Need Analysis of Augmented Reality Based Virtual Laboratory for Chemistry Practicum Purposes

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Abstract. To keep following the Covid-19 protocol, students are not recommended to take courses on campus. As a result, they are not able to do essential lab work as usual. In this paper, we address the early stage of the developing process of an Augmented Reality run on Android devices to help students understand the theoretical framework of atoms. The need analysis was conducted to acquire the teachers‘ and students‘ thoughts toward the development of the AR. The questionnaire was developed based on the Likert scale. 113 respondents including students and teachers volunteered and filled the online questionnaire. The results show that most respondents agree that the AR application is needed for online practicum and they are willing to support and use the application. Android platform is prefered over other platforms, and the concept of atom and molecule was chosen by the vast majority of respondents. Therefore, the AR application about atom will be developed on the Android platform.

Keywords: Augmented Reality, Virtual Laboratory, Chemistry Lab

1 Introduction

The demand for digital resources in the current learning environment is increasing more significantly due to the online learning process conducted by almost all education institutions all over the word [1] . The students either at the university or at high schools are not suggested to attend the class in order to avoid Covid-19 infection. As a results schools or universities have to provide online learning system that support the learning process at any cost. The online learning or distance learning required not only internet access [2] but also adequate learning resources [3] to ensure that students are capable of mastering certain coursworks in their field of study.

Practical work in chemistry is important not only because the practical work is utilized to prove the theoretical knowledge of Chemistry, but it is also essential for students to increase their hard skills. However, since the Covid-19 attack, online learning systems have been widely introduced all over the world. In order to support the online learning environment, Augmented Reality (AR) technology has become a very promising platform for students to be used as a learning tool. The AR technology has been extensively used in the field of medical [4], geography , robotics [5], [6], drug development[7] , medical operations [8], and architecture [9]. Furthermore, the AR has also been widely used and implemented in education as reported by many researchers and educators [10]–[14]. In the field of chemisty education, the AR

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technology has been intensively developed for particular concept like molecular geometry [15], molecular interface [16], and general chemistry course [13], [17]. In this paper, we report the on going development of AR application for several concept in chemistry especially the concept that can be used in practical work in the virtual laboratory.

2 Research Methods

The AR app is being developed through the Research and Development (R&D) which adopts the ADDIE model. The first stage of the development process is need analysis which will be further described in this article. 113 respondents including teachers and students took part in the survey, and the demograpy is depicted in Table 1.

Table 1. Demography of respondents

No	Criteria	Sub-criteria	N
1	Sex	Female	95
		Male	18
2	Profession	Student	65
		Teacher	44
		Other	3
3	Age range (Year)	15-25	59
		26-36	20
		37-47	20
		48-58	5
		ERROR	9

The online questionnaire consisted of 13 items (11 items in the Likert form, and 2 items in a regular multiple choice) were created by using a Google form and delivered to the respondents through a Whatsapp group. The questionnaire results were then collected after 3 weeks and was then analysed.

3 Result and Discussion

Virtual applications are now in a great need due to online learning popularity not only in developed countries like UK, Germany and the US, but also in developing countries such as Indonesia. The survey results indicate that most educators and students have never used AR applications in learning even though the majority of them know about AR as depicted in Table 2.

Table 2. Teachers and Student responses toward the need for AR applications

No	Response Questions	SA	A	NAD	DA	SDA
1	In my opinion, practicum is important in studying chemistry	107	5	1		
2	Practicum helps students in understanding chemical concepts	108	5			
3	Virtual Chemistry Practicum (Online) is needed during the Covid-19 Pandemic	88	22	1	2	
4	Learning resources for online practicum are still limited	55	41	14	3	
5	A special application for online practicum is very much needed	98	12	3		
6	I know about Augmented Reality (AR)	22	30	25	19	17
7	In my opinion, AR applications are very good for practical use	71	36	6		
8	I believe that AR applications can help students in doing chemistry practicum virtually	81	28	4		
9	I have used the AR app	17	17	18	24	37
10	I support if anyone develops AR-based Virtual Lab applications	98	14	1		
11	I am willing to try the AR application	113				

SA=Strongly Agree, A=Agree, NAD=Neither Agree or Disagree, DA=Disagree, and SDA=Strongly Disagree

When asked about their opinion about how important is the practical work in learning chemistry and the role of practical work in comprehending chemistry, most of them strongly agree that the practical work is essential for students in mastering chemistry concepts. In current situation where physical attentance of students in the class room for practical work is not recommended, a virtual simulation become very important for learning. When asked about whether online resources for chemistry practicum edequate or not, most respondents agree that it is available but limited in number.

Based on literature exploration, most of the online or virtual resources for practical work is dominantly available in English. Because English is a foreign language in Indonesia, it is quite difficult for students to follow the steps provided by developer of the virtual simulating program of a practicum. Therefore, virtual resource for practicum especially in chemistry concept is essential to be developed.

Furtermore, because an AR app usually requires many big file of 3D, it is necessary to break out the particular concept to be developed. In this work therefore, after deep analysis, we selected some particular concepts to be included in the app as depicted in Figure 1.

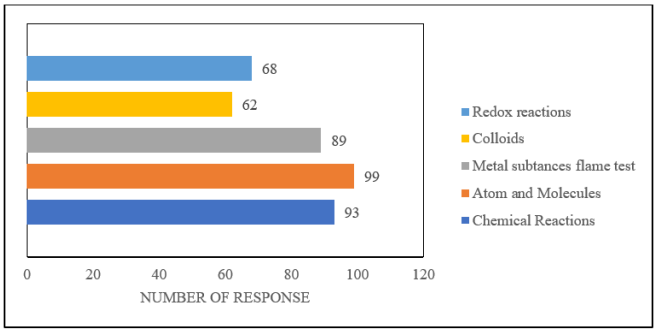

Fig.1. The concepts chosen by respondents to be included in the content of the AR

When asked about what concepts should be included in the AR app, majority of the respondents suggested the concepts of atom and molecule, chemical reactions, and metal substances flame test more dominantly compared to colloids and redox reactions. The concept of atom and molucule is an interesting concept in chemistry that could promote students learning motivation increase. Therefore, in this work the concept of atom and molecule will be further included in the AR app.

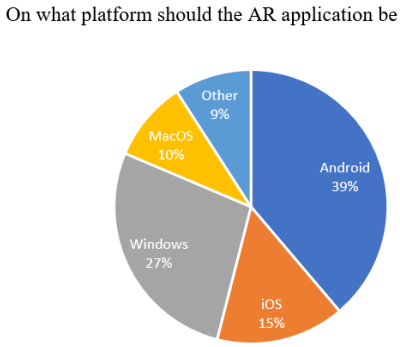

Fig.2. Different platforms of development suggested by respondents

Fig.2 depicts the platform's preferences where the AR application should be developed according to respondents. Android OS and Windows are the two platforms that are dominantly chosen by most respondents. However, 39% of respondents prefered Android for its practicality over Windows (27%). Android dominates the global smartphone operating system market share and more than 72% of the world's population uses Android devices based on the data of last year.

4 Conclusions

To conclude, because most respondents show their interests in the development and the results of AR and based on their response regarding both prefered concepts and platforms, the

AR based virtual lab will be developed on Android platform for several concepts of Chemistry including Atom, Chemical Reactions, and metal subtances flame test.

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