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The development of Virtual Reality (VR) Micro Teaching Laboratory to improve TPACK Skills of FISIP-UNY education students

by

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Abstract

This study aims to develop a Virtual Reality (VR)-based learning media in the form of a Micro Teaching Laboratory to enhance the Technological Pedagogical Content Knowledge (TPACK) of pre-service teacher students at the Faculty of Social and Political Sciences, Yogyakarta State University.The research employed a Research and Development (RnD) approach using the ADDIE development model (Analysis, Design, Development, Implementation, and Evaluation). The research trial involved 48 pre-service teacher students from FISIP UNY. Effectiveness testing was carried out through quantitative analysis, including prerequisite testing (data normality using the Shapiro-Wilk test), effectiveness testing using the Wilcoxon Signed Rank Test, and calculation of Normalized Gain (N-Gain). The results show that the developed VR media is highly feasible based on expert validation. A total of 88% of students showed increased learning scores after using the media. The Wilcoxon test result yielded a significance value of 0.000 (p < 0.05), indicating a significant difference between pre-test and post-test scores. The average pre-test score of 70 increased to 93.33 in the post-test, with an N-Gain score of 0.82, indicating a "high" level of improvement. This media can be accessed anytime and anywhere via the link: https://unyku.id/VirtualRealityUNY. In conclusion, the developed Virtual Reality Micro Teaching Laboratory learning media is proven to be feasible, effective, and innovative in supporting the enhancement of students' TPACK. These findings contribute to the integration of immersive technology in higher education learning, particularly in the context of micro teaching training.

Introduction

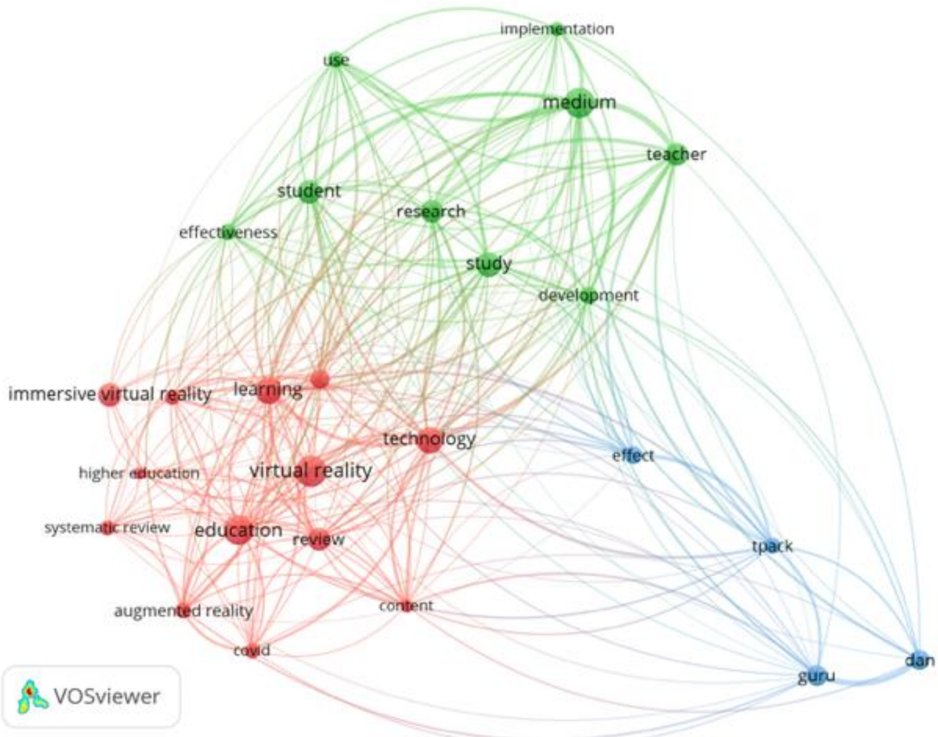
Improving the quality of education in Indonesia is closely related to the professionalism of teachers in delivering effective, innovative, and adaptive learning in line with technological developments. National regulations through the Minister of National Education Regulation No. 16 of 2007 and the Minister of Research, Technology, and Higher Education Regulation No. 55 of 2017 emphasize that teachers must master four main competencies, one of which is pedagogical competence, which includes the ability to utilize Information and Communication Technology (ICT) in learning. In line with this, the Technological Pedagogical and Content Knowledge (TPACK) framework developed by Koehler and Mishra (2006) is an important reference for measuring the integration of technology in teaching practices. TPACK emphasizes that quality learning can only be achieved if content mastery (CK), pedagogy (PK), and technology (TK) can be integrated harmoniously.

Despite its obvious urgency, various studies show that the ability of teachers and prospective teachers to integrate technology is still low. Data from the Ministry of Education and Culture (2021) reveals that around 60% of teachers in Indonesia have not mastered ICT optimally. Andriani (2021) reported that out of 28,000 teachers tested, only 14% reached level 2 ICT proficiency. Rahayuningsih (2022) further notes that while some students are capable of using computers, their proficiency in operating educational applications remains limited. These findings are in line with research by Mujiono et al. (2024), which highlights obstacles such as limited facilities, lack of ongoing support, and low creativity among teachers in utilizing educational technology.

In the context of higher education, micro teaching is a strategic tool for developing the pedagogical and TPACK competencies of education students (Saptadi et al., 2023). As Sardiman (2018) emphasizes, the effectiveness of teaching and learning interactions is strongly influenced by student motivation and the ability of educators to create meaningful learning experiences. However, at the Faculty of Social and Political Sciences (FISIP) of Yogyakarta State University (UNY), the implementation of micro teaching still faces significant laboratory limitations. There are only two studios available for six education study programs, which restricts students' opportunities to practice teaching. Initial observations also reveal that students have relatively low skills in utilizing the available technological devices, such as smartboards and interactive screens. These conditions not only reduce student motivation but also highlight the urgency of adopting innovative, technology-based learning solutions to enhance micro teaching practices.

One potential solution is the use of Virtual Reality (VR). VR technology can provide an immersive and interactive learning experience with simulations of real environments (Helmie et al., 2022). International research has confirmed the benefits of VR in improving learning engagement, digital literacy, and pedagogical skills of prospective teachers (Radianti et al., 2020; Jensen & Konradsen, 2018). However, research in Indonesia that specifically examines the use of VR in the context of micro teaching is still very limited. Most previous studies have only focused on VR for general simulations or science learning, while the strengthening of TPACK among education students through VR has not been widely explored.

Figure 1.
Bibliometric visualization of keywords Virtual Reality, Teaching, Learning, Technology, and TPACK using VOSviewer



Source: Data processed by researchers, 2025

Bibliometric analysis using VOSviewer (see Figure 1) also shows that the keywords virtual reality, learning, teaching, technology, and TPACK appear in closely connected clusters. This indicates that the integration of VR in TPACK-based learning is a global research trend and is receiving serious attention in the current academic literature. In particular, the association of the term TPACK with the words “effect” and “teacher” confirms that the effectiveness of VR in improving the pedagogical competence of prospective teachers is an issue that remains relevant and urgent to research.

Thus, this study has an important contribution to filling the research gap, namely the limited studies on VR in the context of micro teaching and the development of TPACK skills of education students in Indonesia. Based on this description, this study aims to develop a Virtual Reality (VR) Micro Teaching Laboratory that is feasible, practical, and effective in improving the TPACK skills of FISIP-UNY education students.

Method

This study uses a research and development (R&D) approach with the ADDIE model (Analysis, Design, Development, Implementation, Evaluation). The ADDIE model was chosen because it provides a systematic framework for developing technology-based learning media (Branch, 2010; Sugiyono, 2022). The purpose of this study was to produce a Virtual Reality (VR) Micro Teaching Laboratory that could improve the Technological Pedagogical Content Knowledge (TPACK) competencies of FISIP-UNY education students. In the analysis stage, the researchers identified student needs and examined the limitations of the micro teaching laboratory facilities. This needs analysis is important to ensure that the developed product is in line with the context and needs of users (Suryandari et al., 2020).

The design stage was carried out by compiling content, features, and micro teaching-based learning scenarios, which included the integration of pop-up information, device usage simulations, and teaching strategy guidelines. This design was developed in accordance with instructional design principles that emphasize the integration of technology, pedagogy, and content (Koehler & Mishra, 2006; Oktaviana & Yudha, 2021).

The development stage then focused on creating the product using Lapentor software, resulting in an interactive 3D micro teaching laboratory simulation. The resulting product was validated by media experts, subject matter experts, and education lecturers to ensure its content and technical feasibility (Helmie et al., 2022). The data collected from the assessments of subject matter experts and media experts, as well as the student assessments, is still in quantitative form. To provide a more meaningful interpretation, the results of the quantitative data need to be converted into qualitative data using a 5-point Likert scale.

The implementation stage was carried out through limited trials on students of the History Education Study Program at FISIP-UNY who were taking micro teaching courses. These trials aimed to assess the practicality of using media and its effectiveness in supporting TPACK mastery. This phase focused on measuring students' understanding before and after the implementation of the learning media through pre-tests and post-tests. The tests were designed to assess cognitive development across the three core knowledge domains Technological Knowledge (TK), Pedagogical Knowledge (PK), and Content Knowledge (CK), as well as their ability to integrate these domains within a teaching context (TPACK integration).

The development of test items was grounded in Bloom's Taxonomy of Cognitive Domains, which allows for systematic measurement of students' cognitive processes, ranging from lower-order thinking skills (such as remembering and understanding) to higher-order skills (such as analyzing, evaluating, and creating). Each test item was carefully aligned with specific indicators derived from the learning objectives and the targeted knowledge domain, ensuring content validity and construct coherence.

The following table presents the detailed guidelines for the test instruments, including the subject matter, question indicators, cognitive domain classification, and corresponding item numbers. This table serves as a blueprint for evaluating students' cognitive performance and provides a transparent framework for the measurement of TPACK mastery in the limited implementation stage.

Table 1.
Test Instrument Guidelines (pre-test and post-test)

No	Subject matter and question indicators	Cognitive Domain	Item Number
A.	***Technological Knowledge*** **(TK)**		
1	Students are able to state the definition of Virtual Reality (VR) technology.	C1	1
2	Students can explain the concept of immersion in the use of VR.	C2	2
3	Students are able to analyze hardware and software requirements for VR implementation.	C4	3
4	Students are able to understand how VR works in providing an immersive learning experience.	C5	4
5	Students can compare the advantages and limitations of using VR technology in learning.	C5	5
6	Students are able to use the basic features of Smartboard for interactive learning activities.	C3	6
7	Students are able to operate advanced Smartboard features to support a variety of learning interactions.	C3	7
B	***Pedagogical Knowledge*** **(PK)**		
8	Students can explain the differences between VR media and conventional learning media.	C2	8
9	Students are able to explain the procedures for using the micro teaching laboratory effectively.	C2	9
10	Students understand the function of micro teaching laboratory facilities in supporting the learning process.	C2	10
C	***Content Knowledge*** (CK)		
11	Students are able to state the definition of learning media.	C1	11
12	Students can compare the advantages and disadvantages of VR and conventional learning media.	C4	12
13	*Students are able to identify the equipment in the micro teaching laboratory.*	C1	13
D	***TPACK Integration***		
14	Students are able to explain how VR technology can improve the effectiveness of teaching materials delivery.	C2	14
15	Students can choose the appropriate learning method for specific materials by utilizing VR technology.	C5	15

Source: Data processed by researchers, 2025

Next, a comprehensive evaluation stage was conducted to assess the feasibility, practicality, and effectiveness of the media. Quantitative data analysis was performed using prerequisite tests, the Wilcoxon Signed Rank Test, and N-Gain calculations to determine the improvement in students' abilities after using VR media (Nasirun et al., 2020; Fitri Ginting et al., 2024). The following is the determination of Normalized Gain

(N-Gain) using a formula developed by Richard R. Hake (1999) to measure learning effectiveness based on the increase in pre-test and post-test scores.

Table 2.
Criteria for Interpreting Normalized Gain (N-Gain) Values

N-Gain Range	Improvement Category
$g > 0.70$	Height (Effective)
$0.31 \leq g \leq 0.70$	Moderate (Fairly effective)
$g < 0.30$	Low (Less Effective)

Source: Richard R. Hake (1999); Sugiyono (2022)

The following table presents the research stages according to the ADDIE model:

Table 3.
Stages of ADDIE Model Development in Research

Phase	Description
Analysis	Analysis of student needs and identification of limitations in micro teaching laboratory facilities (Suryandari et al., 2020).
Design	Development of content, features, appearance, and micro teaching-based learning scenarios (Koehler & Mishra, 2006).
Development	Media development using Lapentor in the form of interactive 3D simulations, validated by media and material experts (Helmie et al., 2022).
Implementation	A limited trial was conducted with education students to assess the practicality and effectiveness (Fitri Ginting et al., 2024).
Evaluation	Comprehensive evaluation through questionnaires, observation, and quantitative analysis (pre-test, post-test, Wilcoxon test, and N-Gain) (Nasirun et al., 2020).

Source: Data processed by researchers, 2025

Result and Discussion

This research product is a Virtual Reality (VR) Micro Teaching Laboratory learning medium designed to help FISIP-UNY education students improve their TPACK skills. This medium takes the form of an interactive 360° virtual tour that allows students to explore the laboratory immersively. A needs analysis conducted in the initial stage showed that the majority of students wanted VR-based innovations to support micro teaching learning. A total of 88-94% of respondents stated that VR-based media was urgently needed to overcome facility limitations, improve technology usage skills, and provide a more realistic learning experience. The location and documentation of the image capture can be seen in Figure 2 below:

Figure 2
Location Mapping and and 360° Panorama Image Capture Documentation 1

Figure 3
Location Mapping and and 360° Panorama Image Capture Documentation 2

Figure 4
Location Mapping and and 360° Panorama Image Capture Documentation 3

Figure 5
Location Mapping and and 360° Panorama Image Capture Documentation 4

Figure 6
Location Mapping and and 360° Panorama Image Capture Documentation 5

The media was developed using Lapentor software supported by an Insta360 camera for panoramic imaging, the Insta360 Studio application for visual processing, and Canva for supporting graphic design. The media content includes room navigation, information pop-ups, narrative audio, and other interactive features. All elements are designed to support students in understanding the functions of the room, equipment, and teaching strategies in the micro teaching laboratory.

Validation was conducted by subject matter experts and media experts to assess the feasibility of the product. The results of the subject matter expert validation showed an average score of 4.78 (Excellent category) with a feasibility percentage of 92.9% (Highly Feasible). The aspects assessed included the suitability of the content to micro teaching competencies, the completeness of the material, and the integration of technology. Media expert validation also confirmed that the visual aspects, interactive navigation, and immersive media level strongly support the learning objectives. The following are the results of the Material Expert Validation (see Table 4):

Table 4.
Results of Expert Validation

Aspects Assessed	Average Score	Category
Content suitability	4,80	Very Good
Integration of materials	4,75	Very Good
Technology integration	4,79	Very Good
Total average	4,78	Very Good

Source: Data processed by researchers, 2025

A limited trial was conducted on students of the History Education Study Program at FISIP-UNY who were taking micro teaching courses. The results showed a significant increase in students' TPACK abilities. The average pre-test score of 70 increased to 93.33 on the post-test. The N-Gain calculation showed a value of 0.82, which is categorized as high. In addition, students responded positively to the practicality and ease of use of VR media.

The results of the observation also show that students are more confident in operating micro teaching devices after practicing using VR media. This media helps them understand the layout, use of supporting technology, and pedagogical strategies before practicing directly in the laboratory. The results of this study confirm that the development of VR Micro Teaching Laboratories is effective in improving the TPACK competencies of education students. This is in line with Hamilton's (2021) findings, which state that the use of VR in learning can increase students' motivation and pedagogical skills. Radianti et al. (2020) also found that VR provides a more interactive and in-depth learning experience, which has a positive impact on the teaching skills of prospective teachers.

This study also reinforces the findings of Helmie et al. (2022), which show that VR training can develop the pedagogical competencies of elementary school teachers. In the context of education students, VR has been proven to overcome the limitations of physical laboratories, improve technological readiness, and foster TPACK-based pedagogical skills. Thus, VR can be a strategic solution in micro teaching learning in higher education, especially in facing the challenges of the digital era and 21st-century education.

Conclusion

This study successfully developed a Virtual Reality (VR) Micro Teaching Laboratory learning medium aimed at improving the Technological Pedagogical Content Knowledge (TPACK) of FISIP-UNY education students. The results of the development show that this medium not only presents a simulation of a micro teaching laboratory room in a 360° virtual tour format, but is also equipped with various interactive features such as pop-up information, narrative audio, and simulations of the use of learning devices. The resulting product was deemed highly feasible based on the results of subject matter expert validation with an average score of 4.78 or 92.9% (Very Feasible category) and media expert validation that emphasized visual quality and interactivity. Thus, this VR media has been proven to meet feasibility standards in terms of both content and technical aspects as a means of supporting micro teaching in a university environment.

A limited trial involving students from the History Education Study Program at FISIP-UNY showed a significant increase in TPACK competence. Quantitative analysis results showed that the average pre-test score of 70 increased to 93.33 on the post-test with an N-Gain value of 0.82, which is classified as high. This data indicates that the use of VR media can strengthen students' understanding of TPACK concepts, improve pedagogical skills, and train technological skills in the context of learning. Students also responded positively to the ease of access, practicality, and appeal of the media, and felt more confident when operating micro teaching laboratory equipment directly after practicing through VR.

With these results, it can be concluded that the development of the Micro Teaching Laboratory VR media is a strategic solution in overcoming physical facility limitations, improving the readiness of prospective teachers, and supporting 21st-century technology-based learning. This media also makes a real contribution to learning innovation in teacher training colleges, particularly in strengthening students' TPACK competencies. The research product is openly accessible via the website https://unyku.id/VirtualRealityUNY.

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