menu material become of concern to you in the application?
F : Interestingly, the show is just not fine.
W : Can the learning process help you understand the principle of 3D geometry using AR applications?
F : Helps research, especially if done at home.
W : Does the appraisal menu in the AR program help you test your ability to understand the principles of 3D geometry?
F : In reality, the questions posed in the assessment menu are not too challenging, it's just that there are too many questions.
W : Does it inspire you to study 3D geometry using AR applications?
F : I am inspired to open a more materials menu.

Students have a clear perception of the AR program and its use, based on extracts from interviews with male students and female students in general. It is only that, by using the program, students face several problems. The positive impressions of this application by students can be seen from the students' behavior to be interested and to obey any direction given by the teacher of the class.

b. Discussion
The findings based on observations during the learning process using the AR application indicate that the use of the AR application for studying 3D geometry still faces many obstacles. The first challenge was faced when the program was mounted on teachers and students' smart phones. The second barrier relates to the presence of AR inside the symbol. When the smartphone camera was aimed at the image, some students reported problems when detecting markers. The third challenge is linked to the requirements students have for smart phones. Students with good memory and speed specifications have no major issues, but vice versa, these restrictions are faced by students with weak memory and speed specifications. The fourth challenge to accessing the Content menu is related to quota and network.

This is because the menu of products absorbs a considerable amount of money in combination with the instructional videos on YouTube. For students, that becomes an obstacle. The fifth hurdle refers to the assessment questions provided in the examination menu that are perceived to be too many by students. This is because the length of the review is just 60 minutes, although the questions are 15 questions in all. The restrictions faced by using AR applications are consistent with what [16] said in current AR research that monitoring and registering is one of the most essential and yet available challenges. Also with new technology, such as the hybrid Global Positioning System (GPS) [16], monitoring particularly in outdoor environments is still difficult to achieve. The content of AR applications related to merging physical and virtual objects can be challenging as students face difficulties in manipulating 3D animation and reality [17]. The constraints of the students when
cognitively using AR applications will cause overload due to the vast amount of knowledge they learn [17]. In addition, the material available by AR applications is frequently inflexible, restricting the teacher's power over the curriculum and preventing modification to meet student needs [17]. This could also take time for users to become acquainted with and relaxed with AR technology [18].

While there are so many barriers to applying AR applications, students offer a good view of integrating AR applications in the course of learning the 3D geometry. This is in line with the findings of research [19], which concluded that it gave a favorable outcome based on the average score of student expectations of the use of augmented reality. Furthermore, [19] based on the findings of this analysis revealed that the impressions of augmented reality by students and teachers showed a high mean score and was graded as very favorable. In comparison, learners contend that virtual reality assists them in the sense of imagination [19].

4. Conclusion
This study concludes that there are five barriers that teachers and students face in using AR programs, namely (1) limitations when downloading the program on the cellphones of the instructor and the student. (2) the second challenge has to do with the identification of AR in the marker, (3) the restriction has to do with the student's cellphone requirements. (4) limit and network restrictions for accessing the Resources menu. (5) Constraints pertaining to the assessment questions found in the assessment menu that are perceived to be too many by the students. While several challenges remain, throughout the COVID-19 pandemic teachers and students had good perceptions when implementing AR applications during the 3D geometry learning process. This analysis thus means that the use of AR should be seen as an approach to teaching geometry content in secondary schools.

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