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Augmented Reality Needs Analysis in Science Learning: Teacher's Perspective

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ABSTRACT

The use of Augmented Reality can increase the activities of students to blend into a natural learning environment no longer abstract. It was merging virtual objects and fundamental interactions anytime and anywhere, which can present 3D objects, which are the most important features of Augmented Reality, resulting in a learning experience different from before. The main purpose of this study is to focus on teachers' views related to material needs and the supporting factors in the acceptance of Augmented Reality, especially in science learning in elementary schools. This study took a sample of teachers in 20 public elementary schools in Surakarta, Central Java, Indonesia, with a total population of 200 teachers with a sample of 30 teachers. The sample includes teachers who have years of teaching experience with different schools. The result is that STEM and Augmented Reality have not been maximally applied in schools; There needs to be broader socialization and training to the need for various Augmented Reality-based science materials that need to be developed.

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1. INTRODUCTION

In recent decades, augmented reality (AR) has made a significant acceleration, so this has also encouraged the creation of Augmented Reality applications that can be considered and applied in practice in all sectors, especially the education sector. Augmented Reality was first introduced as a training tool for airline and air force pilots in the 1990s (Caudell and Mizell, 2003). Augmented Reality itself is a technology that overlays virtual objects in the real world. These objects are in harmony with objects in the real world (Azuma *et al.*, 2001). Augmented Reality has become an important research focus for researchers in recent years.

Augmented Reality is important because it no longer requires expensive hardware, complex tools, sophisticated equipment. It can be used via a computer or mobile device to save on

manufacturing costs. Mobile devices and computers offer a suitable platform to support Augmented Reality (Chiang, T. H., Yang, S. J., & Hwang, 2014). Mobile devices have many advantages in portability, high interaction drive and ease of use (Chang and Hwang, 2018). Augmented Reality is already used at every elementary school level (Kerawalla *et al.*, 2006; Chiang, T. H., Yang, S. J., & Hwang, 2014); up to the university level (Ferrer-Torregrosa *et al.*, 2015).

The utilization of Augmented Reality can increase the activities of students to blend into the real learning environment, no longer abstractly. The merging of virtual and real objects brings interaction anytime and anywhere, which is able to present 3D objects, which is the most important feature of Augmented Reality, resulting in a learning experience that is different from before (Azuma, 1997; Moreno, E., MacIntyre, B., & Bolter, 2001). With Augmented Reality, it is as if the application of learning becomes concrete information (Walczak, Wojciechowski and Cellary, 2006). Other benefits of using Augmented Reality technology highlighted in education include: opportunities for experiences not available to people in real life (Wojciechowski and Cellary, 2013; Wu *et al.*, 2018); increased student participation (Wojciechowski and Cellary, 2013) learn with fun (Yoon *et al.*, 2012); save time and space (Li, 2010; Aziz *et al.*, 2012); increase motivation and level of learning focus (Aziz et al., 2012; O'Brien, H. L., & Toms, n.d., 2013; Sumadio & Rambli, 2010) and improve collaboration (Billinghurst, 2002; Yuen, Yaoyuneyong & Johnson, 2011). Another factor is that Augmented Reality supports approaches such as constructivism, learning by doing, and authentic learning, which makes students active in the learning environment (Yuen, Yaoyuneyong and Johnson, 2011; Kirner, Reis and Kirner, 2012; Wojciechowski and Cellary, 2013; Yilmaz and Goktas, 2017).

Science education is constantly evolving and is important in promoting and encouraging the skills needed for reflective practice (Tytler, 2007). Each field of education has its own role in creating a sustainable future. Teachers play an important role in sustainable development therefore providing students with the knowledge and equipping must be chosen wisely to overcome future challenges (Kevany, 2007; Shephard, 2008). The purpose of science education is to build scientifically educated students, solve problems, evaluate information logically, and prove it with authentic/logical evidence (Tytler, 2007). Science education is a field of education where Augmented Reality is very prominent.

In general, students often experience obstacles in understanding the abstract concepts contained in each science material (Palmer, 1999). Science learning supported by technology, including visuals, is more effective than science learning with conventional classes. This encourages students' interest in science to increase and encourages concrete knowledge in the field of science (Rehmat and Bailey, 2014). The use of virtual technology actually makes it easier for students to understand even complex abstract concepts (Arvanitis *et al.*, 2009). Augmented Reality technology can visualize three dimensions, facilitate Reality and provide an understanding of difficult material for students (Wu *et al.*, 2018)

STEM education has increased in most parts of the world, with advances in technology (ICT) increasing student engagement in classroom learning and increasing student motivation for STEM (Honeywell, 2014; Urban and Falvo, 2015). Augmented Reality can help students facilitate the learning process, both remembering information and achieving the desired goals. Augmented Reality will involve students to facilitate the STEM learning process, more fun and better than before. So it can be concluded that science is a basic component of STEM. Integrating Augmented Reality in science learning can increase students' STEM motivation, increase student involvement in class, and strengthen the future.

Applying science learning with Augmented Reality on a large scale has mechanisms related to obstacles, educator needs and obstacles in implementing integrated science learning with Augmented Reality. Because Augmented Reality is built from the needs of educators to facilitate the learning process in modern classrooms, this study focuses on educators' views regarding the needs and constraints of Augmented Reality in science learning materials. This study looks at the teacher's views on the need for Augmented Reality, especially in science learning materials in elementary schools.

2. METHOD

The method in this study is a mixed-method with the main aim of focusing on the teacher's views regarding material needs and exploring the factors that become obstacles in the acceptance of Augmented Reality, especially in learning science in elementary schools. This study took a sample using simple random sampling. This data is presented in qualitative data and quantitative data. Qualitative data is in the form of structured interviews with a qualitative approach. The researcher adds the following questions to the research.

- How to apply STEM and Augmented Reality in elementary schools?
- What are the things that affect the delay in AR learning in elementary schools?
- How do teachers view materials that require AR in science learning in elementary schools?

Quantitative data is in the form of samples based on questionnaire scores from grade 3 to grade 6 teachers with a sample of 30 teachers from 20 elementary schools in Surakarta, Indonesia.

3. FINDINGS AND DISCUSSION

Sample responses related to each area based on the questionnaire scores in the sample distribution by class and gender are presented in Table 1.

Table 1 Teacher sample data by class and gender

Class	Man	Woman	Total
3	6	2	8
4	4	3	7
5	3	3	6
6	3	6	9
Total	16	14	30

The following is to determine the percentage of teacher responses to the needs of Augmented Reality in science learning. It can be processed through the data in Table 2.

Table 2 Results of Response Data to Teacher Needs

Respondent	Total Score (n)	Maximum Score (N)	Percentage $P = \frac{n}{N} x100\%$	Category
30 Teachers	5200	5400	96%	Strongly agree

Table 2 provides information that teachers strongly agree with Augmented Reality technology. This is indicated by the large percentage obtained by 96% from the maximum percentage of 100%. And according to the Likert scale interpretation table for data with a percentage of 76%-100% in the category of strongly agree. The percentage of teacher responses to the needs analysis of Augmented Reality in science learning materials is described in the diagram as follows:

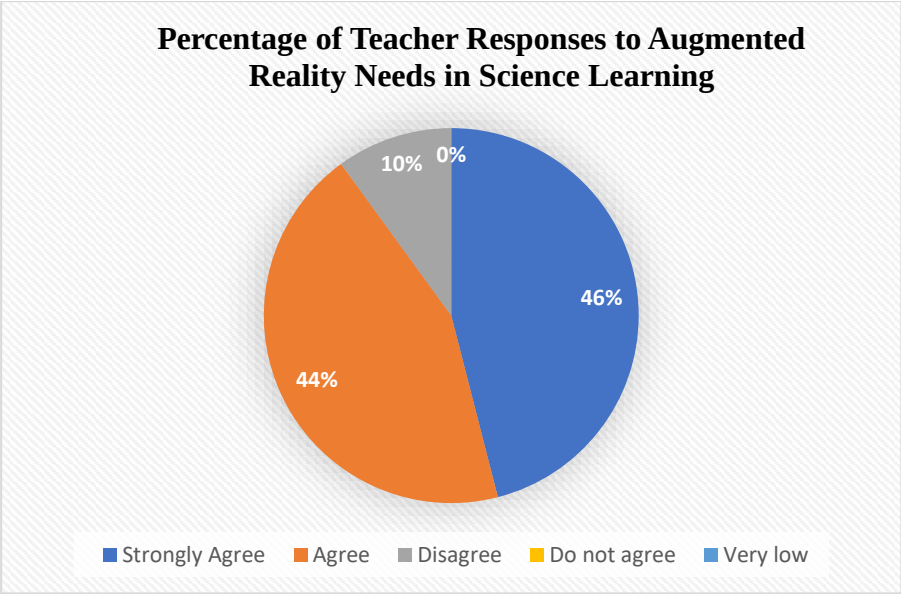

Figure 1 Percentage of Teacher Responses to Augmented Reality Needs in Science Learning

The following are sample responses related to each area based on interview questions.

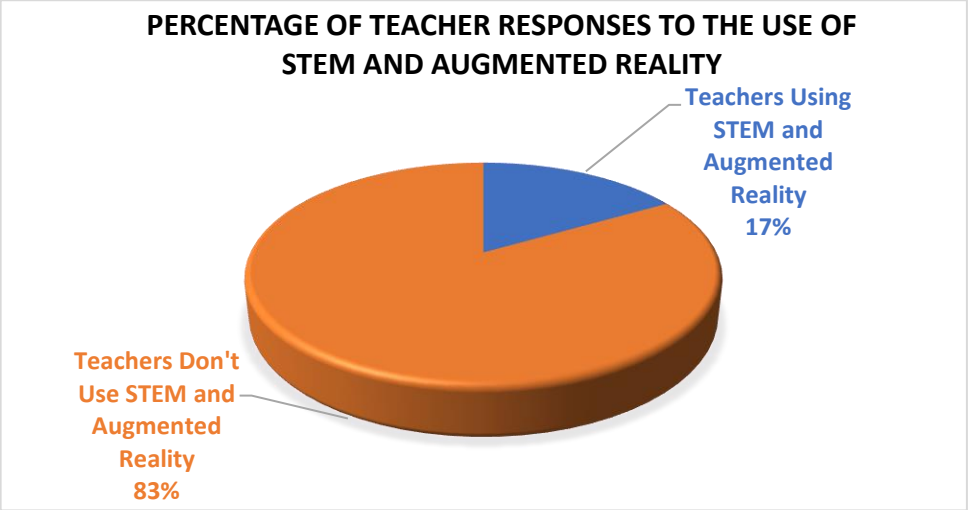

Figure 2 Percentage of Teacher Responses to the Use of STEM and Augmented Reality

STEM and Augmented Reality are not maximized

Based on the response to the question "How is the application of STEM and Augmented Reality in elementary schools?" In the coding phase, the researcher uses responses by the teacher whose answers have the same or repeated answers. Then the teacher's response to the question was "The application of STEM does not seem to be able to run optimally as well as Augmented Reality cannot be applied in elementary schools".

Need for Training and Socialization

Based on the response to the question, "What are the things that affect the delay in learning Augmented Reality in elementary schools? Researchers found responses to responses that describe teacher barriers that affect the inhibition of Augmented Reality learning in elementary schools, namely

"most teachers still have difficulty applying Augmented Reality because there is no practice and lack of socialization about Augmented Reality learning in the school environment, some schools are far from cities that are minimal technology and located in the countryside plus there is a need for incentive training carried out by experts to socialize the use of Augmented Reality in a simpler and easier to understand package for all people".

Need for Augmented Reality in Science Learning Materials

The response to the question "materials that require Augmented Reality in science learning in elementary schools?" the researcher found sfocus of science material needed in the development of Augmented Reality in elementary schools, among others, "Morphology of plants, animals and humans; human organs (blood circulation, digestive organs, respiratory organs, the workings of the heart) as well as the material of the solar system.

This study aims to find out teachers' views regarding the use of STEM and Augmented Reality so far in elementary schools, including obstacles and material needs, especially in learning science. This is useful for understanding stakeholders making decisions to develop AR to meet the needs of teachers.

The analysis of the results can be seen in Table 2 and Figure 1**.** It can be seen that the results of the percentage of teacher response questionnaires to the need for Augmented Reality in science learning which consists of 5 categories of assessment, there is a percentage of teacher responses based on the questionnaire, namely, there are 46% of teachers who have the opinion that the need for Augmented Reality in science learning is very high. There are 10% of teachers who believe that the need for AR in science learning is moderate or if it meets the criteria for implementing technology in schools. This shows that almost most of the teachers in several public elementary schools in Surakarta require Augmented Reality in science learning. This is evidenced by the fact that 46% of teachers fall into the category of strongly agree and 44% agree, according to the questionnaire response. Thus, it means that the overall analysis of Augmented Reality needs is strongly agreeing to be applied in science learning.

From the results of the analysis, it can be seen that STEM and Augmented Reality have not been implemented optimally. Many things need to be optimized so that STEM and Augmented Reality can be spread in elementary schools. This is because the education system in Indonesia is still struggling with various classic problems, such as indecision in determining the curriculum in elementary schools so socialization is not yet widely spread to areas far from the city. Research shows that science and mathematics teachers lack knowledge in pedagogics, especially in STEM and Augmented Reality education (Stohlmann, Moore and Roehrig, 2012).

In this regard, the results of discussion obstacles that occur are the lack of training, support and socialization, because teaching is a profession that requires special knowledge and skills, teachers as mentors need to have certain competencies, it is important to obtain these competencies through organized training by the relevant department because teachers must be given special training before starting professional teaching (Sisman, M., & Acat, 2003).

An overview of most of the needs for Augmented Reality in supporting science materials, which consist of "Morphology of plants, animals and humans; human organs (blood circulation, digestive organs, respiratory organs, the workings of the heart) as well as the material of the solar system. Therefore, special attention is needed in developing Augmented Reality-based materials as soon as possible from both educational institutions and technology experts in supporting Augmented Reality-based science materials. Because Augmented Reality-based learning can increase student motivation (Cascales-Martínez *et al.*, 2017; Chang and Hwang, 2018). Augmented Reality technology is also a facility for understanding scientific concepts, complemented by the user's sensory perception of the real world as well as interesting computer-generated content to the user's environment, offering new creativity that students have never experienced before between the real and virtual worlds (Azuma *et al.*, 2001; Billinghurst, 2002).

Percentage yield in Figure 1**.** Explain that the proposed Augmented Reality technology work intends to provide immersive experiences and visualizations in the teaching and learning process which should not only be useful for students but also for teachers to understand the morphological

appearance of plants, and, animals and humans; human organs (blood circulation, digestive organs, respiratory organs, the workings of the heart) as well as the material of the solar system, based on cellular. Augmented Reality app has been designed where students can get personal help and better imagination through different angles. Students can also get instructions in completing science learning. This Augmented Reality needs analysis is to equip students with new additional learning methods in science learning using Augmented Reality technology. On students from the perspective of learning effects, learning attitudes and usefulness, as well as on future research for improvement formulated based on information obtained from the effects of applying Augmented Reality in science learning (Arulanand, RameshBabu and Rajesh, 2020; Gargrish, Mantri and Kaur, 2020; Zhou *et al.*, 2020; Liono *et al.*, 2021).

Augmented Reality technology in education has enormous potential, which still has to be exploited. Augmented Reality in curriculum books: curriculum books are presented with schematics and syllabus of various subjects and their objectives and results. When new to understand, it is very difficult because students do not have prior knowledge about it. There is a big gap between schools that are developed and schools that do not meet the technological aspects. So, Augmented Reality is an application based on a scheme that will benefit teachers in their respective technical disciplines involving the adoption of practical knowledge learned by students and generating creative designs new models. Because the Augmented Reality application in the syllabus explains the importance of the teacher to practice so that it helps students to understand the essence of learning it and that knowledge can be applied in school. Today, Augmented Reality is booming, with great potential to revolutionize learning in various fields. To support individual learning styles, we explain the importance of visual channels in the learning process (Scaravetti and Doroszewski, 2019; Bellalouna, 2021).

Dünser et al. explored the principles of application interaction for Augmented Reality-based applications and found that Augmented Reality-based education mainly focuses on technology and hardware. Therefore, they suggest several design principles, including affordability, user satisfaction, fault tolerance, low physical effort, flexibility in use, learning ability, feedback and responsiveness, reducing cognitive overhead, resulting in schools having problems with use. Augmented Reality should be followed up and get special attention from the local government of each elementary school. Based on the views of elementary school teachers, they can support aspects of teacher constraints in applying Augmented Reality technology (Macariu, Iftene and Gîfu, 2020; Tuli and Mantri, 2020).

Indeed, the results of several studies suggest that Augmented Reality may help provide solutions to 3D visualization problems (Kaufmann and Schmalstieg, 2003; Martín-Dorta, Saorín and Contero, 2008; Kaur *et al.*, 2018; Choi, Lee and Kim, 2019; Gecu-Parmaksiz and Delialioglu, 2019). Therefore, Augmented Reality technology can be useful for reducing students' cognitive load when engaging in difficult-to-understand material, especially in science material in elementary schools.

4. CONCLUSION

Overall, the use of STEM and Augmented Reality is considered very useful in supporting the process of successful learning and learning in elementary schools, especially in science learning, and can facilitate teachers in teaching. However, many teachers face barriers to utilization ranging from STEM and Augmented Reality that has not been maximally implemented in schools; the need for wider socialization and training to the need for various Augmented Reality-based science materials that need to be developed. These challenges and obstacles require support from various parties in supporting the start of the Augmented Reality-based material era.

This study only uses interviews as a data collection tool so that it is deemed less in-depth, further researchers need to consider and add other methods so that the research results are broad and the discussion is in-depth, further researchers also need to review the extent to which Augmented Reality and STEM projects can be applied in Indonesia by region.

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