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Physics teachers' perceptions and anxieties about the use of technology-integrated learning resources on magnetic field material: A preliminary research on augmented reality-integrated STEM learning

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Abstract. The educational world development faces the challenges of the 21st-century where technology plays an important role in learning so that technology-integrated teaching material is needed. The subjects of this study were 48 physics subject teachers in several schools in Lampung province. The research method used was a mixed method. The data was collected using questionnaires and interviews. The results of the study revealed that the teachers have never made learning resources assisted by the integration between STEM and augmented reality technology. The teachers also revealed that they were anxious that the learning resources that they will use cannot fully meet the competency standards if they are not equipped with learning technology that supports the abstract concepts learning. Thus, the teachers expected technology-assisted learning resources in which texts, images, 3D animations, and videos can be integrated. For further researchers, it is necessary to develop STEM learning resources assisted by augmented reality technology.
Keywords: Augmented Reality, STEM, Learning Resources

1. Introduction

The development of science and technology has brought the world to the era of industrial revolution 4.0 where science and technology have provided many innovations in conveying knowledge in the field of education. Innovation is closely related to creative-thinking skills which must be achieved in 21st-century education [1]. The competencies that must be achieved in 21st-century education include critical, creative, innovative, and collaborative thinking skills. These skills can be accommodated through various literacy activities, such as media literacy and information and communication technology literacy [2]. Based on this statement, the existence of a learning resource that is integrated with technology and information is needed to convey information to students to overcome the challenges of 21st-century education.

Physics learning materials consist of concrete and abstract concepts. Some materials with abstract concepts include electricity, magnetism, and modern physics which are difficult to visualize so that students find it difficult to understand the material. Therefore, a learning resource is needed that can help students learn abstract concepts. One of the learning alternatives that can present the visualization of 3D objects is a learning resource that integrates augmented reality technology [3]. Several previously done research reveals that learning media that integrates augmented reality technology could help

students understand the abstract concepts materials [4] by displaying 3D images and animations as if they were real objects. It could improve students' understanding of learning physics' abstract concepts [5].

Studying physics is not only limited to understanding concepts but also requires expertise to analyze and solve problems mathematically. Besides, the expertise in designing or engineering a product and technology that can solve problems is also needed. Therefore, an approach that integrates science, technology, engineering, and mathematical observations, often called STEM. The STEM approach can improve students' creative thinking skills in solving problems [6]. STEM is an approach consisting of Science, Technology, Engineering, and Mathematics which is associated with problems in everyday life so that it can improve students' achievement in the fields of science and mathematics [7, 8]. Previous research stated that the STEM approach assisted by augmented reality technology facilitates problem-solving and experimental activities that can improve collaboration skills, critical thinking, and creative-thinking [9]. Based on this statement, STEM learning integrated with augmented reality technology is one of the components that can be collaborated as a learning resource that can facilitate the demands of 21st-century skills.

2. Method

2.1 Research Method

The research method used was the mixed method consisted of qualitative and quantitative data analysis.

2.2 Data Collection Techniques

The subjects of this study were 48 physics teachers from several schools in Lampung province. Data collection techniques used were questionnaires and interviews. The questionnaires contained teachers' perceptions and anxieties about STEM-integrated learning technology while the interviews were conducted with 3 teachers who were experienced in teaching. The interviews were conducted to find out the learning resources and learning technology that the teachers often use in schools. A quantitative data analysis technique was carried out to interpret the results of the questionnaire into percentages while the data obtained through the interviews was analyzed qualitatively. The interpretation of the results of the questionnaires can be seen in Table 1.

Table 1. The Interpretation of Teachers' Perceptions of the Use of Technology in STEM Learning

Interval%	Positive Statements	Negative Statements
$75 < X \leq 100$	Strongly agree	Disagree
$50 < X \leq 75$	agree	Quite agree
$25 < X \leq 50$	Quite agree	Agree
$0 < X \leq 25$	Disagree	Strongly agree

The rubric of the questionnaire can be seen in Table 2.

Table 2. Teacher Anxiety toward the Use of Technology in Learning

Score	Statement
5	Very Anxious
4	Anxious
3	Quite Anxious
2	Unanxious
1	Very Unanxious

The experienced teachers who were interviewed can be seen in Table 3.

Table 3. The Interview Respondents

Respondents	Last Education	Teaching Experience
YS	S1	31 years
SN	S2	28 years
DA	S1	23 years

3. Results and Discussions

3.1 Results

The teachers' perception and anxiety about the use of technology in STEM learning can be seen in Table 4.

Table 4. The Results of the Questionnaire on Teachers' Perceptions of STEM-Integrated Learning Technology

No	Statement	%	Category
1	I use technology to help me in the learning process	65%	Agree
2	I often use the STEM approach in physics learning	40%	Quite agree
3	I use printed learning resources in the form of books, student worksheet, and modules	92%	Strongly agree
4	I don't need technology to make it easier for students to learn physics concepts	87%	Disagree
5	I use technology in the form of cellphones or laptops to facilitate expository activities in the learning process	76%	Agree
6	The learning resources I use are integrated with STEM	30%	Agree
7	I have integrated 3D animation into learning resources to improve students' understanding of learning	10%	Disagree
8	I don't need learning resources that are equipped with text, videos, and 3D animation in the learning process	95%	Disagree
9	I make learning resources that I use at school	34%	Quite agree
10	I use software or applications as the learning resource for physics	50%	Quite agree

The results of the questionnaire about the teachers' anxiety about the use of technology in learning can be seen in Table 5.

Table 5. The Results of the Questionnaire on Teachers' Anxieties of STEM-Integrated Learning Technology

No	Statement	Very Anxious	Anxious	Quite Anxious	Unanxious	Very Unanxious
1	I am worried if I cannot use learning technology appropriately and accordingly	40%	40%	10%	10%	0%
2	I am worried that the technology I use will not be able to achieve basic learning competencies	50%	30%	0%	110 %	10%
3	I feel burdened because I don't use technology that facilitates students' understanding of learning materials	50%	20%	10%	10%	10%
4	I feel burdened if I have to prepare learning technology before the learning starts	50%	12.5%	12, 5%	12.5%	12.5%
5	I feel burdened and anxious because the learning resources I use are not equipped with 3D animation which helps students understand abstract concepts	44.4%	44.4%	11.1%	0%	0%
6	I am anxious if I have to prepare different technologies for different learning topics	30%	20%	30%	10%	10%
7	I am worried that the technology I use is difficult for students to understand	22.2%	33.3%	22.2%	11.1%	11.1%
8	I am worried because I am not sure the technology I have used so far is good enough or not	20%	60%	10%	10%	0%
9	I feel frightened because I am not good at using technology (not using technology)	50%	20%	10%	10%	10%
10	I am worried that the technology I use is misused by students	30%	30%	10%	20%	10%

3.2 Discussion

Based on the results of the questionnaire shown in Table 4, it can be seen that teachers often use printed learning resources such as printed books, student worksheets, and modules. In the learning process, the teachers used technology in the form of a smartphone and laptop to facilitate the exploration of additional reading sources. Only 34% of teachers stated that they made their learning resources, meaning that most teachers had never made their learning resources and only used learning resources provided by the schools. Thus, the learning resources used were not integrated with STEM. The results of the questionnaire also showed that teachers need technology-integrated learning resources equipped with texts, images, videos, and 3D animations to make the learning more interesting and easier for students to understand the material.

Based on the results of the questionnaire in Table 5, the level of teacher anxiety about the use of STEM-integrated technology in learning resources can be seen. The teachers stated that they felt burdened if they have to prepare different technologies for each learning topic. They also said that they were worried if the learning resources they used could not achieve learning competencies because the

learning resources were not equipped with technology to visualize abstract concepts material. Therefore, teachers need learning resources which consist of texts, images, videos, and 3D animations that can visualize learning content more clearly and interestingly. Based on the teacher's wishes, it is very appropriate to conduct a study on the use of augmented reality technology as a solution to the problems found during the needs's analysis. This is supported by relevant research which states that the use of augmented reality technology in the learning process can make it easier for teachers to explain abstract physics concepts through 3D animation visualization [10]. Another study revealed that using augmented reality technology applied in virtual lab activities can improve students' concept understanding [11].

Based on the results of interviews with 3 physics teachers, it was found that, so far, the learning resources that were often used were books, student worksheets, and modules provided by schools (YS and SN), PowerPoint, and Path Simulation (DA). Smartphones and laptops were used as tools to find additional information and to help students complete portfolio assignments. The teachers also stated that the use of smartphones and laptops needed to be integrated into learning resources to make it easier for teachers to explain abstract material. Besides, students also found it easier to understand teacher explanations (YS, SN, and DA). The three interviewed teachers stated that they had never used e-books as learning resources.

The teacher said that the magnetic field material is difficult to explain without the help of media or technology that can visualize images or videos in 3D. Therefore, a technology is needed so that the abstractness of the magnetic field material can be clearly understood by students. So far, teachers have used learning resources in the form of printed-books from Erlangga Publisher. The books consisted of materials or concepts that are connected to everyday life, instructions for implementing practicum, sample questions, practice questions, and enrichment. The books used had not been integrated with STEM because the contents were dominated by concept explanations and were not equipped with activity to train students to manipulate concepts variables. Thus, the students' creativity in designing and engineering had been less trained.

Based on the results of questionnaires and interviews, the STEM learning resources assisted by augmented reality technology had never been used. This was caused by the inexperience in using various learning resources that involve technology. One of the learning resources that can be developed as a solution to meet the needs of teachers for learning resources that are equipped with texts, images, videos, and 3D animations is an e-book. This is supported by previous research which states that learning using e-books through smartphones is effective for improving students' understanding of concepts compared to using printed-books [12] because e-books are packaged attractively so that they are not only text but also equipped with moving images, animations, and video links. The use of e-books can increase literacy activities because e-books can change reading styles to be more practical, effective, and interactive [13]. Another study revealed that e-books can significantly improve students' achievement [14].

The learning resources that integrate various sciences such as STEM can improve students' creative thinking skills through project-based learning and can facilitate students' collaborative thinking and problem-solving skills [15]. Integrating technology in learning can improve students' STEM skills. Thus, providing an integrated STEM learning simulation is very important because it can help students understand concepts and solve problems [16, 17]. Augmented reality technology supports future learning in the form of sensory learning at affordable prices so that it can make a very profitable contribution to the learning process [18]. The augmented reality technology makes learning more relaxed as if the students were playing a game so that it can strengthen their motivation [19,20,21]. Previous research revealed that learning in a physics laboratory using augmented reality had been successful in improving student learning achievement [22]. Therefore, the collaboration between the augmented reality technology and the STEM approach is very important to be applied in learning at various school levels [23]. The substance of STEM which consists of Science, Technology, Engineering, and Mathematics can increase students' conceptual understanding and can also transfer knowledge into various fields of science [24]. Therefore, students from elementary to university level must apply STEM integrated learning to achieve 21st-century skills. STEM learning guarantees students a career after graduating from school because it can train engineering skills [25].

4. Conclusion

The results of the questionnaires and interviews discovered that the teacher had never used STEM learning resources assisted by augmented reality technology. The teacher stated that the learning resources for physics should not only in the form of books that are dominated by reading passages, but they also need images, videos, and 3D animations which can facilitate students' understanding of abstract concepts such as magnetic field material. Based on the needs analysis, the use of a STEM approach integrated with augmented reality technology is highly approved as a solution to the problems experienced by teachers and students so far. It is recommended for further researchers to develop STEM learning resources assisted by augmented reality technology.

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