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Education for Prospective Teachers on Augmented Reality (AR) Learning Media in Science Subjects

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Abstract: The improvement of education quality can be supported by the utilization of technology such as Augmented Reality (AR) as a learning media that can help teachers visualize the material. Prospective teachers need to understand the benefits of using AR as a learning media and be motivated to realize it. This education activity aims to increase the knowledge of prospective science teachers regarding the utilization of AR as a learning media and how to create it. The target participants in this education activity are prospective science teacher students from various universities in Indonesia. The participants who attended this education activity were 115 prospective science teacher students from several universities in Indonesia. Data collection of participant responses used a questionnaire consisting of 10 statements and one open-ended question regarding the participants' messages and impressions of this education activity. Participants gave very good responses, averaging 82% towards this activity. These response results indicate that this education activity achieved its goals in terms of the number of participants and the types of responses from participants. Participants are interested in this activity and motivated to practice creating AR media.
Keywords: augmented reality; education; learning media; prospective teachers; science

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INTRODUCTION

Teachers, as educators, are always looking for new teaching methods to ensure that learning activities can be carried out effectively so that students can achieve maximum learning outcomes (Nasir et al., 2019). Innovation and effectiveness of learning activities can be achieved by integrating technology into learning (Efwinda & Mannan, 2021; Rahmawati et al., 2021). The need to adapt to technological developments is increasing (Hebebci & Usta, 2022). Unfortunately, this need cannot be met now due to the technology adaptation gap between educators and students. Generally, educators have limited adaptation abilities, so there is a need to improve their ability to adapt to the use of technology in learning activities (Trismawati et al., 2022). Technology supports learning activities and helps students understand what is being taught (Efwinda et al., 2022).

Augmented Reality (AR) technology is one of the well-known technologies in

education (Zafeiropoulou et al., 2021). AR technology is a technology that can combine virtual objects in two dimensions with the real world in three dimensions in the form of direct or real-time projections (Mustaqim, 2016). AR differs from another popular term, virtual reality (VR), a technology that brings two-dimensional virtual objects into the real world in three dimensions. VR technology creates a virtual world where users experience it as the real world (Indrawan et al., 2021).

AR technology can help educators educate students because AR can convey learning materials more clearly (Nistrina, 2021). In developing countries, AR technology is a learning medium for 21st-century learning (Asbulah et al., 2022). However, AR technology has not yet spread widely as a supporting tool for interactive learning in Indonesian schools, even though AR technology strongly supports learning, especially in science subjects (Indrawan et al., 2021).

In science subjects, the use of AR technology varies depending on the subject; for example, in biology, AR technology can be used to show three-dimensional shapes of human organs; in physics, AR technology can be used to show sound waves, and in chemistry, AR technology can be used to show molecular structures (Indrawan et al., 2021). However, despite the sophistication provided by AR technology, the number of teachers capable of mastering this technology is still minimal (Hariawan et al., 2020). Before implementing it in the classroom, teachers should be trained first in using AR technology (Jamrus & Razali, 2021). Education in creating AR can start when they become prospective teachers so that they are more prepared. 21st-century learning demands that prospective teachers be able to prepare their abilities and skills in integrating technology as a learning media. 21st-century learning demands changes, one of which is in the learning media provided to students to face increasingly stringent global demands (Mardhiyah et al., 2021). Therefore, it is necessary to conduct education as an initial step before conducting education activities to increase the knowledge of prospective science teachers regarding the utilization of AR as a learning media for prospective science teachers in the field of natural sciences. There is a problem regarding the lack of teachers' adaptation abilities to the use of technology in learning activities, so this education aims to increase knowledge and improve technology adaptation abilities for prospective science teachers regarding the utilization of AR as a learning media and how to create it. With knowledge regarding the utilization of AR, it is hoped that prospective teachers will be motivated to improve their competencies in integrating technology in learning to create more interesting, empowering, and student-friendly learning experiences.

METHOD

Education for prospective teachers on AR learning media in Science subjects aims to enhance their knowledge of using AR as a learning tool and how to create it. Future science teachers must be innovative and creative in utilizing technology to ensure that classroom learning is not monotonous and encourage students to participate actively in the use of technology. The success of this educational activity is determined by the number of participants and the positive responses from participants regarding their interest and knowledge of AR-based learning after the activity. It is hoped that participants will be motivated to create AR media and implement it in their teaching practices after participating in this activity. This activity was attended by 115 prospective Science teachers from several universities in Indonesia, with the majority from Mulawarman University (106 participants) and a minority from

Garut University (3 participants), Lampung University (2 participants), Pakuan University, Indonesia University of Education, State University of Medan, and Sarjanawiyata Tamansiswa University Yogyakarta, each with 1 participant. Participant selection was done by creating a digital flyer for the activity, distributed online in forums for lecturers to share with interested students.

This education activity was conducted online on March 11, 2023. Six speakers for the activity, each specializing in the topic they presented. The presentation of the material consisted of three sessions: the first session on "The Profession of Teachers and the Competencies Teachers Must Possess," the second session on the integration of pedagogy, content, and technology in learning, and the third session on AR media that can be used as learning media. Each session included a discussion forum and a question-and-answer session. The third session also presented the procedure for creating AR media, including the applications that can be used, step-by-step instructions for creating simple AR, and examples of AR in electricity and magnetism topics.

Participant responses to this education activity were collected through a questionnaire consisting of 10 statements and one open-ended question regarding their messages and impressions of the activity. The questions were related to various aspects, including participants' interest and enthusiasm in participating in the education activity (question 1), participants' understanding of the explanations provided by the speakers (questions 2, 6, and 7), the ease of access and application of the applications used in the activity (questions 3, 8, and 9), participants' awareness of applying AR-based learning (question 4), participants' desire to continue practicing creating AR media as a way of applying the knowledge they gained from this education (question 5), and whether the material provided by the speakers helped participants in improving their understanding of AR-based learning (question 10). Question 11 was an open-ended question regarding participants' messages and impressions after participating in the education activity. Each answer was accompanied by multiple-choice responses ranging from strongly disagree to strongly agree. Each answer was scored from 1 to 4 for negative to positive responses. The scores were then averaged and converted into percentages, and categories were determined based on Table 1.

Table 1 Category of responses from prospective science teachers

Category	Average Value
Very Poor	$x \leq 20\%$
Poor	$20\% < x \leq 40\%$
Adequate	$40\% < x \leq 60\%$
Good	$60\% < x \leq 80\%$
Very Poor	$80\% < x \leq 100\%$

RESULTS AND DISCUSSION

Technological advancements have led to increased expectations for improving the quality of education (Sulisworo et al., 2021). AR technology is one of the learning technologies that can assist students in learning (Yu et al., 2022). 115 prospective science teachers attended the workshop on creating AR-based learning media for prospective science teachers. The material was presented in 3 sessions and not only focused on AR-based learning media but also started with general topics about the Teacher Profession and the framework of knowledge in integrating pedagogy, content, and technology so that participants gained comprehensive knowledge about the background of the necessity of utilizing AR in learning.

The first material presented by the speakers was about the teaching profession and its competencies. This material was intended to provide participants with an understanding of the teaching profession and its qualifications. According to policymakers (Undang-

Undang Nomor 14 Tahun 2005 Tentang Guru Dan Dosen, 2005), the qualifications of a teacher include academic qualifications, competencies, educator certificates, physical and spiritual health, and the ability to achieve national educational goals. Teachers need to have pedagogical competence, personality competence, social competence, and professional competence acquired through professional education. Figure 1 shows documentation of the question-and-answer session for the first material education session.

Figure 1 Q&A session for the first material

The second material presented by the speakers was about the framework of pedagogical, content, and technological knowledge in teaching that teachers need to have to teach effectively. The presentation of this material aims to cultivate and strengthen participants' knowledge that to become a teacher, one not only needs to master teaching techniques not only needs to master the content to be taught or not only needs to master technology but must be able to integrate all three. Figure 2 shows documentation of the presentation of the second material.

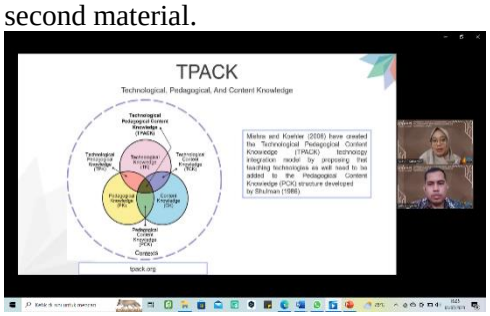

Figure 2 Presentation of the second material

The speakers presented a third material related to AR technology that can be used as a learning media. Before the education activity, information about the applications that can be used to create AR was provided so that participants could download them before the activity started and follow the step-by-step instructions from the speakers on how to create AR.

In this session, the speakers presented the use of AR in education and how to use AR as a learning media. The applications used to create AR are the Unity application and the Vuforia application. Unity is an application used to create 3-dimensional and 2-dimensional games. Meanwhile, Vuforia is an application used as a library to support AR programs on Android programs. Figures 3 show documentation of the presentation of the third material.

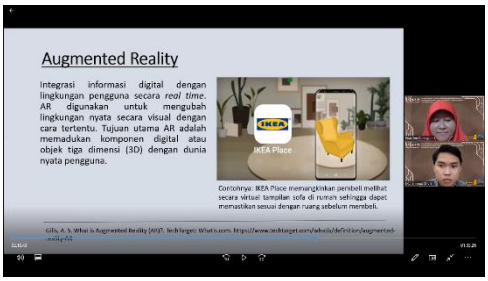

Figure 3 Presentation of the third material

Figures 4 show the question-and-answer session for the third session.

Figure 4 Q&A session for the third material

Participants' enthusiasm can be seen, for example, in their active participation in asking questions and even directly expressing their opinion that there should be an exclusive training activity for

creating AR media. To determine the participants' responses to this activity, the researchers provided a questionnaire to the participants at the end of the activity. The questionnaire consisted of 10 closed-ended questions and 1 open-ended question.

The first closed-ended question concerns participants' interest and enthusiasm in the education activity. The results of participants' answers to this question can be seen in Table 2.

Table 2 Percentage of participant responses to question 1

Response	Number of Participants
Strongly Agree	58%
Agree	41%
Disagree	0%
Strongly Disagree	1%

Table 2 shows that 58% of participants strongly agree that they are interested and enthusiastic in participating in the education activity. 41% of participants agree. Only 1% disagree that they are interested and enthusiastic in participating in this education activity.

The second closed-ended question is about participants' understanding of the explanations provided by the speakers in this activity. The results of participants' answers to this question can be seen in Table 3.

Table 3 Percentage of participant responses to question 2

Response	Number of Participants
Strongly Agree	47%
Agree	52%
Disagree	0%
Strongly Disagree	1%

Table 3 shows that 47% of participants strongly agree that they understand the explanations provided by the speakers in this education. 52% of participants agree, and only 1% disagree that they understand the explanations provided by the speakers in this education.

The third closed-ended question is about the ease of access and application of the applications used in the activity. The results of participants' answers to this question can be seen in Table 4.

Table 4 Percentage of participant responses to question 3

Response	Number of Participants
Strongly Agree	34%
Agree	65%
Disagree	0%
Strongly Disagree	1%

Table 4 shows that 34% of participants strongly agree that the applications used in this education are easy to access and apply for beginners. 65% of participants agree, and only 1% disagree that the applications used in this education are easy to access and apply for beginners.

The fourth closed-ended question concerns participants' awareness that AR-based learning is very interesting to apply The results of participants' answers to this question can be seen in Table 5.

Table 5 Percentage of participant responses to question 4

Response	Number of Participants
Strongly Agree	79%
Agree	35%
Disagree	0%
Strongly Disagree	1%

The fifth closed-ended question is about participants' willingness to continue practicing creating AR media as a form of applying the knowledge they gained from this education. The results of participants' answers to this question can be seen in Table 6.

Table 6 Percentage of participant responses to question 5

Response	Number of Participants
Strongly Agree	45%

Response	Number of Participants
Agree	50%
Disagree	4%
Strongly Disagree	1%

The Table 6 shows that 45% of participants strongly agree that they will continue practicing creating AR media to apply the knowledge they gained from this education. 50% of participants agree, 4% disagree, and only 1% strongly disagree that they will continue practicing creating AR media to apply the knowledge they gained from this education.

The sixth closed-ended question is a negative question asking participants about the explanations provided by the education speakers, making it difficult for them to understand the competencies teachers need, such as PCK, TPACK, and AR-based learning. The results of participants' answers to this question can be seen in Table 7.

Table 7 Percentage of participant responses to question 6

Response	Number of Participants
Strongly Agree	24%
Agree	17%
Disagree	35%
Strongly Disagree	23%

Table 7 shows that 24% of participants strongly agree that they find it difficult to understand the explanations provided by the speakers. 17% of participants agree, 35% disagree, and 23% strongly disagree that they find it difficult to understand the explanations provided by the speakers.

The seventh closed-ended question is a negative question about participants finding it difficult to understand the material about creating AR Media explained by the speakers. The results of participants' answers to this question can be seen in Table 8.

Table 8 Percentage of participant responses to question 7

Response	Number of Participants
Strongly Agree	20%
Agree	13%
Disagree	47%
Strongly Disagree	20%

Table 8 shows that 20% of participants strongly agree that they struggle to understand the material about creating AR Media explained by the speakers. 17% of participants agree, 35% disagree, and 23% strongly disagree that they find it difficult to understand the material about creating AR Media explained by the speakers.

The eighth closed-ended question is about the ease of participants in understanding AR learning and how to create AR media after receiving material from the speakers. The results of participants' answers to this question can be seen in Table 9.

Table 9 Percentage of participant responses to question 8

Response	Number of Participants
Strongly Agree	38%
Agree	61%
Disagree	0%
Strongly Disagree	1%

Table 9 shows that 38% of participants strongly agree that they find it easy to understand AR learning and how to create AR media after receiving material from the speakers. 61% of participants agree, and only 1% disagree that they find it easy to understand AR learning and how to create AR media after receiving material from the speakers.

The ninth closed-ended question is about the ease of participants in understanding creating AR materials after practicing in education. The results of participants' answers to this question can be seen in Table 10.

Table 10 Percentage of participant responses to question 9

Response	Number of Participants
Strongly Agree	37%
Agree	62%
Disagree	0%
Strongly Disagree	1%

Table 10 shows that 37% of participants strongly agree that they find it easy to understand creating AR materials after practicing in education. 62% of participants agree, and only 1% disagree that they find it easy to understand creating AR materials after practicing in education.

The tenth closed-ended question is whether the educational materials can help participants improve their insights into interesting AR-based learning. The results of participants' answers to this question can be seen in Table 11.

Table 11 Percentage of participant responses to question 10

Response	Number of Participants
Strongly Agree	47%
Agree	52%
Disagree	0%
Strongly Disagree	1%

Table 11 shows that 47% of participants strongly agree that educational materials can help participants improve their insights into interesting AR-based learning. 52% of participants agree, and only 1% disagree that the educational materials can help participants improve their insights into interesting AR-based learning.

After analyzing participants' responses to each question in the questionnaire, an analysis of participant responses was also conducted, as shown in Figure 5.

Based on Figure 5, there are differences in the responses given by participants to this educational activity. More than half of the participants gave a very positive response, with 56% of participants. Not less than 43% of participants gave a good answer to this educational activity. Only 1% of participants gave a negative response to this educational activity. Statements on the response questionnaire relate to participants' responses to whether they agree or disagree that the educational activity is interesting and motivating and adds knowledge related to the use of AR as a learning medium.

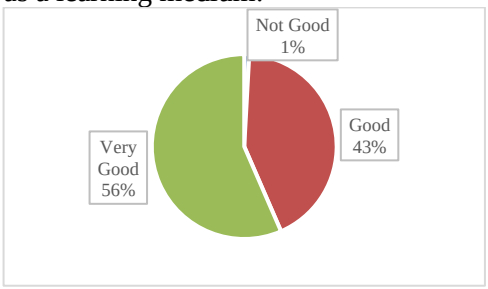

Figure 5 Diagram of response categories for each participant

The average response given by all participants also shows a very positive response category with a percentage of 82%. The number of participants who gave a very positive response indicates that this educational activity can be considered successful in increasing the knowledge of prospective science teachers on the use of AR as a learning medium and how to create it. This is also supported by the messages and impressions given by participants, such as those stated by CG-38:

"The educational activity was very good; I gained a lot of new knowledge and insights, especially regarding AR-based learning. Thank you to the extraordinary speakers."

Most participants strongly agree that they are interested and enthusiastic about participating in this educational activity, as stated by CG-12 and CG-53.

"This educational activity is very interesting and enlightening. Hopefully, this educational activity can be continued."

"I hope it can be held for a longer duration and can be educational in person."

Most of them also agree that the explanations given in this activity make them understand AR Learning Media more easily. Participants also expressed interest in using AR as a learning medium. The use of AR as an effective learning medium has been proven through research conducted by Dewi & Anggaryani (2020), which showed an average percentage answer for the question table of 98.5% with very good criteria. This value was obtained from student feedback, and students had tried using the learning media. In addition, research conducted by Gargrish et al. (2020) shows that AR-based learning can improve educators' teaching and learning experience. AR is also beneficial for improving the quality of education by facilitating student learning activities (Dewi et al., 2021).

CONCLUSION

Based on the description of the results and discussion, it can be concluded that: (1) AR-based educational activities for prospective science teachers have been successfully implemented according to the planned program, and (2) as prospective science teachers, all student participants gave a very positive response to this educational activity, with an average of 82%. These response results indicate that this educational activity has successfully increased the participants' understanding as prospective science teachers about the use of Augmented Reality (AR), making learning interesting and effective.

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