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Student Response in Using Smartphone-Assisted Augmented Reality Video in Learning

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Abstract: Smartphone-assisted video augmented reality was developed to facilitate students who want to study anywhere, and anytime. The material studied includes the presentation of information about the work procedures of a concept being practiced. This study aims to develop a prototype for Chemistry Learning Using Video Program-Based Augmented Reality Applications and to get student responses about the use of augmented reality videos practiced in chemistry learning. This study uses a research and development approach based on the ADDIE method which has five steps, namely: analysis, design, development, implementation, and evaluation. The activity was preceded by developing a video program and being validated by a media expert, followed by making markers and developing applications. The results of the development were tried 39 students, as well as 4 teachers. The data were obtained through a questionnaire and were analyzed by descriptive qualitative. The results showed that the Prototype Development for Chemistry Learning Using Video Program-Based Augmented Reality Applications has been developed. Students responded stated that Augmented Reality (AR) video shows were able to build an understanding of teaching materials (92.3%), provide an initial understanding before working in the laboratory (95.9%), introduce the object of the experiment to be carried out (100%), explain the procedure for using the tool easily (100%).

Keywords: Augmented reality video; Chemistry learning; Student response

Introduction

Augmented Reality (AR) is a technology that enhances the real world by integrating virtual objects, creating an interactive and dynamic user experience. It has diverse applications, and in the context mentioned, it's highlighted for its potential in transforming education by offering a more engaging and immersive learning environment (Nevarini et al., 2023). iT has been recognized as a valuable and effective approach to learning. It is viewed as complementary to traditional learning methods, indicating that it can enhance and supplement the educational experience, especially in the field of chemistry (Macariu et al., 2020).

AR is defined as a technology that combines the real world with the virtual world, is interactive in real time (Azuma, 1997). Vallino (1998) stated that Augmented Reality is a technology that combines two-dimensional or three-dimensional virtual objects and then projects these virtual objects in real time. Augmented Reality (AR) can be defined as a technology capable of incorporating virtual objects in two dimensions or three dimensions into a real environment and then displaying or projecting them in real time.

The main components of augmented reality technology are hardware and software (Ramadhanti et al., 2021). Hardware consists of: a) sensors such as cameras, accelerometers, and other motion sensors used to collect data from the physical environment. b) Display is a display device, such as an AR headset, smartphone, or tablet, used to display additional information or virtual objects to the user (Abdusselam et al., 2020). Software includes a) tracking system, which determines the position and orientation of devices in physical space

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to unite virtual elements with the real world. b) rendering i.e. a graphical process that allows virtual objects or information to be integrated with real scenes. c) aninteraction algorithm: Processes user input from various sensors and generates appropriate responses in an AR environment (Turan et al., 2021).

Augmented Reality is divided into 3 types (Prasetiyo et al., 2020). Marker-Based AR is AR that relies on markers or markers in the physical environment to determine the location and orientation of virtual objects (Kuit et al., 2021). Markerless AR is AR that uses natural features of the environment, such as the shape of buildings or objects, to determine the position of virtual objects (Cai et al., 2017). Projection-Based AR is AR that uses direct projections on physical objects or surfaces to display additional information (Chandrakar et al., 2020).

Augmented Reality (AR) technology offers a number of advantages in learning activities, bringing the learning experience to be more interesting and interactive (Talan, 2021). Immersive Learning Experiences i.e. AR allow students to learn in a virtual environment closer to the real world. This can increase student engagement levels and make learning more enjoyable (Lytridis et al., 2018). Abstract Concept Visualization means that with AR, abstract concepts can be visualized in a more concrete way. For example, three-dimensional models can be used to explain scientific or mathematical concepts that are difficult to understand using only textbooks (Pegrum, 2021). Active Learning because AR allows students to participate directly in the learning process. They can interact with virtual objects, extract additional information, and apply knowledge in real contexts (Ambarwulan et al., 2016).

In addition, it also makes it easy to personalize learning, with AR, the learning experience can be tailored to the individual needs of students. Each student can access additional content or materials designed according to their level of understanding (Hafidha et al., 2014). Simulation and Virtual Experimentation where AR allows students to conduct virtual experiments or simulations in a safe and controlled environment. It is very useful in the fields of science, mathematics, and engineering (Yilmaz, 2021). Enable Collaborative Learning In an AR environment, students can collaborate on learning projects or assignments. They can share virtual objects, work together in groups, and understand concepts together (Carreon et al., 2020).

AR provides access to live information and provides instant access to additional information when students encounter a physical object or a specific area. This can improve students' understanding of the learning content (Czerkawski et al., 2021). AR can help in integrating different subjects, creating stronger connections between concepts in different disciplines (Supriono et al., 2018). The presence of interactive elements and advanced technology can increase student motivation to learn (Sahida et al., 2020). Fun and innovative learning experiences can increase student learning satisfaction (Behmke et al., 2018). AR helps students to develop skills relevant to the real world, such as problem-solving, creativity, and collaborative skills (Ardian et al., 2021).By combining these advantages, AR can have a positive impact in improving learning effectiveness and preparing students for future challenges.

In learning chemistry, especially for chemical experiments, augmented media can be used, both in the form of interactive and those given through video shows. The use of video is intended so that the work process can be seen as a whole, and it is easier to use and manufacture. Especially if the process of carrying out an experiment requires a long time and uses a rather complicated set of equipment, so the use of augmented applications for learning videos can be an option. One of the advantages of using video is that it is expected to be able to provide an overview or present overall performance (Hauff et al., 1996).

The current use of AR has expanded to various aspects of our lives and is projected to experience very significant developments. This is because the use of AR is very interesting and makes it easy to use in doing something, for example in learning chemistry. By utilizing AR technology as well, augmented applications through video programs can be used to provide experimental examples that are displayed virtually using an Android mobile device.

An introduction to chemical experiments needs to be introduced to students to help students understand the experimental material to be carried out. This is so that dangerous things do not happen because of the nature and presence of chemical substances before students work in the laboratory.

Consideration of using a program-based augmented reality application because AR can combine real and virtual environments in the introduction of chemical experiments. The existence of a video is expected to be able to provide an overview or present the overall implementation procedure (Hauff et al., 1996). This application can be used by students anywhere if the institution has provided flexibility for students to use it and at the same time can assist students in introducing working in chemical laboratories and introducing students to carrying out work procedures. Distance education students sometimes experience obstacles in carrying out practicums, for example because they do not understand the equipment that will be used, and do not understand the work procedures that must be carried out. Meanwhile, students still must do hands-on practicum activities. The existence of videos and augmented reality applications regarding examples of chemical experiments is deemed necessary to be developed and given to students so that they have provisions before working in a real laboratory.

The characteristics of distance education are shown, among other things, by the separation between lecturers and students. Even though they are separated, there is still a learning process, namely there is two-way communication and interaction between lecturers or tutors and students. This interaction is facilitated through learning media, including print, audio, video, web and other multimedia. Distance education students are required to be able to study independently, including chemistry practicum activities, which are activities that must be carried out in the Chemistry Education study program. Considering that the use of chemicals and laboratory equipment generally requires great care, students need to be provided with an introduction to chemicals, laboratory equipment and chemical experiments before they work for real in the laboratory. Providing knowledge that can describe/visualize the existence of a tool that will be used is intended so that there are no obstacles to carrying out practical work. Apart from that, the increasing development of web and internet technology now makes it possible to provide material for chemical experiments through electronic learning.

The results of research conducted by Adji et al. (2022) showed that students still need to be given an overview of work in the laboratory including the reintroduction of laboratory equipment before students work in the laboratory. With the spread of students and independent study students, students need to be equipped with an introduction to virtual work procedures before they work in the laboratory. Provision of knowledge that can visualize the existence of a tool and work procedures for chemical experiments is intended so that there are no obstacles to doing practicum. Hence how the video-based augmented reality prototype was developed? and how do students respond to using it?

Method

This study uses a research and development approach based on the ADDIE method which has five steps, namely: analysis, design, development, implementation, and evaluation. This procedure is based on the steps described above, and the purpose of this research is to develop and implement an augmented reality application to determine student perceptions of a given program.

The activity was preceded by developing a video program and being validated by a media expert, followed by making markers and developing applications. The results of the development were tried 39 students, as well as 4 teachers. The data were obtained through a questionnaire and were analyzed by descriptive qualitative.

Result and Discussion

R&D Research Steps Using the ADDIE Approach

By using the ADDIE method, the research and development steps are shown in Figure 1.

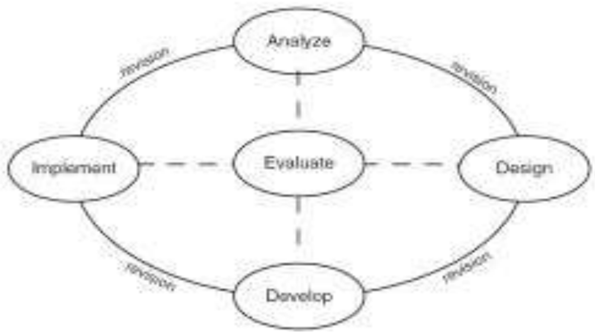

Figure 1. R&D research steps using the ADDIE approach (Branch, 2009)

Analysis

The analysis stage is the initial stage to find out what is needed in mapping the problems that occur in the process of implementing learning in the Chemistry Practicum course. To map the problem, the researcher conducted a study of the results of previous research related to chemistry practicum, as well as interviews or direct discussions with students. The results obtained are used as an initial framework for improving or developing a research design. The results of the analysis phase obtained answers received from student respondents related to the need for video such as students need examples of practicum presentations, students need that practicum can be assessed through an online form, and learning through video still needs to be done.

Design

After completing the analysis phase and determining that the video program-based augmented reality application will be the product to be utilized, then determine the basis for product development, design the product form and design, determine program usefulness indicators from the augmented application quality assessment tool for video programs, and finally compile a questionnaire for applications that have been developed.

Developed

The research was conducted by involving 2 video program developers and 3 AR developers. At the development stage obtained augmented reality applications from videos of chemical experiment tools and examples of chemical experiments. The AR being developed is AR 2 D and does not include direct interaction between the user and the teaching materials. AR is developed based on videos that have been made before.

Evaluation

This research is to develop an augmented reality application that utilizes chemical experiment tools and videos of chemical experiment examples. This video was previously developed and verified. A questionnaire of 39 students and 4 chemistry instructors was used to assess the quality of the development results of this extended application. The developed questionnaire device was verified by two chemistry education instructors and one learning designer. During data collection, students are assembled in a room, given an initial briefing, and then divided into small groups of 2-4 students to try out the augmented reality application individually. After trying them out, students were given a question-based tool to assess the quality of their augmented reality applications. The questionnaire results received were descriptively and qualitatively analyzed.

The Prototype Development for Chemistry Learning Using Video Program-Based Augmented Reality Applications

The video program-based augmented reality application developed is a 2D AR. The development of augmented reality applications was first developed as markers read through Android mobile phones using app address links. Then download and install the AR app. An icon will appear on the HP screen. Then click the Android phone's icon to open the installed app and point the HP camera at the marker to access the video. An animated video will appear on the phone screen showing you the practical steps of a simple laboratory instrument.

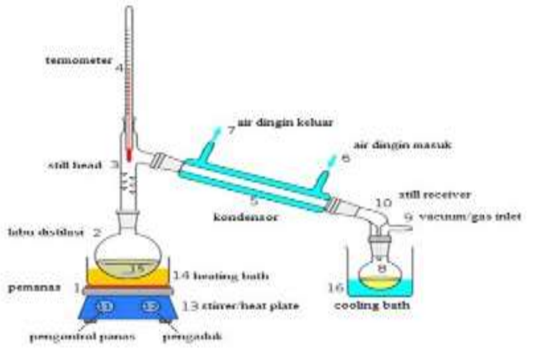

Figure 2. Distillation apparatus markers

Figure 3. Marker identification of double bond lipids

Figure 4. Marker determination of dissolved oxygen levels

As shown in Figures 5, the results obtained show that students can access lab materials via smartphones.

Figure 5. Using android to access AR video

The student's response to the Chemistry Learning Prototype Using the Video Program-Based Augmented Reality Application

The results obtained showed that the questions given were responded to well and very well by the students in terms of display quality as shown in Table 1. Student responses stated that Augmented Reality (AR) video shows were able to show the clarity of the image and display an attractive image. In addition, it also shows the suitability of illustrations, easy to remember and there is information about instructions for carrying out experiments. They also show clear articulation with language that is easy to understand. According to Solomon (1979) individuals learn new ideas more easily and quickly while information is presented simultaneously in the form of images and words.

Table 1. Student Responses to the Clarity of the Presentation

Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
AR video showing an introduction to the lab equipment and examples of hands-on experiments demonstrating image clarity	25.60	74.40	0.00	0.00	0.00
Show an AR video Introduction to lab equipment and real-life experiment examples showing relevancy of illustrations.	38.50	61.50	0.00	0.00	0.00
AR video introducing lab equipment and experimental examples with easy-to-remember tool illustrations.	30.80	59.00	10.30	0.00	0.00
AR video show Intro to lab equipment and interesting visual display experiment examples	30.80	66.70	2.60	0.00	0.00
The use of the given AR can introduce the experimental object to be carried out	33.30	66.70	0.00	0.00	0.00
AR video show Lab equipment demo and test examples show clear articulation	25.60	66.70	7.70	0.00	0.00
AR shows use communicative and easy-to-understand language	30.80	64.10	5.10	0.00	0.00

Through the data listed in Table 2 it can be explained that the material in the AR learning media regarding the introduction of laboratory experiments and experimental examples is in accordance with the learning objectives. Besides is in accordance with the material needed in practicum activities. This is because the existing shows are in accordance with the topics that will be practiced as stated in the modules provided and can introduce students to the basic material of chemical experiments and have been presented in a sequential manner. Therefore, the AR shows provided are very useful for students. According to Cai et al. (2014) AR technology enhances the science learning capabilities of the students.

Table 2. Student Response to Suitability with the Teaching Materials

Statement	Strongly Agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Strongly Disagree (%)
The material in the AR shows is in accordance with the material needed/taught in practicum activities	35.90	61.50	2.60	0.00	0.00
The material in the AR learning media regarding the introduction of laboratory experiments and experimental examples is in accordance with the learning objectives	23.10	74.40	2.60	0.00	0.00
The material in the AR learning media is in accordance with the topic to be practiced as stated in the given module	25.60	69.20	5.10	0.00	0.00
Material in AR learning media can introduce students to the basic material of chemical experiments	43.60	56.40	0.00	0.00	0.00
The material broadcast has been presented in a sequential manner	23.10	71.80	5.10	0.00	0.00
The AR impressions provided were very useful for me	59.00	41.00	0.00	0.00	0.00

Table 3. Student Responses to Display Quality

Statement	Strongly Agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Strongly Disagree (%)
AR video showing introduction to laboratory equipment and examples of practicum experiments are given before the practicum activities take place	56.40	43.60	0.00	0.00	0.00
Although still carrying out actual practicum activities (hands on activity), learning via video is still needed	30.80	61.50	7.70	0.00	0.00
AR video display Introduction to laboratory equipment and experimental examples explaining the function of the equipment properly	30.80	59.00	10.30	0.00	0.00
AR video display Introduction to laboratory equipment and experimental examples explaining the characteristics of the types of equipment	35.90	61.50	2.60	0.00	0.00
All symbols of the components of the experimental topic are displayed clearly on the mask according to the standard	17.90	79.50	2.60	0.00	0.00
The characteristics of the experimental subject components are clearly displayed in the AR book	23.10	71.80	5.10	0.00	0.00
The displayed image already represents the shape of the original component	38.50	59.00	2.60	0.00	0.00
Display pictures have introduced students to the components of the experiment to be carried out	30.80	69.20	0.00	0.00	0.00
The instructions given are presented and easy to follow	35.90	64.10	0.00	0.00	0.00
The use of AR provided can overcome the limitations of the experimental tools to be carried out	41.00	59.00	0.00	0.00	0.00
AR presentation about the experiment motivates me to prepare me for the practicum	46.20	51.30	2.60	0.00	0.00
The AR shows that are given are very interesting to follow	56.40	41.00	2.60	0.00	0.00
I am satisfied with the AR presentation of the introduction of the tools and practical experiments given	23.10	76.90	0.00	0.00	0.00

AR technology positively affected the students' laboratory skills. AR technology both improved the students' laboratory skills and helped them to build positive attitudes towards physics laboratories (Akçayır et al., 2016).

Based on the data listed in Table 3 it can be explained, this study shows that students agree that an AR video showing an introduction to laboratory equipment and examples of practicum experiments is given before the experimental / practicum activities take place. The AR video showing the introduction of laboratory equipment and experimental examples has been able to explain the characteristics of the types of equipment such as an explanation of the functions of the equipment that can work properly and easy to follow. In addition, the images displayed already represent the shape of the original components, so that they can introduce the various types of experiments that will be carried out by students. Thus, the use of AR video can introduce the object of the experiment to be carried out, and students are satisfied with the AR presentation of the introduction of tools and practicum experiments given. Using smartphones as a learning medium can provide deeper learning opportunities for students (Rogozin, 2012).

Conclusion

The use of smartphones has high mobility and can be operated even if there is no network available. Smartphones can implement AR video because it can help distance education students who want to study learning material stored on smartphones, including chemistry practical learning. The research results show that AR Video can show images, and real-life experiment examples showing the relevance of illustrations, such as students responded stated that Augmented Reality (AR) video shows were able to build an understanding of teaching materials (92.3%), provide an initial understanding before working in the laboratory (95.9%), introduce the object of the experiment to be carried out (100%), explain the procedure for using the tool easily (100%). Learning science in the field of science, among others, requires the results of experimental work with certain standards, learning science, for example, chemistry, cannot be done only with theoretical material only. The implementation of practicum activities has a very crucial role to support the quality of learning outcomes and processes because practicum activities will be more effective in increasing student expertise in observing and improving psychomotor skills as well as a means of practicing in using or utilizing existing tools and materials in the laboratory. The basic skills that can be observed during the practicum include such as how to: take materials, use tools, observe, communicate, and work safety. Practical activities as a method that puts forward processes and work to find a scientific concept based on a process, observation, analysis, proof and drawing conclusions from an object. Practicum activities that must be carried out online have received more attention because in practicum activities, not only the results of student work are the material for assessment, but the process during which students carry out practicum activities is also a separate assessment. Even though they are still carrying out actual practical activities (hands on activity), learning through video is still needed especially if the video is given before the practical activities are carried out. Media can be one that causes the success of learning, for example video media, can make learning more interesting and fun. In addition, video media can help clarify material to clarify the message conveyed in the teaching and learning process. The use of learning media in science learning needs to be considered. Learning video is one of the media that can be used in the learning process because it contains audio and visual elements. It can be used to convey messages and stimulate thoughts, feelings, and desire to promote the emergence of a deliberate, purposeful, and controlled learning process. Students are less interested in the learning material because of its complicated and complex nature. If the teacher can choose the right learning material, it will affect the students' ability to grasp the material presented. Student participation in practicum activities is still being carried out even though there are some obstacles due to limited facilities and infrastructure. Meanwhile, Sarah-Jane Gregory and Giovanna Di Trapani (2012), explained that the lack of laboratory equipment facilities can lead to a reduction in the understanding of learning. Meanwhile, communication constraints have also been anticipated by institutions by providing guidance assistance through web tutorials.

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Author Contributions
The three of us as authors of this article worked from preparing research proposals to writing reports and journal articles. Meanwhile, practical activities are assisted by chemistry laboratories, and the creation of markers and augmented programs is assisted by developers.

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Conflicts of Interest
There is no conflict of interest.

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