An Analysis Study of the Utilisation of Digital Learning Media in the Implementation of Microteaching Biology

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Abstract. Microteaching is a simulation or training for prospective teachers to explore the ability of skills in teaching that combines the components of learning. The purpose of this study was to analyse the implementation of microteaching learning in terms of the use of various biology learning media with a touch of technology. The method used is descriptive quantitative with observation sheets and interviews. This research uses a squential explanatory design that combines quantitative and qualitative methods sequentially the first stage of collecting and analysing quantitative data followed by collecting and analysing qualitative data to help explain quantitative results. The results of the study regarding the pattern of using technology-based learning media showed that PowerPoint 92% and learning videos 78% were the most widely used media in microteaching practice. While the level of effectiveness of the media used varies. The 4.6% digital microscope showed a high level of effectiveness even though the frequency of use was still low. This indicates that high technology-based learning media has considerable potential in improving the quality of learning. Furthermore, the analysis of students' digital competence shows that 70% of students have good to very good mastery of technology. Furthermore, creativity in media development shows an even distribution while time management is still a challenge for 35% of students at a sufficient or insufficient level. The use of technology-based learning media in micro teaching has considerable potential, but still faces several challenges. A systematic and comprehensive approach is needed to optimise the use of technology in developing the teaching competence of prospective biology teachers.

Keywords: Microteaching, Technology, Media, Biology

1. INTRODUCTION

Microteaching is one of the important methods in preparing prospective teachers to face real learning situations. In the context of biology education, the effectiveness of microteaching can be enhanced through the use of various innovative learning media. The integration of technology and learning media in microteaching not only helps student teachers develop their teaching skills, but also introduces them to various tools that can enhance the understanding of complex biological concepts.

Microteaching allows prospective teachers to develop their pedagogical skills through focused teaching practice and reflection (Kartal et al. 2019). Other sources say microteaching is a teacher training approach that allows prospective teachers to practice teaching skills in a controlled environment and receive constructive feedback from peers and lecturers (Kılıç, 2010). Microteaching can be understood as a training method that allows prospective teachers to practise and develop specific teaching skills in a controlled environment, with a focus on feedback and reflection for improvement.

Microteaching and learning media have a very close and mutually supportive relationship. Learning media play an important role in improving the effectiveness and quality of microteaching, while microteaching provides an ideal platform for teacher candidates to practise the use of various learning media. Microteaching provides an opportunity for teacher candidates to integrate and practise the use of various learning media, including digital technology. Teacher candidates can simulate the use of learning media that they will use in real classrooms, allowing them to anticipate challenges and optimise their use. Microteaching allows teacher candidates to receive immediate feedback from lecturers and their peers on the effectiveness of their use of learning media, helping them to refine and optimise their use of media.

Recent research shows that the use of diverse learning media in microteaching can improve teaching readiness and confidence of student teachers (Husnaini, 2022). In addition, the use of interactive learning media in microteaching has been shown to improve students' ability to explain abstract lesson concepts (Mahmud & Rawshon, 2013). However, despite its great potential, the effective implementation of various learning media in the context of microteaching still faces several challenges, including limited resources and the need for specialised training for microteaching instructors (Marble, 1980).

Research on microteaching and the use of learning media in biology education has been widely conducted, but there are still some gaps that need further research, most studies focus on the short-term impact of using learning media in microteaching, there is still a lack of longitudinal research that examines the long-term effectiveness of teaching performance of teachers after graduation (Rodolico & Hirsu, 2023). Research on the use of emerging technologies such as augmented reality (AR) and virtual reality (VR) in biology microteaching is limited. More studies are needed to understand the potential and challenges of implementing these technologies (Zhang et al, 2024). There are still few studies that specifically examine how the use of learning media in biology microteaching can support the development of 21st century skills such as critical thinking and creativity (Sadikin et al, 2024).

Various problems encountered in the implementation of microteaching lessons related to technology-based learning media include limited adequate technological equipment such as computer projectors or internet connections, in addition to limitations in accessing digital devices in developing learning media. Furthermore, different levels of understanding of digital literacy also affect the implementation of learning that can be

done by providing special training and integrating technology with biology learning content effectively. Furthermore, technical obstacles in operating software or learning applications can be in the form of a lack of compatibility of various equipment and platforms. Then it takes a lot of time to prepare for the development of digital learning media. Another challenge faced is the difficulty in creating simulations or animations to explain various complex biological processes. Then the problem in presenting a realistic virtual practicum experience. The purpose of this study was to determine the implementation of microteaching learning in terms of the use of various biology learning media with a touch of technology.

2. LITERATURE REVIEW

Concept and Development of Microteaching in Biology Education

Microteaching has long been recognised as an effective method in preparing prospective biology teachers. Allen & Ryan (1969) first introduced the concept as a way to improve teaching skills through focused practice. Since then, microteaching has evolved and adapted to technological advances. Fernández (2010) showed that microteaching helps prospective biology teachers develop pedagogical skills and increase their confidence. Furthermore, Fernández (2010) proposed a lesson study-based microteaching model for science education, which involves: Collaborative planning, Teaching and observation, Reflection and revision, Re-teaching.

A recent study by Kartal et al. (2019) confirmed the effectiveness of microteaching in preparing biology teachers to deal with the complexities of science teaching in the modern era. Brown (1975) identified four main components of microteaching in the context of science education, including biology including biological content knowledge, specific teaching skills, feedback, repeated practice. Tondeur et al. (2019) identified challenges and opportunities in microteaching biology in the digital era, including integration of new technologies such as VR and AR, development of 21st century skills, adaptation to changes in the biology curriculum. The concept and development of microteaching in biology education is constantly evolving, adapting to technological advances and new understandings of science teaching and learning. The focus remains on improving the teaching skills and Pedagogical Content Knowledge (PCK) development of prospective biology teachers, with increasing integration of technology to enhance training effectiveness.

Integration of Learning Media in Biology Microteaching

The use of learning media in biology microteaching has been shown to increase the effectiveness of teacher candidate training. Hsu et al. (2017) demonstrated how augmented reality can help visualise complex biology concepts in microteaching sessions. Meanwhile, Martínez-Borreguero et al. (2020) explored the potential of virtual reality in creating a more realistic classroom simulation for microteaching practice. Advances in digital technology have opened up new opportunities for biology microteaching. Theelen et al. (2019) demonstrated the effectiveness of using 360-degree videos in improving the interpersonal skills of prospective biology teachers. Furthermore, Zainuddin & Perera (2018) explored how Learning Management Systems (LMS) can support reflection and feedback in microteaching. Although technology offers many benefits, its implementation in biology microteaching is not without challenges.

Tondeur et al. (2019) identified several barriers, including instructors' technological readiness and inadequate infrastructure. However, they also emphasised the important role of teacher educators in preparing teacher candidates for effective technology integration. Research shows that the use of technological media in microteaching can improve various teaching skills. Fausan et al, (2024) found that prospective teachers who used technological media in microteaching showed significant improvement in the ability to explain complex biological concepts. In addition, Tohani & Aulia, (2022) observed an increase in 21st century skills such as critical thinking and creativity. Danday, (2019) conducted a comparative study on the use of multimedia in biology microteaching between prospective teachers in China and the United States. They found that the effective use of technological media can be influenced by cultural factors and the local educational context. The development of technology also affects the way of evaluation and assessment in microteaching. Kleinknecht & Gröschner (2016) demonstrated how structured video feedback can improve pre-service teachers' reflection skills. Meanwhile, Danday & Monterola, (2019) explored how technology can support more inclusive assessment in biology microteaching.

Digital Technology in Biology Microteaching

The integration of digital technology in biology microteaching is based on the Technological Pedagogical Content Knowledge (TPACK) framework developed by Mishra & Koehler (2006). TPACK emphasises the importance of the interaction between technology, pedagogy and content in effective teaching. Advances in digital technology have opened up new opportunities in the implementation of biology microteaching.

Theelen et al. (2019) demonstrated the effectiveness of using 360-degree videos in improving the interpersonal skills of prospective biology teachers. Furthermore, Zainuddin & Perera (2018) explored how Learning Management Systems (LMS) can support reflection and feedback in microteaching. Jonassen (1994) suggested that technology can serve as a cognitive tool to construct knowledge.

Mayer (2005) explains how multimedia can improve conceptual understanding. Tondeur et al. (2012) proposed the SQD (Synthesis of Qualitative Data) model for technology integration in teacher education, which can be applied in biology microteaching in the form of Role modelling in technology use, Reflection on the role of technology, Instructional design learning, Collaboration with peers, Scaffolding authentic experiences, Continuous feedback. This theory describes how digital technology can be integrated into biology microteaching to improve the effectiveness of prospective teacher training. It covers the theoretical basis, types of technologies used, implementation models, effectiveness, and challenges and considerations in their application.

Challenges and Opportunities of Technology Implementation in Microteaching

Although technology offers many benefits, its implementation in biology microteaching is not without challenges. Tondeur et al. (2019) identified several barriers, including instructors' technological readiness and inadequate infrastructure. However, they also emphasised the important role of teacher educators in preparing future teachers for effective technology integration. Tondeur et al. (2019) identified that one of the main challenges is technology readiness, both in terms of infrastructure and instructor skills. Many teacher education institutions face obstacles in providing the latest technology for microteaching practice. Ertmer & Ottenbreit-Leftwich (2010) pointed out that resistance to change, especially among long-time instructors, can be a significant barrier to technology adoption in microteaching. Mishra & Koehler (2006) emphasise the challenges of meaningfully integrating technology into pedagogical practice. Often, technology is used superficially without deep integration with content and pedagogy.

Admiraal et al. (2017) identified time and resource constraints as key barriers to the implementation of technology in teacher education, including in microteaching. Tondeur et al. (2017) suggested that to overcome the challenges and capitalise on the opportunities, a holistic approach involving: Continuous professional development for microteaching instructors, Curriculum design that integrates technology meaningfully, Collaboration between educational institutions and technology industries, Further research on the effectiveness of various technologies in different microteaching contexts. While the

implementation of technology in microteaching faces various challenges, the opportunities it offers are significant. Successful implementation will depend on a balanced and integrated approach, which considers technology, pedagogy and content aspects holistically.

Impact of Technology Media Use on Teaching Skills

Research shows that the use of technological media in microteaching can improve various teaching skills. Kim & Bolkan (2023) found that prospective teachers who used technological media in microteaching showed significant improvement in the ability to explain complex biological concepts. Furthermore, the use of technology media in microteaching can improve teacher candidates' ability to explain complex concepts. They observed significant improvements in presentation clarity and communication effectiveness. In addition, Rodríguez & Martínez (2019) observed an increase in 21st century skills such as critical thinking and creativity. Tondeur et al. (2012) identified that the use of technology in microteaching can improve prospective teachers' skills in designing lessons that integrate technology effectively. They emphasised the importance of hands-on experience in developing Technological Pedagogical Content Knowledge (TPACK).

Admiraal et al. (2017) found that the use of technology in microteaching can improve prospective teachers' reflection and self-evaluation skills. They observed an improvement in prospective teachers' ability to analyse and improve their own teaching practices. Hsu et al. (2017) demonstrated that the use of technology such as augmented reality in microteaching can improve teacher candidates' skills in using educational technology. They found an improvement in pre-service teachers' ability to integrate advanced technology into their teaching. The use of technological media in microteaching had a significant positive impact on various aspects of teaching skills. From improved presentation and communication skills to the development of reflection and self-evaluation skills, technology plays an important role in preparing teacher candidates for the demands of teaching in the digital age. However, it is important to note that the effectiveness of using technological media depends on proper implementation and adequate support for teacher candidates in integrating technology into teaching practice.

3. METHODS

This research uses a mixed-method approach, combining quantitative and qualitative methods. The research design used was sequential explanatory, where quantitative data

was collected and analysed first, followed by qualitative data collection and analysis to deepen the understanding of the quantitative results. This study was designed to provide a comprehensive understanding of the implementation of microteaching with a focus on the use of various technology-based biology learning media. The mixed-method approach enabled an in-depth analysis of the effectiveness and challenges in the implementation of technological learning media in the context of biology microteaching.

The research was conducted in biology education, Faculty of Teacher Training and Education, Surakarta Muhammadiyah University in the even semester of the 2023/2024 academic year. The research time was from February 2024 to June 2024. The population and sample of this study were all biological education students in semester VI who took microteaching courses. The sampling technique was carried out by selecting a random class sample (Cluster Random Sampling) from all 6th semester biology classes with certain criteria such as microteaching course teachers and experience using technology in learning.

Data collection techniques were taken by observation and documentation. The instrument in this study is an observation sheet that contains observation indicators in the implementation of microteaching practices which include being able to determine learning strategies, learning media appropriately according to the needs of students with a touch of TPACK (The chosen learning strategy is appropriate, learning media in accordance with the material and students, Using a touch of technology). Furthermore, it is analysed and concluded.

4. RESULTS

This study uses a squential explanatory design that combines quantitative and qualitative methods in a sequential manner, first collecting and analysing quantitative data followed by collecting and analysing qualitative data to help explain the quantitative results.

Table 1. use of technology-based learning media in microteaching

No.	Media type	Frequency of use (%)	Effectiveness level (1-5)	Technical constraints (%)
1	PowerPoint presentation	92	4,2	15
2	Learning video	78	4,5	25
3	Virtual lab simulation	45	4,3	40
4	Interactive Quiz App	65	4,0	30
5	Digital microscope	35	4,6	45

| 6 | LMS Platform | 85 | 3,8 | 20 |

Source: author's data processing, 2024

The table on the use of learning media shows that PowerPoint is still the most frequently used media at 92% while learning videos show a high level of effectiveness, while virtual lab simulations have considerable potential but are still subject to high technical constraints or 40%.

Table 2. student competence in the use of learning media

No.	Aspects of competence	Very good (%)	Good (%)	Simply (%)	Less (%)
1	Technology mastery	25	45	20	10
2	Integration with material	30	40	25	5
3	Creativity	35	35	20	10
4	Time management	20	45	25	10
5	Interaction with students	40	35	15	10

Source: author's data processing, 2024

In the student competency table, 70% of students have good to excellent mastery of technology while integration with learning materials shows positive results as much as 70% while time management is still a challenge as much as 35%.

Table 3. interview analysis themes

No.	Main theme	Subtheme	Frequency of occurrence (%)
1	Technical constraints	a. Unstable internet connection b. Device limitations c. Software compatibility issues	85 75 60
2	Competency development	a. Specialised training needs b. Continuous mentoring c. Access to learning resources	90 80 70
3	Institutional support	a. Infrastructure availability b. Development policy c. Budget	95 85 80

Source: author's data processing, 2024

The table of supporting and inhibiting factors for learning media includes institutional support being a key success factor, then internet connection and device limitations are the most important obstacles, while the need for specialised training is very high at 90%.

5. DISCUSSION

The results of the research on the pattern of using technology-based learning media show that PowerPoint and learning videos are the most widely used media in microteaching practice. This is due to several factors, among others: Students' familiarity

with basic presentation applications to support teaching flow and not as a substitute for verbal communication. Learning PowerPoints are easier to create and operate. It is more flexible to integrate with various multimedia contents. PowerPoint also provides slide templates and other supportive resources such as inserting quiz questions, discussions, or links to other resources to make it more interesting. However, the low usage of virtual lab simulations and digital microscopes indicates a gap in the utilisation of more sustainable learning technologies. This is related to the complexity of operating the equipment, limited access to technological tools and lack of specialised training on advanced learning technologies.

The data shows that the level of effectiveness of the media used varies greatly. The digital microscope shows a high level of effectiveness even though the frequency of use is still low, this indicates that high technology-based learning media has considerable potential in improving the quality of learning. Furthermore, there needs to be a systematic effort to increase the accessibility of learning technology on an ongoing basis and then there needs to be investment in the use of learning technology equipment that can have a significant impact on student understanding.

Analysis of students' digital competence shows interesting results as 70% of students have good to very good mastery of technology, then creativity in media development shows an even distribution while time management is still a challenge as many as 35% of students are at a sufficient or insufficient level.

The impact of these findings include the need for training that focuses on aspects of time management in the use of learning media, the importance of developing creativity in designing learning media and the need for a sustainable learning technology utilisation assistance system. This study strengthens previous research that emphasises the integration of digital technology in the learning process that can increase the effectiveness of biology learning through innovative media (Fausan et al, 2024).

6. CONCLUSION

Microteaching learning with a touch of technology needs to be done gradually and structured. The success of learning depends not only on the sophistication of the technology used, but also on the ability of prospective teachers to integrate the technology effectively in biology learning. the level of effectiveness of technology-based learning media used varies. the use of technological media in microteaching must remain focused

on achieving learning objectives and increasing student understanding of biological material, not solely on its technological aspects.

REFERENCES

Admiraal, W., Louws, M., Lockhorst, D., Paas, T., Buynsters, M., Cviko, A., ... & Kester, L. (2017). Teachers in school-based technology innovations: A typology of their beliefs on teaching and technology. *Computers & Education, 114*, 57–68. https://doi.org/10.1016/j.compedu.2017.06.013

Allen, D., & Ryan, K. (1969). *Microteaching reading.* Massachusetts: Addison-Wesley.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Brown, G. (1976). *Microteaching: A programme of teaching skills.* London: Methuen.

Creswell, J. W., & Creswell, J. D. (2017). *Research design: Qualitative, quantitative, and mixed methods approaches.* Sage Publications.

Danday, B. A. (2019). Active vs. passive microteaching lesson study: Effects on pre-service teachers' technological pedagogical content knowledge. *International Journal of Learning, Teaching and Educational Research, 18*(6), 181–200.

Danday, B. A., & Monterola, S. L. C. (2019). Effects of microteaching multiple-representation physics lesson study on pre-service teachers' critical thinking. *Journal of Baltic Science Education, 18*(5), 692–707.

Ertmer, P. A., & Ottenbreit-Leftwich, A. T. (2010). Teacher technology change: How knowledge, confidence, beliefs, and culture intersect. *Journal of Research on Technology in Education, 42*(3), 255–284. https://doi.org/10.1080/15391523.2010.10782551

Etikan, I., Musa, S. A., & Alkassim, R. S. (2016). Comparison of convenience sampling and purposive sampling. *American Journal of Theoretical and Applied Statistics, 5*(1), 1–4. https://doi.org/10.11648/j.ajtas.20160501.11

Fausan, M. M., Hakim, S., & Pujiastuti, I. P. (2024). Transformation of technology literacy and creative thinking skills of prospective biology teachers through interactive microteaching. *Journal of Education Research, 5*(4), 5229–5238.

Fernandez, M. L. (2010). Investigating how and what prospective teachers learn through microteaching lesson study. *Teaching and Teacher Education, 26*(2), 351–362. https://doi.org/10.1016/j.tate.2009.09.012

Hsu, Y. S., Lin, Y. H., & Yang, B. (2017). Impact of augmented reality lessons on students' STEM interest. *Research and Practice in Technology Enhanced Learning, 12*, 1–14. https://doi.org/10.1186/s41039-016-0039-z

Husnaini, H. (2022). Development of self-esteem-oriented microteaching materials for IAIN Palopo English education students. *IDEAS: Journal on English Language Teaching*

and Learning, Linguistics and Literature, 10(1), 538–560. https://doi.org/10.24256/ideas.v10i1.2408

Ivankova, N. V., Creswell, J. W., & Stick, S. L. (2006). Using mixed-methods sequential explanatory design: From theory to practice. *Field Methods, 18*(1), 3–20. https://doi.org/10.1177/1525822X05282260

Jonassen, D. H. (1994). Technology as cognitive tools: Learners as designers. *ITForum Paper, 1*(1), 67–80.