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Analysis of the Need for Development of Virtual Reality-Based Learning Media to Build Technological Pedagogical and Content Knowledge (TPACK) Competencies for Prospective Physics Teachers

Fajrul Wahdi Ginting[1], Halimatus Sakdiah[1], Widya[1*], Ratna Unaida[2]

[1] Phyisics Education Department, Universitas Malikussaleh, Lhokseumawe, Indonesia.
[2] Chemistry Education Department, Universitas Malikussaleh, Lhokseumawe, Indonesia.

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Corresponding Author:
Widya
widya@unimal.ac.id

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Abstract: Technological Pedagogical and Content Knowledge (TPACK) is a conceptual framework used to describe the knowledge needed by a teacher to integrate technology into the learning process. In the context of developing Virtual Reality (VR) based learning media, physics education students as prospective teachers need to have a strong understanding of how VR technology can be used as a medium for teaching specific topics (TK), how to actively involve students in the VR environment (PK), and a deep understanding of the lesson topics taught (CK). This research aims to produce Virtual Reality-Based Learning Media to build the TPACK competency of Physics Teacher Candidates that is feasible, practical, and effective. The development research method used is EDR (Educational Design Research) with the following stages: analysis and exploration; design and construction; and evaluation and reflection. Based on the questionnaire given to students, interviews conducted with lecturers, and literature review studies that have been carried out, it was concluded that it is necessary to develop Virtual Reality-based Learning Media Development to Build the Technological Pedagogical and Content Knowledge (TPACK) Competencies of Prospective Physics Teachers.

Keywords: Analysis; Media; Need; TPACK; Virtual reality

Introduction

The development of information and communication technology (ICT) has brought about changes in education, both in preparing and managing learning (Yojana, 2022; Dewi et al., 2021; Alismail & McGuire, 2015). Through ICT innovation, teachers can enrich students' learning experiences by providing semi-real understanding to students (Widya et al., 2022;Unaida & Lukman, 2022; Widya et al., 2021). Therefore, teachers need to adapt to technological advances to provide meaningful learning experiences to students (Santika et al., 2022). Competent teachers must be able to integrate this technology into their education (Warjanto, 2015; Moreno et al., 2019; Anandari et al., 2019). The Technological Pedagogical and Content Knowledge (TPACK) concept is a conceptual framework that describes the importance of teacher knowledge and skills in integrating technology with an understanding of pedagogy and subject matter (Pimthong & Williams, 2018; Irmita & Atun, 2018). TPACK is a conceptual framework model that describes the knowledge that teachers must have in teaching using technology (Nofrion et al., 2012; Nursyifa et al., 2020). TPACK presents a clear framework and is able to assess and identify challenges and opportunities in the application of ICT in the future (Lye, 2013). TPACK describes knowledge about effective teaching with ICT

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applications that suit pedagogical and content demands (Valtonen et al., 2017; Jang & Tsai, 2013). TPACK is related to the application of technology to support the pedagogical abilities of teachers/prospective teachers.

Virtual Reality (VR) is a promising technological innovation because it can develop and be applicable in the future (Musril et al., 2020; Bolter et al., 2021). VR is a simulated environment created by a computer that allows users to interact with an immersive digital world (Sá et al., 2021). In education, VR has great potential to enhance students' learning experiences by providing immersive and interactive experiences (Sumardani et al., 2020). In recent years, VR has been used in various educational fields, including science, mathematics, history, and languages (Anderson et al., 2010). VR in education can help students understand complex concepts, visualize information, and develop practical skills (Sá et al., 2021). However, the use of VR in teacher preparation is still relatively new and has not been fully explored (Coelho et al., 2012). Virtual reality is a technology that displays a digital environment that resembles the real world and allows users to interact with that environment. Students can learn directly through virtual reality media (Bolter et al., 2021). Prospective teachers are expected to be able to understand and develop virtual reality media to create fun learning in the classroom.

Although VR has been widely studied in student education, its use in teacher preparation remains limited. Prospective teachers need to gain experience with VR technology due to a need for more understanding in integrating it into learning (Anderson et al., 2010). Prospective teachers' understanding of VR media still needs to improve, so they need to be introduced to learning using VR media. The introduction of VR media needs to be done to increase understanding of TPACK. Apart from that, the availability of learning media that contain TPACK material is still lacking, so it is necessary to develop learning media that increases the teacher's understanding of TPACK and VR media.

Therefore, concrete steps need to be taken to develop learning media in VR so that students can try direct learning experiences and understand more deeply about VR. The learning material presented in VR media aims to develop TPACK competencies. Previously, Musril et al. (2020) researched VR development and found that computer assembly learning media received product validity test results of 79% with valid criteria. Practicality test results of 84.11 with efficient standards. From research conducted by Musril et al. (2020) regarding the development of VR as a learning medium for solar systems, based on product feasibility test results, results were 83% with very feasible criteria. They received positive responses from users, both teachers and students.

Method

This research is research and development using the EDR (Educational Design Research) development method. This research develops virtual reality-based learning media to build TPACK competencies for prospective physics teachers. The schematic design of the EDR development model is:

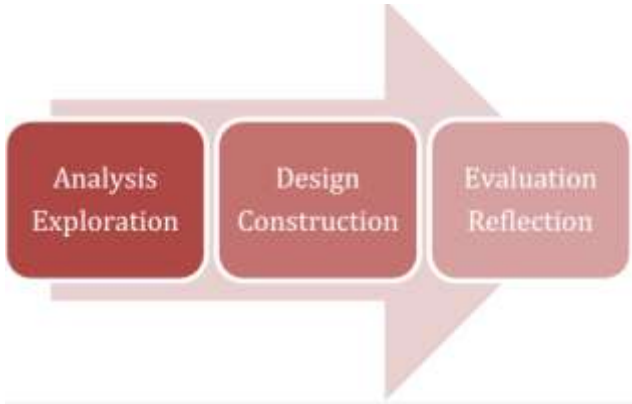

Figure 1. A general model for conducting educational design research (McKenney & Reeves, 2021)

In this article, we discuss in more depth the first stage of the EDR model, namely analysis and exploration. This stage is carried out through several activity steps, including: first, distributing questionnaires to microteaching students to see students' learning difficulties and collecting opinions from students regarding the ideal learning that students want. ; second, interviews with microteaching lecturers, aimed at seeing the problems encountered by lecturers in carrying out microteaching lectures and seeing the ideal conditions for microteaching courses from the lecturer's point of view; last, review several documents related to virtual reality and TPACK competencies.

Result and Discussion

Analysis and Student Results

Analysis was carried out to see students' opinions regarding the implementation of Microeaching. Student analysis explores information related to difficulties, suggestions, and learning, such as what students like or need. The results of the distribution of student analysis questionnaires can be seen in the figure 2.

Figure 2 illustrates some information: First, only 15% of students already know information about Virtual Reality media; second, 97 students expressed interest in knowing more in-depth information related to VR; third, no students have used VR media during microteaching

lectures; fourth,58% of students do not understand the TPACK concept well; fifth, 80% of students agree that VR media can support the achievement of TPACK competencies; sixth, 92% of students agree that VR media can support the implementation of the Merdeka curriculum; seventh, Students do not yet have teaching materials/media that contain information about TPACK in digital form; eighth 100% of students agree that media in the form of VR makes it easier for students to obtain information about TPACK; nineth, 93% of students agree that VR media can be accessed by students anywhere and anytime. Based on the data above, information is obtained that there are still many students who know about VR media, students have an interest in learning more about VR media, students have not used VR media when microteaching, most students do not understand TPACK, students agree that VR media makes it easier in understanding the material. VR media can make it easier for students to understand the material because learning is presented virtually (Musril et al., 2020; Sholihin et al., 2020). Students' understanding of TPACK is still lacking, while TPACK ability is a basic ability that students must have before teaching in class (Nofrion et al., 2012; Safriana et al., 2023).

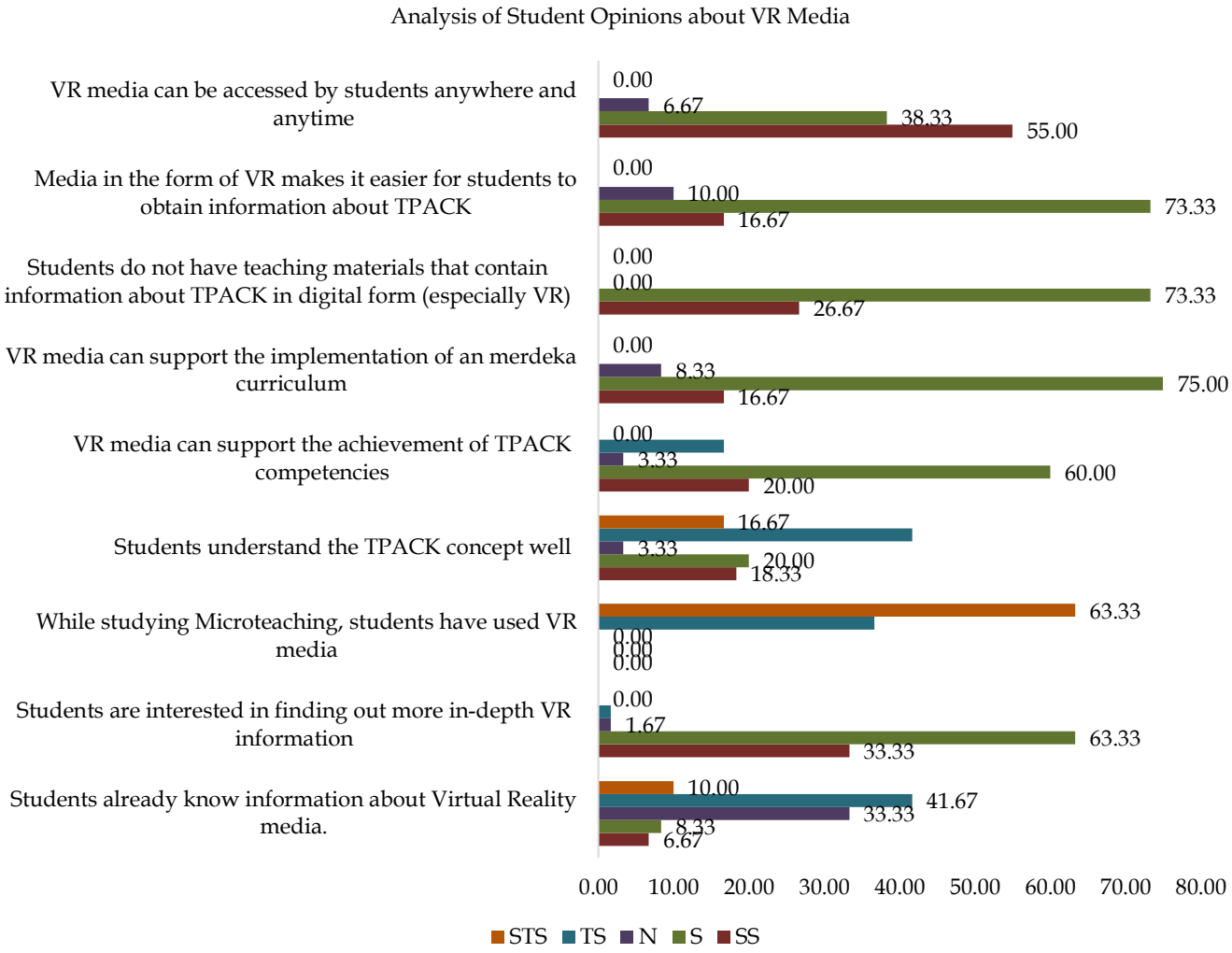

Figure 2. Result of student opinions analysis about VR media

Teacher Interview Results

Apart from distributing questionnaires to students, the research team also collected information through interviews with ten lecturers who teach micro-teaching courses at FKIP Malikussaleh University. The information obtained are: Students' mastery of TPACK is not optimal; Students have not developed learning media in the form of VR; VR media is suitable for learning in the Merdeka curriculum; TPACK material can be delivered via VR and can be accessed by students anywhere and anytime; Lecturers agree to carry out VR development research, especially for TPACK material,

so that it can be used as a solution for teaching materials for microteaching courses (Valtonen et al., 2017; Moreno et al., 2019).

Review Related Documents

To complete the analysis and exploration stages, the research team also completed the exploration by reviewing related documents. The documents analyzed are scientific journals related to research on TPACK and VR: Sri Sekaesih et al., through their research, found that prospective biology teachers still experience obstacles in managing adequate teaching time. It was identified that 46% of students still had difficulty managing their time because prospective teacher students did not have sufficient teaching experience. Also, 77% of future teachers experience problems in classroom management. Therefore, prospective teachers' TPACK abilities still need to be improved in several aspects of mastery of content, pedagogy, and technology (Sukaesih et al., 2017); (2) The main advantage of VR media is the experience that makes users feel the sensation of the natural world in the virtual world. Through VR, users feel taken to another dimension where the situation's depiction resembles the object's original shape. VR has 4 essential elements: a) virtual worlds, which are three-dimensional environments that are often realized through media (i.e., renderings, displays, etc.); b) immersion, namely the perception of being physically present in a non-physical world, a sensation created by VR technology for users to feel a natural environment even though it is fictitious; c) sensory feedback, where virtual reality requires as many of our senses as possible to be simulated: d) interactivity, tasked with responding to user actions so that users can interact directly in a fictional field (Musril et al., 2020).

Based on the findings above, several solutions need to be taken, including there need to be concrete steps taken by lecturers to prepare microteaching lessons so that students can master TPACK competencies well. There are no TPACK teaching materials in digital form yet, so it is necessary to develop TPACK teaching materials in digital form, so it is required to create digital teaching materials that allow students to learn anywhere and anytime (Purwanto & Risdianto, 2022). Digital teaching materials allow students to study independently and interact longer with teaching materials so that students can understand the material well and completely (Setiawardani et al., 2021; Siahaan, 2021; Widya et al., 2022). One form of digital media is VR; through VR, students will feel the sensation of learning in the real world but feel like they are in a real space (Musril et al., 2020). Apart from that, based on the questionnaire distributed to students, information was obtained that students were interested in learning to use VR and wanted to know more details about VR. Therefore, it is necessary to develop digital teaching media in VR to support students' achievement of TPACK competencies

Conclusion

Based on the questionnaire given to students, interviews conducted with lecturers, and literature review studies that have been carried out, it was concluded that it is necessary to develop Virtual Reality-based Learning Media Development to Build the Technological Pedagogical and Content Knowledge (TPACK) Competencies of Prospective Physics Teachers.

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Author Contributions

Dveveloping VR Media: W, F.W.G; Making instruments: H.S, R.U; Processing data: W, F.W.G.

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Conflicts of interest

The authors declare no conflictofinterest.

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