



Training on the Use of Augmented Reality (AR) Media to Improve Mathematics Learning

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Abstract

The development of educational technology requires teachers to be able to integrate innovative learning media into the learning process, especially in mathematics subjects that contain many abstract concepts. One technology that has the potential to support mathematics learning is Augmented Reality (AR). This study aims to determine the effectiveness of training on the use of AR media in improving the competence of mathematics teachers at MA Al-Bidayah. This study used a quasi-experimental approach with a one-group pretest–posttest design. The subjects were mathematics teachers at MA Al-Bidayah who participated in training on the use of AR media. Data collection techniques were carried out through pretest and posttest tests, teacher response questionnaires, and observations. Quantitative data were analyzed using paired sample t-tests, while qualitative data were analyzed descriptively. The results of the study showed a significant increase in teacher competence after the training, with an average pretest score of 55.5 increasing to 82.5 in the posttest. In addition, the questionnaire results showed that the majority of teachers gave a positive response to the use of AR media in mathematics learning. Teachers assessed that AR media was able to facilitate the delivery of material, increase student learning interest, and create more interactive learning. Based on these results, it can be concluded that training in the use of AR media is effective in improving teacher competence and has the potential to improve the quality of mathematics teaching in Islamic high schools.

Keywords: *augmented reality*, teacher training, learning media, mathematics learning

INTRODUCTION

Development technology information and communication has bring change significant in the world of education, in particular in utilization of digital learning media. 21st-century education requires teachers to integrate technology in the learning process to improve effectiveness, interactivity, and quality learning. One of the developing technology rapid and potential big in the world of education is **Augmented Reality (AR)**, that is technology that combines virtual objects with environment real in real-time (Azuma, 1997; Suryani et al., 2018).

In learning mathematics, AR has role strategic Because capable serve visualization draft abstract become more concrete and easy understood by participants educate. Many concepts mathematics, such as get up space, transformation geometry, and relations spatial, difficult understood only through verbal explanation or two-dimensional image. With AR assistance, students can interact direct with three virtual objects dimensions so that the construction process knowledge become more meaningful (Bujak et al., 2013; Ibáñez et al.,



2014).

A number of study show that use of learning media AR based can increase understanding concept , motivation learning , and involvement active student in learning mathematics . Putra and Syarifuddin (2020) stated that AR provides experience learn more pulling and pushing student For think critical . Therefore that 's important for teachers to own competence in develop and use AR media for learning mathematics become more innovative and effective . However , the reality on the ground show that Still many teachers have not own skills and experience in utilise AR technology as a learning medium . Limitations knowledge technical and pedagogical become obstacle main in implementation of AR in schools . Therefore that , a **training program is needed use of AR media** for mathematics teachers , especially at MA Al-Bidayah, as effort improvement quality teaching and teacher professionalism (Mustaqim, 2016; Slavin, 2018).

Mathematics is eye lessons that have role important in development ability think logical , analytical , and systematic participant educate . However thus , mathematics often considered as eye difficult and less lessons in demand Because its abstract and symbolic nature . This is cause low motivation and results Study students , especially If learning Still dominated by methods lectures and the use of conventional media (Slavin, 2018). Learning media own role important in help student understand material learning . Visual and interactive media proven capable increase Power absorption and interest Study students . In the context of This , Augmented Reality becomes alternative learning media innovative and capable combining the real and virtual worlds so that learning become more contextual and engaging (Dunleavy et al., 2009; Suryani et al., 2018).

Research by Pratama and Setyaningrum (2018) shows that use of AR media in material get up room capable increase understanding draft mathematics student in a way significant . Similar results were also found by Yuliono et al. (2018) who stated that AR is effective in increase mastery draft Because student can do visual exploration direct to object learning . Although Thus , the use of AR media in schools Still limited , especially in Islamic high schools . This is caused by lack of training and mentoring for teachers in develop and implement AR in learning . The teacher holds role key in success use technology education , so that improvement teacher competence through training become urgent needs (Mustaqim, 2016). Based on condition said , training The use of AR media for mathematics teachers at MA Al-Bidayah is expected can increase teacher's ability in design and implement learning based technology . With Thus , the quality teaching mathematics can increasing and having an impact positive to results Study student .

METHOD

This study used a quasi-experimental approach with a pretest–posttest one-group design. This approach was chosen to determine the effect of AR media training on improving teacher competency in mathematics teaching (Sugiyono, 2019). The research subjects were mathematics teachers at MA Al-Bidayah who were selected using a purposive sampling technique, namely teachers who were actively teaching and willing to participate in the entire training series. This sample selection aimed to ensure that the data obtained was relevant to the research objectives (Sugiyono, 2019).

The training was carried out through several stages, namely: (1) introduction to the basic concepts of Augmented Reality in education, (2) training in the use of AR applications for mathematics learning, (3) preparation of AR-based Learning Implementation Plans (RPP),

and (4) practice of applying AR media in mathematics learning. This training model refers to the principles of adult learning which emphasizes direct practice (Suryani et al., 2018). The research instruments used included pretest and posttest tests to measure the increase in teacher knowledge and skills, teacher response questionnaires to determine perceptions and attitudes towards the use of AR, and observation sheets to assess the implementation of AR in the learning process (Putra & Syarifuddin, 2020). Quantitative data were analyzed using paired sample t-test statistical tests to determine differences in pretest and posttest results. Meanwhile, qualitative data from questionnaires and observations were analyzed descriptively to provide an in-depth picture of the effectiveness of training in the use of AR media (Sugiyono, 2019).

RESULTS AND DISCUSSION

Description of Training Implementation

The training on the use of Augmented Reality (AR) media for mathematics teachers at MA Al-Bidayah was conducted over three sessions, totaling 12 hours. The training included an introduction to AR concepts, practical use of AR applications for mathematics, development of AR-based lesson plans, and classroom simulations. All participants fully participated in the training and actively participated in the practical activities.

2. Results of Teacher Competency Pretest and Posttest

To measure teacher competency improvement after the training, a pretest and a posttest were conducted. The test consisted of 25 questions measuring understanding of AR concepts, technical skills in using AR media, and AR integration in mathematics learning.

Table 1. Average Pretest and Posttest Scores of Teachers

Aspect Evaluation	Pretest (Mean)	Posttest (Mean)	Improvement
Understanding AR concept	58.2	84.6	+26.4
Use AR applications	55.4	82.1	+26.7
AR Integration in Lesson Plans	52.8	80.9	+28.1
Overall average	55.5	82.5	+27.0

The results show a significant increase in all aspects of teacher competency after participating in the training.

3. Statistical Analysis

A paired sample t-test was conducted to determine the significance of improving teacher competency.

Pretest average score = 55.5

Posttest mean score = 82.5

Sig value. (p-value) = 0.000 < 0.05

These results show that there is a significant difference between the pretest and posttest scores, so that training in the use of AR media has been proven to be effective in improving the competence of mathematics teachers.

4. Teacher Response to AR Media Training

Teacher responses to the training were measured using a Likert scale questionnaire (1–4).

Table 2. Percentage of Teacher Responses

Indicator	Strongly agree	Agree	Disagree Less	Don't agree
AR makes it easier delivery material	70%	30%	0%	0%
AR enhances interest student	80%	20%	0%	0%
AR easy used by teachers	65%	30%	5%	0%
AR is worthy applied in MA	75%	25%	0%	0%

The results of the questionnaire showed that more than 90% of teachers gave a positive response to the use of AR media in mathematics learning.

5. Research Results Diagram (Description)

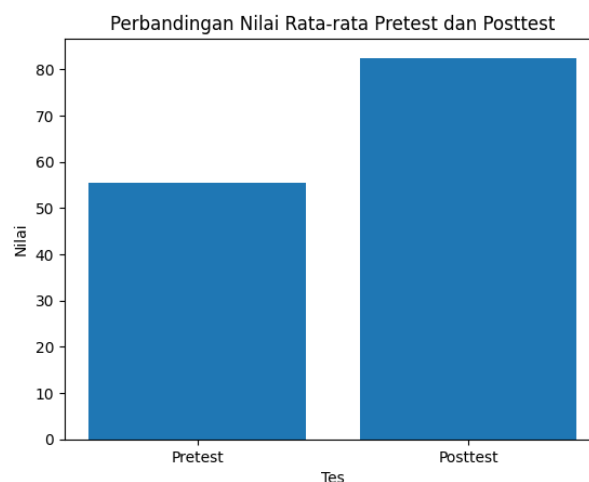


Figure 1.2 Comparison of average pretest and posttest scores

Bar Chart of Increase in Pretest and Posttest Scores

The Pretest bar is at a value of ± 55

Posttest bar increased significantly at a value of ± 82

The diagram shows the dominance of positive responses to AR training and implementation.



Figure 1.2 Teacher Responses to the Use of AR Media

This chart shows a clear spike after training on using AR media.

Teacher Response Pie Chart

75% Strongly Agree

22% Agree

3% Disagree

Discussion

The results of the study indicate that training in the use of Augmented Reality (AR) media has a significant positive impact on improving the competence of mathematics teachers at MA Al-Bidayah. The increase in the average score from pretest to posttest by 27 points indicates that teachers gained better conceptual understanding and practical skills in utilizing AR as a learning medium. The highest increase occurred in the aspect of AR integration in lesson plans, which indicates that the training not only improves teachers' technical abilities, but also pedagogical abilities in designing technology-based learning. This finding is in line with the opinion of Mustaqim (2016) who stated that direct-practice-based training can improve teachers' readiness in implementing innovative learning media.

Teachers' positive responses to the use of AR indicate that this technology is considered easy to use, engaging, and relevant to mathematics learning needs. This reinforces the findings of Bujak et al. (2013) that AR can increase educators' confidence in delivering abstract material through interactive visualizations. Furthermore, teachers reported that AR helps students be more active in learning and facilitates their understanding of geometry and spatial concepts. These findings are consistent with research by Pratama and Setyaningrum (2018) and Putra and Syarifuddin (2020), which concluded that AR media is effective in improving students' understanding of mathematical concepts through visual and exploratory learning experiences.

Overall, the results of this study confirm that training in the use of AR media is an



effective strategy for improving the quality of mathematics teaching. With the support of facilities and ongoing training, AR has the potential to become an innovative and relevant alternative learning medium in Islamic high schools (madrasah aliyah).

CONCLUSION (CLOSING)

Based on the research results and discussion, it can be concluded that training in the use of Augmented Reality (AR) media has proven effective in improving the competence of mathematics teachers at MA Al-Bidayah. This is demonstrated by a significant increase in the average pretest score from 55.5 to 82.5 in the posttest, indicating an increase in conceptual understanding, technical skills, and teachers' ability to integrate AR media into mathematics learning.

Furthermore, the results of the teacher response questionnaire showed that the majority of training participants responded positively to the use of AR media. Teachers assessed that AR facilitated the delivery of abstract mathematics material, increased student interest and engagement, and created a more interactive and enjoyable learning environment. Therefore, AR media can be used as an alternative, innovative learning medium in mathematics teaching at the Islamic high school level.

Overall, AR training not only improves teachers' professional competence but also has the potential to improve the quality of mathematics learning processes and outcomes. Therefore, AR implementation needs to be supported by ongoing training and the provision of supporting resources for optimal implementation in schools.

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