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Making Android-Based Augmented Reality in Buffer Solution Practicum to Improve Students Multiple Representation Ability

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Abstract: This study aimed to develop android-based augmented reality multiple representation in buffer solution practicum. The research wants to describe the appearance, analyze results of the validation test and feasibility test of android-based augmented reality in buffer solution practicum, which is named Augmented Reality of Buffer Experiment (ARBE). The research was conducted using the Design Based Research (DBR) method which consisted of the analysis and development stages. The subjects of this research were two lectures of chemistry education, one lecture of informatics engineering, one teacher of chemistry, for validation test and 31 high school students of eleventh grade of nature science program for feasibility test. This research use a validation test and feasibility test instruments. The display on ARBE present a practicum menu and also five other menus completes the practicum menu. The results of the validation tests obtained an average value of rcount 0.85 and was declared valid, while the feasibility test obtained an average percentage of 82.14% indicating that android-based augmented reality in the buffer solution practicum to improve student's multiple representation abilities is very feasible to use as a learning medium for buffer solution material.

Keywords: Android-based media; Augmented reality; Buffer solution practicum; Multiple representations; Virtual laboratory

Introduction

In 21st century there are three skills that must be possessed, namely ICT skill, life and career skill, and learning and innovation skill (Usman et al., 2021). So, for increase the skills which needed in 21st century, learning is must to combining skills, knowledge abilities, behaviors, and mastery of technology (Dakhi et al., 2020). Chemistry is one part of science which is obtained through a process of observation, research and experimentation. Chemistry can developing students' curiosity of scientific phenomena around them, developing knowledge and understanding science consept in daily life by being trained to find facts and concept that are studied so that students can have 21st century skills (Astuti, 2020; Sujono et al., 2023). One of methods can used in chemistry that support 21st century skills is practicum.

Practicum is one of the learning methods that can be used to integrate the knowledge, skills, and attitudes of students (Sobandi et al., 2017). In practical activities, there are experiment activities that can answer the questions contained in the phenomenon natural about structure substance, a natural substance, composition matter, transport, energetics, and dynamics substance (Atrisman et al., 2017). By practicum, students are better how to use practicum tools, better understanding the material, increasing analytical skills and covenying information (Lestari et al., 2021). In reality Setiadi et al. (2012) and Setiawaty et al. (2023) founds that many students didn't have any chance for doing practicum because of there are some schools which not have a laboratory room, lack of availability in tools and materials, expensive chemical, lack of lesson hours, and lack of teacher awareness about the importance doing practicum. Furthermore, there is a phenomena makes

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almost all kind of activities including learning activities have to be done by online named COVID-19 pandemic (Danin et al., 2023). Since the COVID-19 pandemic has happened, practicum activities at school could not be implemented (Sugiharti et al., 2020). When COVID-19 pandemic subsided, learning activities can be done by blended learning concept. Blended learning is a learning system by face to face and online simultaneously (Setyoko et al., 2023). It makes learning can be carried out anytime and anywhere. Meanwhile, blended learning also have challenges namely, internet signal, students economic condition and practicum activities during the online learning (Herliani et al., 2023).

Multiple representation is an instrument as a facility for meaningful learning and for developing scientific knowledge by representing a phenomenom . Gilbert and Treagust said multiple representations play a key role in chemistry because there are sub-macroscopic in multiple representations that explain changes in subtances that do not exist when direct observation is carried out (Adadan, 2013). There are three levels in multiple representation including macroscopic, sub-macroscopic, and symbolic representation leverls . Macroscopic representation is representation that obtained from direct observation of an event, sub-macroscopic representation is representaion that explain phenomena that occur microscopoally such as electron tranfer, atomic, etc, and symbolic representation can be qualitative such as reaction equations, chemical formulas, and other (Safitri et al., 2019).

The theory of solution buffer has a concept that requires observation directly by students so that could improve their understanding of the theory (Santhiy et al., 2015). It is still found a number of misconceptions about the theory of solution buffer as students can not differentiate between buffer and non-buffer solution, do not understand the principle of buffer solution, and how to make buffer solution (Hidayah et al., 2018). To solve this, it is required to learn to use chemical representations (Kamila et al., 2018). Chemical representation by visualizing three kind of representation; macroscopic, sub-microscopic, and symbolic can increasing student's understanding (Sukmawati, 2019).

In 21st century delivery of material in learning should be using a technology, one of the way is is the use of Microsoft PowerPoint in the classroom, but this technology still places the role of students in the learning process as a passive element (Kamelia, 2019). To make an active learning we can use virtual laboratory. The virtual laboratory is a learning media utilizing technology that can be a medium to conduct practicum as if it was real (Arsyad, 2020). It can make students more active, and can upgrade motivation learning (Nurrokhmah et al., 2013). In addition, virtual laboratories can improve students^ mastery of concepts and cognitive learning outcomes (Sari et al., 2019). There is a technology that has potential in learning chemistry, namely AR (augmented technology reality) based on an android system that is able to display three-dimensional objects so that they look like real (Irwansyah et al., 2018). AR technology can show indicators of macroscopic and submicroscopic (Billah et al., 2018) is also symbolic with a wider scope (Malihah et al., 2021). Based on the background that has been described, the researchers developed virtual laboratory learning media using augmented learning media reality in the buffer solution practicum. With this learning media, students can have an experience doing practicum because it can do everywhere and every time.

Method

The method used was Design Based Research (DBR) which has four stages, namely problem analysis by researchers and practitioners, solution development with a theoretical framework, solution testing, and evaluation, and product documentation and reflection to create design principles (Alghamdi et al., 2013). There are two stages in the research, namely problem analysis and solution development. The research procedure can be seen in Figure 1.

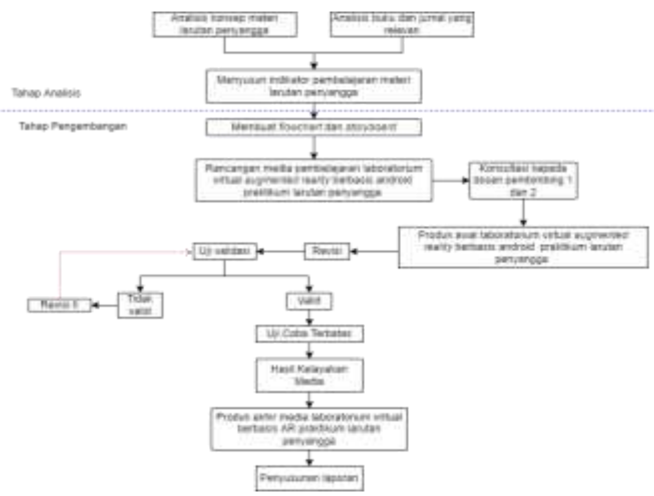

Figure 1. Trial procedure

Analysis Stage

Before the learning media was developed, an analysis of the problem topics was carried out in related journals. Furthermore, concept analysis, concept map analysis, indicator making, material collection on buffer solution material referring to KD 4.13 2013 curriculum, and selection of software to create learning media were carried out.

Development Stage

At this stage, an application display design was made which was visualized with a storyboard and a flowchart design for application usage is visualized with a flowchart. Then an android based augmented reality virtual laboratory application was created. The augmented reality laboratory was made by using adobe illustrator for made user interface of application, visualstudio code for made algoritm and coding it, and unity 3D pro for assembly the algoritm, coding, and user interface. After the application is completed, a media validation test is carried out. After revisions were made to the media, then a limited trial was conducted on students.

Sources of data for the validation test were obtained from a chemical teacher and three expert lecturers in the fields of education and media as validators and the feasibility test it was obtained from 31 students of class XI IPA SMAN 2 Setu District, Bekasi Regency through a limited trial. The data obtained from the validation test and limited trial were analyzed by giving a score for each answer obtained based on table 1.

Table 1. Score Information

Score	Information
1	Strongly disagree
2	Disagree
3	Neutral
4	Agree
5	Strongly agree

The total score of each validator was calculated and then compared with the critical value. The observed object can be said to be valid if it exceeds the critical value of 0.30. The formula used to calculate the value of validity (r) show on equation 1:

$$r = \frac{x}{N.n} \qquad (1)$$

Information:
r = feasibility value
x = weight of respondent's answer
N = maximum score
n = number of respondents

The data from the limited trial results were calculated to get the percentage of eligibility. The percentage of eligibility is then interpreted according to the table of eligibility criteria (Hera et al., 2014) in table 2. The percentage of eligibility is calculated by the formula shown on equation 2:

$$\% = \frac{total\ of\ obtained\ score}{maximum\ score} \times 100\% \qquad (2)$$

Table 2. Eligibility Criteria

Percentage	Eligibility Category
81% - 100%	Very Feasible
61% - 80%	Feasible
41% - 60%	Quiet Feasible
21% - 40%	Less Feasible
0% - 20%	Not Feasible

Result and Discussion

The result of this study is an android-based augmented reality application of buffer solution practicum, the results of the validation test, and the results of the feasibility test of the application. The appearance of the application is made according to the storyboard that has been created. The application is named augmented reality of buffer experiment (ARBE). The name is explain that this media will show about an experiment of buffer solution in the form of augmented reality.

ARBE APP

Figure 2. AR markers

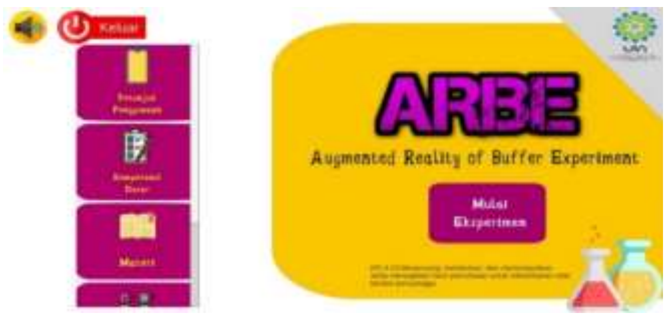

Figure 3. Main menu display

On main menu of ARBE application there are the logo of creator's university, information of basic competencies that have to achive by user, and music button to turn on and turn off the music. Music is used in the application aims to increase enthusiasm, focus, provide relaxation, have fun, stimulate experiences, provide relaxation, determine the theme of the day, and build relationship (De porter in Supradewi, 2010). On main menu there is also exit button to exit the application. ARBE application consists of six menus, namely the general instructions menu, basic competencies, materials, start experiment, quizzes, and compiler profile, as shown in Figure 3. The material menu, start experiment, and quizzes can only be opened sequentially. To run the practicum, users are required to use the markers in Figure 2 to display 3D objects.

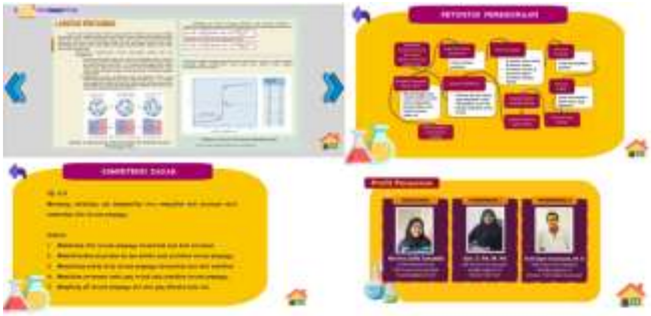

Figure 4. Display of material menu, instructions for use, basic competencies, and compiler profile

Figure 5. Start experiment menu display

Figure 4 displays the content menu, user manual, basic competencies, and compiler profiles. The material menu consists of discourses and animated videos of the working principle of a buffer solution. Learning using animation can increase students^ interest in learning and help students understand the concept (Eli et al., 2018). The display of the experiment start menu is shown in Figure 5. This menu can only be opened after the user opens the material menu so the students will have the provision of information to relate the information obtained after experiment. This is in line with Ausubel's learning theory which in meaningful learning students are asked to link the knowledge that students already have with information so that it can produce a complete understanding of the material (Gazali, 2016). In this menu, there are three experiments available, namely the acetic acid buffer experiment with sodium acetate, the ammonia buffer with ammonium chloride, and the sodium chloride solution. In each experiment, information is provided regarding the Material Safety Data Sheet (MSDS) of the materials used and the experimental procedures to be carried out. On the practicum page, three aspects of multiple representations are shown. Macroscopic aspects are visualized in the form of 3D objects, submicroscopic in the form of molecular animations contained in 3D objects, and symbolic in the form of reaction equations for each reaction that is being carried out. Implementation practice should be done coherently in accordance with procedures listed to avoid the occurrence of error so that users should repeat the practicum.

Figure 6. Quiz menu display

Figure 6 shows what the quiz menu looks like. It questions about practicum that has been done. The Quiz menu only can be open if the user has already opened the start experiment menu. It is available three group questions according to the experiments that have been carried out. Multiple representations used in the quiz are macroscopic, submicroscopic, symbolic, macro-symbolic, and sub-micro-symbolic.

Validation is done by showing the media created and providing sheet questionnaire validation as an instrument of media assessment to the validator. The results of the validation test can be seen in Table 3.

Table 3. Validation Test Result

Aspect	R_{count}	R_{crital}	Result
Visual	0.84	0.30	Valid
Software	0.87	0.30	Valid
Suitability desciption of materials and procedure	0.83		Valid
Language Structure	0.85	0.30	Valid
Multiple Representation	0.80	0.30	Valid
Presentation	0.90	0.30	Valid
Average	0.90	0.30	Valid

Based on Table 3, the highest test result value is presentation with 0.90. If the value is bigger than rcritical of 0.3 then could be said to be valid (Hera et al., 2014). A teaching material must be raise user interest to use the teaching material (Delvia et al., 2021). The whole validation results of android-based augmented reality media on buffer solution to upgrade ability of students' multiple representations obtained rcount of 0.9 and declared valid with some suggestions for improvements to the material menu, quizzes, and start experiment.

The feasibility test was carried out to get responses from students regarding learning media that was made after students installed media applications on student devices and tried to use the media independently under the supervision of researchers. After that students were given an eligibility test questionnaire to assess media. The results of the feasibility percentage of the limited trials carried out can be seen in Table 4.

Table 4. Feasibility Test Result

Aspect	Skor	Max Score	Precentage	Result
Material substance	386	465	83.01%	Very feasible
Language Structure	514	620	82.90%	Very feasible
Media	850	1085	78.34%	Feasible
Benefit	392	465	84.30%	Very feasible
Average			82.14%	Very feasible

Based on Table 4, feasibility test results with the highest percentage is benefit aspect of 84.3% with a very feasible category. Indicators on material aspect namely android-based augmented reality media on practicum buffer solution to improve students^ multiple representation ability could grow study motivation of buffer solution theory, can upgrade multiple representation ability, and can overcome problem practice in real.

Results of the feasibility test with the lowest percentage is media aspect of 78.3% which is categorized as feasible. The indicator with the lowest value in the media aspect namely augmented reality on media works properly. It is because, during the limited trial, students feel really enthusiastic to try augmented reality practicum on the app so that make students did not notice the instructions. Implementation of practicum should be done coherently in accordance with the procedure listed. Implementation of a practicum that does not coherent in accordance with the procedure could cause augmented reality becomes an error so the student should repeat the practicum.

Overall, the results of the media feasibility test are categorized as very feasible with an average percentage is 82.14%. This is line with research of Rahmi et al. (2023) which reported that reaction rate lab media in basic chemistry media were declared valid and feasible to use because it obtained result test of 86.66%.

Thus, augmented reality media android based on practicum solution buffer to improve students^ multiple representation ability is declared very feasible to be used as a learning medium.

Conclusion

Based on result if the research and product developed, it can be concluded that media accompanied by materials, practicum with visualize multilevel representation and quizzes that are equipped with discussion and key answers and they must be opened in sequence. The results of the validation test carried out obtained an average value of rcount 0.8482 and was declared valid, while the feasibility test was carried out in a limited manner, obtaining an average percentage of 82.14% indicating that android-based augmented reality on buffer solution practicum to improve students^ multiple representation ability was very suitable to be used as a learning medium for buffer solution material.

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Author Contributions

Nisrina Zulfa Salsabila contributes to conseptualising the research idea, developing products, analyzing data, and writing articles. Sari and Ferli Septi Irwansyah contributes as a supervisor in research activities to article writing, reviewed, and edited.

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Conflict of interest

The authors declare there are no conflicts of interest.

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