Transformation of Technology Literacy and Creative Thinking Skills of Prospective Biology Teachers through Interactive Microteaching

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Abstrak

Perguruan tinggi memiliki peran penting dalam menyiapkan mahasiswa calon guru biologi yang kompeten dalam perkembangan teknologi guna menghadapi tantangan pembelajaran abad ke-21. Penelitian ini bertujuan untuk mengetahui perbedaan literasi teknologi dan keterampilan berpikir kreatif pada mahasiswa sebelum dan setelah dibelajarkan dengan model microteaching interaktif yang mengintegrasikan teknologi dan kreativitas. Penelitian ini merupakan penelitian kuasi eksperimen dengan menggunakan rancangan one-group pretest-posttest design. Populasi dalam penelitian ini adalah seluruh mahasiswa sedang memprogram mata kuliah microteaching. Selanjutnya dengan menggunakan teknik cluster random sampling, dipilih dua kelas (jumlah mahasiswa= 33 orang) sebagai sampel penelitian. Instrumen yang digunakan dalam penelitian ini yaitu lembar observasi untuk mengukur literasi teknologi dan keterampilan berpikir kreatif mahasiswa. Analisis data yang digunakan adalah analisis deskriptif dan inferensial (uji t-berpasangan). Hasil penelitian menunjukkan bahwa semua indikator literasi teknologi dan keterampilan berpikir kreatif yang diamati menunjukkan peningkatan yang signifikan dari pretest ke posttest. Hasil uji komparatif menggunakan uji t-berpasangan juga menegaskan bahwa terdapat perbedaan signifikan variabel literasi teknologi dan keterampilan berpikir kreatif pada mahasiswa sebelum dan setelah penerapan model microteaching interaktif.

Kata Kunci: *Microteaching interaktif, literasi teknologi, berpikir kreatif.*

Abstract

Higher education institutions play a crucial role in preparing biology teacher candidates to be proficient in technological advancements to meet the challenges of 21st-century learning. This study aimed to determine the differences in technology literacy and creative thinking skills among students before and after being taught using an interactive microteaching model that integrated technology and creativity. This quasi-experimental study used a one-group pretest-posttest design. The study population consisted of all the students enrolled in the microteaching course. Using the cluster random sampling technique, two classes (33 students) were selected as the research sample. The instruments used in this research were observation sheets that were used to measure students' technological literacy and creative thinking skills. Descriptive and inferential analyses were used for data analysis (paired t-test). The results showed that all observed indicators of technology literacy and creative thinking skills demonstrated significant improvements from pretest to post-test. Comparative test results using the paired t-test also confirmed that there were significant differences in the technology literacy variables and creative thinking skills among students before and after the implementation of the interactive microteaching model.

Keyword: *Interactive microteaching, technology literacy, creative thinking.*

INTRODUCTION

Higher education institutions play a crucial role in preparing biology teacher candidates to be proficient in technological advancements to meet the challenges of 21st-century learning. Along with these technological developments, innovative and interactive approaches are needed for the teaching skill development process (Orhan & Sahin, 2018). This not only enabled them to integrate technology in learning but also helped them adapt to diverse learning needs and styles in the modern era.

The teaching skills of prospective teacher students can be empowered through a micro-teaching course (El-Koumy, 2022; Faisal & Martin, 2019). Students in the microteaching course were taught basic teaching principles and provided opportunities to teach microsessions to their fellow students and/or lecturers (Arnaz & Adnan, 2021). The purpose of this activity was to provide constructive feedback on their teaching techniques so that they could gradually improve their teaching skills. Furthermore, microteaching has also been reported to be the best way to improve the teaching competencies of teacher students (Kimaro et al., 2021).

Although the microteaching course was always present in the curriculum, previous microteaching models rarely integrated the aspects of technology and student creativity. The results of a preliminary study conducted in mid-February 2024 in microteaching lectures at the Biology Education Study Program, FKIP, West Sulawesi University, showed that a) prospective biology teachers wanted more interactive learning experiences in accordance with the digital era they experienced, b) students' technological literacy was not optimal, and c) students' creative thinking skills were still at the basic level. In fact, technology literacy and creative thinking skills are two important competencies needed by prospective teachers in the future because they have a close relationship, where digital technology could be a powerful tool to support creative thinking (Holm, 2024; Rizal et al., 2021). Regression analysis results showed that technology literacy and integration had a significant influence on students' teaching competencies (Santoso & Lestari, 2019). On the other hand, creative thinking can provide opportunities for students to use their ideas, thoughts, intelligence, and insights to deal with certain situations for long-term success (Perry & Karpova, 2017). Therefore, an interactive microteaching model that integrates technology and creativity is needed so that this research is novel, while serving as an alternative solution to the problems that have occurred.

The development of an interactive microteaching model that integrates technology and creativity has become increasingly important. For example, the use of technology in microteaching enables students to be more actively involved in the learning process and creates a dynamic, interesting, and meaningful learning environment (Ledger & Fischetti, 2020; Yuvita et al., 2022). On the other hand, creativity was a key element in effective and meaningful learning (Mathews & Reddy, 2019), where by integrating it into the learning process, it could create a learning environment that was interesting, challenging, and motivated students to achieve their best potential. Thus, this model not only helped students understand learning concepts but also provided valuable practical experience in dealing with real situations in the classroom.

Technology and creativity in the context of biology learning have become an inseparable part of daily life, making it important for prospective teachers to understand and integrate them. The interactive microteaching model can also provide a more engaging and motivating learning experience for students, as it combines elements of creativity and technology to deliver learning materials. Research has shown that technology has a positive and significant impact on student engagement and learning in higher education, including behavioral, social, cognitive, and reflective engagement (Katyara et al., 2022). Therefore, students should be better prepared to face learning challenges in the digital era and create an inspiring learning environment for their students in the classroom. Collaboration between lecturers and students in an interactive microteaching model that integrates technology and creativity is expected to become a strong foundation for preparing prospective biology teachers to become innovative and adaptive educators.

The research problems proposed in this study were as follows: 1). Is there a difference in technology literacy between students before and after being taught using an interactive microteaching model that integrates technology and creativity?, 2). Is there a difference in creative thinking skills between students

before and after being taught using an interactive microteaching model that integrates technology and creativity?

METHOD

This quasi-experimental study used a one-group pretest-posttest design. The research procedure began with direct observation (technology literacy and creative thinking skills) at the beginning of learning (teaching practice), followed by the implementation of an interactive microteaching model that integrates technology and creativity. Another teaching practice was conducted to observe technological literacy and creative thinking skills after treatment. Each indicator of technology literacy and creative thinking skills was assessed using a 1-4 Likert scale.

The population in this study consisted of all students in the Biology Education Study Program, Faculty of Teacher Training and Education, Universitas Sulawesi Barat, who were enrolled in a microteaching course. Using a cluster random sampling technique, two classes (total number of students = 33) were selected as the research sample.It means, the researchers used cluster random sampling, which is a probability sampling technique where the population is divided into clusters, and then some of these clusters are randomly selected to form the sample.

The instrument used to measure science literacy was an observation sheet that had 6 indicators: the use of technology devices in learning, integration of digital media in material delivery, implementation of interactive learning applications, use of digital learning resources, use of technology for assessment and evaluation, and digital collaboration in the learning process. Meanwhile, the instrument used to measure students' creative thinking was an observation sheet that had 5 indicators: originality in material delivery, flexibility in solving learning problems, elaboration in concept explanation, fluency in generating new ideas, and sensitivity to learners' needs. The instruments were first validated by peers and then declared valid. Table 1 lists the instruments used in this study.

Table 1. Research Instruments

No	Variable	Instrument	Number of Indicators
1	Technology Literacy	Observation Sheet	6
2	Creative Thinking	Observation Sheet	5

The data analysis was descriptive and inferential. Descriptive analysis included the mean, median, standard deviation, and minimum and maximum values. For inferential statistical analysis, a prerequisite test was first conducted, namely the normality test using the Shapiro-Wilk test. If data were normal, a paired t-test was performed. All analyses were performed using the SPSS software.

RESULTS AND DISCUSSION

Students' Technology Literacy

The observed indicators of technology literacy consisted of six components, as presented in Table 2. A summary of the pre-test and post-test means for technology literacy is presented in Table 2. For an easier understanding, digital literacy data are also visualized in Figure 1. Table 3 presents the descriptive statistics of the technology literacy data. The prerequisite test in the form of a normality test for the technology literacy data is presented in Table 4. Finally, Table 5 presents the comparative test results of the technology literacy data using the paired t-test.

Table 2. Pretest and Posttest of Technology Literacy

No	Observed Indicators	Mean	
		Pretest	Posttest
1	Use of technology devices in learning	64.4	93.2
2	Integration of digital media in material delivery	48.5	77.3

No	Observed Indicators	Mean	
		Pretest	Posttest
3	Implementation of interactive learning applications	43.2	70.5
4	Use of digital learning resources	59.1	87.9
5	Use of technology for assessment and evaluation	47.0	69.7
6	Digital collaboration in learning process	40.9	76.5

Table 2 shows that there was a significant improvement in students' technology literacy after the implementation of the interactive microteaching model that integrates technology and creativity. All indicators showed improvement from pretest to post-test. The largest improvement was in the use of technological devices in learning, from 64.4 to 93.2. The other indicators also showed significant improvement. In the digital collaboration in the learning process indicator, although it initially had the lowest score (40.9), it showed an impressive improvement, reaching a mean of 76.5 in the posttest. The potential reasons for several indicators experiencing substantial increases include: a) the interactive microteaching model likely provided direct and hands-on experience with technological devices; b) students may have gained confidence in using technology through structured and creative learning activities; and c) students may have learned new tools and strategies for digital collaboration.

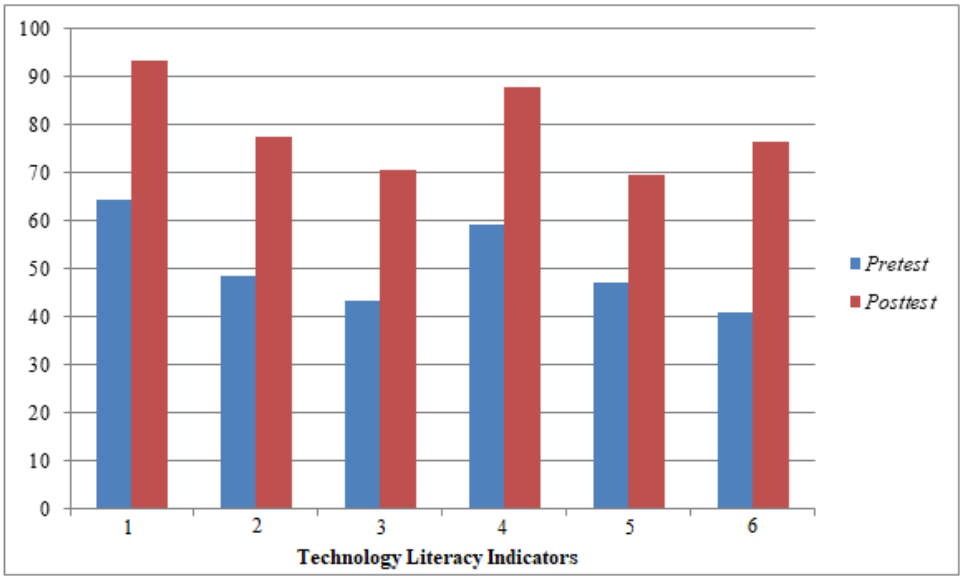

Figure 1. Pretest and Posttest for Each Technology Literacy Indicator

Figure 1 displays a comparison of pre-test and post-test scores for the six technology literacy indicators. Posttest scores were consistently higher than pretest scores for all indicators. Indicator 1 (use of technology devices in learning) recorded the highest scores in both the pre-test and post-test, while Indicator 6 (digital collaboration in the learning process) had the lowest pre-test score but still showed significant improvement in the post-test. Overall, Figure 1 indicates the success of the interactive microteaching model, which integrates technology and creativity to improve students' technological literacy skills across all measured indicators.

Table 3. Descriptive Statistics of Technology Literacy

	Mean	Median	Std. Deviation	Minimum	Maximum
Pretest Technology Literacy	50.500	50.000	5.0804	37.5	58.3
Posttest Technology Literacy	79.161	79.200	6.0732	66.7	91.7

Table 3 presents a broader statistical picture of the changes in technology literacy. The mean score increased from 50.500 in the pre-test to 79.161 in the post-test, indicating substantial improvement. An increase in the minimum value from 37.5 to 66.7 and the maximum value from 58.3 to 91.7 indicated that progress occurred across all aspects of student ability. The increase in the standard deviation from 5.0804 to 6.0732 indicated a slightly wider score distribution in the post-test results. This could be interpreted as diversity in the students' learning pace. Some students may have shown faster progress, whereas others developed at different rates, resulting in a more varied range of scores on the final assessment.

Table 4. Normality Test of Technology Literacy

	Shapiro-Wilk		
	Statistic	df	Sig.
Difference between Pretest and Posttest Technology Literacy	.940	33	.069
Lilliefors Significance Correction			

Table 4 presents the results of the Shapiro-Wilk normality test for technology literacy data. A test statistic value of 0.940 with 33 degrees of freedom (df) resulted in a significance value (Sig.) of 0.069. With a significance value greater than 0.05, it can be concluded that the difference between the pretest and posttest technology literacy data was normally distributed. This met the normality assumption required for further analysis using the paired t-test.

Table 5. Comparative Test of Technology Literacy using Paired T-Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Pretest Technology Literacy – Posttest Technology Literacy	-28.6606	5.0867	.8855	-30.4643	-26.8569	-32.367	32	.001

Table 5 displays the paired t-test results for the technology literacy data. The mean difference between the pre- and post-test was -28.6606, showing a significant increase. The 95% confidence interval for this difference ranged from -30.4643 to -26.8569, not including zero, which was statistically significant. The t-value (-32.367) with 32 degrees of freedom (df) resulted in a significant value (Sig. 2-tailed) of 0.001, which was well below 0.05. Thus, it can be concluded that there was a significant difference in technology literacy among students before and after being taught using the interactive microteaching model that integrated technology and creativity ($p = 0.001 < 0.05$).

The results showed that the implementation of an interactive microteaching model that integrated technology and creativity had a significant positive impact on improving technology literacy among pre-service biology teachers. The results of the data analysis show a significant improvement in students' technological literacy. This improvement occurred across all measured

technology literacy indicators, with the greatest improvement in the use of technological devices in learning indicators. These findings align with Tondeur et al. (2017), who stated that technology integration in teacher education programs could improve pre-service teachers' readiness to use technology for teaching. The interactive microteaching model implemented in this study provides opportunities for students to practice using technology in real learning contexts, thus increasing their confidence and competence in integrating it. On the other hand, the significant improvement in digital collaboration in the learning process indicator showed that this model successfully encouraged students to explore the potential of technology in facilitating collaborative learning. This aligns with the view of Voogt et al. (2013), who emphasized the importance of developing digital collaboration skills as part of 21st-century competencies.

Students' Creative Thinking Skills

The observed indicators of creative thinking skills consist of five components, as presented in Table 6. A summary of the pretest and posttest means for creative thinking skills is also shown in Table 6. For easier understanding, the creative thinking skills data are shown in Figure 2. Descriptive statistics for the creative thinking skills data are presented in Table 7. The prerequisite test, in the form of a normality test for creative thinking skills, is shown in Table 8. Finally, Table 9 presents the comparative test results of the creative thinking skills data obtained using the paired t-test.

Table 6. Pretest and Posttest of Creative Thinking Skills

No	Observed Indicators	Mean	
		Pretest	Posttest
1	Originality in material delivery	40.2	78.8
2	Flexibility in handling learning problems	41.7	74.2
3	Elaboration in concept explanation	31.8	63.6
4	Fluency in generating new ideas	37.1	70.5
5	Sensitivity to student needs	32.6	78.8

Table 6 shows the significant developments in the students' creative thinking skills. All observed indicators demonstrated significant improvement from pretest to post-test. Indicator 5 (sensitivity to student needs) showed a substantial jump from 32.6 in the pretest to 78.8 in the posttest. Indicator 3 (elaboration in concept explanation), which initially had the lowest score of 31.8, also experienced a significant increase to 63.6 in the post-test. The potential reasons for several indicators experiencing substantial increases include: a) potential exposure to student-centered teaching strategies; b) improved communication skills; c) more in-depth understanding of subject matter; and d) practice in breaking down complex concepts.

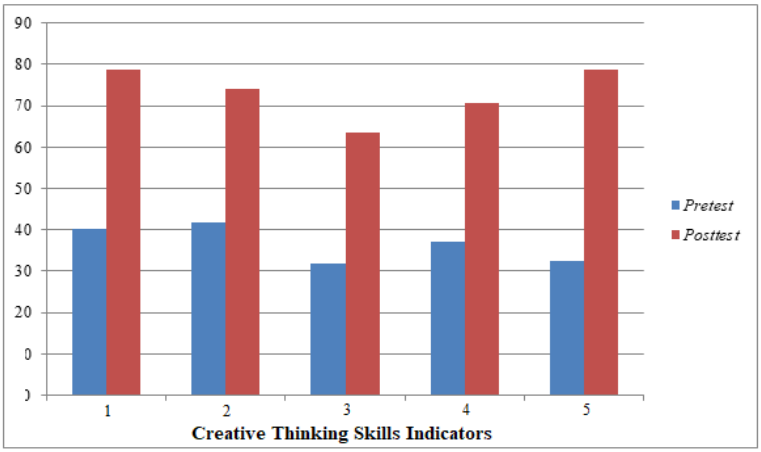

Figure 2. Pretest and Posttest for Each Creative Thinking Skills Indicator

Figure 2 displays a comparison of pre-test and post-test scores for the five creative thinking skill indicators. Significant improvements were consistently observed from pre-to post-test scores across all indicators. Indicator 5 (sensitivity to student needs) showed the most striking improvement, with a post-test score approaching 80, far exceeding the pre-test score by approximately 30. Indicator 3 (elaboration in concept explanation) had the lowest pre-test score but still showed a significant improvement in the post-test. Overall, Figure 2 indicates that the interactive microteaching model integrating technology and creativity successfully improved students' creative thinking skills significantly across all measured aspects, with the largest improvements seen in Indicator 5 (sensitivity to student needs) and Indicator 1 (originality in material delivery).

Table 7. Descriptive Statistics of Creative Thinking Skills

	Mean	Median	Std. Deviation	Minimum	Maximum
Pretest Creative Thinking Skills	36.667	35.000	8.2601	25.0	50.0
Posttest Creative Thinking Skills	73.182	70.000	10.5932	50.0	95.0

Table 7 provided comprehensive statistical insights about changes in creative thinking skills. The mean score increased markedly from 36.667 in pretest to 73.182 in posttest. The increase in minimum value from 25.0 to 50.0 and maximum value from 50.0 to 95.0 indicated that improvement occurred across all student ability categories. The increase in standard deviation from 8.2601 to 10.5932 indicated greater variation in posttest scores, possibly reflecting differences in student responses to the treatment provided in learning.

Table 8. Normality Test of Creative Thinking Skills

	Shapiro-Wilk		
	Statistic	**df**	**Sig.**
Difference between Pretest and Posttest Creative Thinking Skills	.950	33	.136

Lilliefors Significance Correction

Table 8 presents the Shapiro-Wilk normality test results for creative thinking skills data. A test statistic value of 0.950 with 33 degrees of freedom (df) yielded a significance value (Sig.) of 0.136. With a significance value greater than 0.05, it was concluded that the difference between pre-test and post-test data for creative thinking skills was normally distributed. This also indicated that the prerequisite test before the comparative test with the paired t-test was satisfied.

Table 9. Comparative Test of Creative Thinking Data using Paired T-Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Pretest Creative Thinking – Posttest Creative Thinking	-36.5152	9.9597	1.7338	-40.0467	-32.9836	-21.061	32	.001

Table 9 displays the paired t-test results for creative thinking skills data. The mean difference between the pre-test and posttest was -36.5152, showing a very large increase. The 95% confidence interval for this difference ranged from -40.0467 to -32.9836, indicating statistical significance. The

t-value (-21.061) with 32 degrees of freedom (df) yielded a significant value (Sig. 2-tailed) of 0.001, which was well below 0.05. Therefore, it was concluded that there was a significant difference in students' creative thinking skills before and after being taught using the interactive microteaching model that integrated technology and creativity ($p = 0.001 < 0.05$).

The results showed a significant improvement in the students' creative thinking skills. The largest improvements were observed in the indicators of sensitivity to student needs and originality in material delivery. This improvement could be attributed to the implementation of the interactive microteaching model, which encourages students to explore creative ways to integrate technology into biology teaching. This aligns with the findings of Henriksen et al. (2016), who stated that appropriate technological integration can foster creativity in teaching and learning. On the other hand, significant improvements in the elaboration of concept explanation indicators showed that this model successfully encouraged students to develop the ability to explain biological concepts more deeply and creatively. This corresponds with Doppelt's (2009) view that emphasizes the importance of developing higher-order thinking skills, including elaboration, in science education.

Student Responses

Student responses after learning represent the feedback or reactions given by students after the implementation of the interactive microteaching model that integrates technology and creativity. Students completed the questionnaire by selecting the following response options: 1= strongly disagree, 2= disagree, 3= agree, and 4= strongly agree. A summary of the student response data is provided in Table 10.

Table 10. Student Responses

No	Statement	Mean
	A. Planning Aspect	
1	This microteaching model helped me plan technology-integrated learning	3.8
2	I felt more creative in designing learning media	3.4
3	This model encouraged me to prepare more interactive learning	3.6
	B. Implementation Aspect	
4	The use of technology in microteaching made biology learning more interesting	3.8
5	I felt more confident in using technology when teaching biology	3.6
6	I could encourage active student participation through technology use	3.7
7	This model helped me develop creativity in teaching	3.7
	C. Evaluation Aspect	
8	I could design more innovative biology learning evaluations	3.5
9	This model helped me reflect on teaching practices	3.4
	D. Professional Development Aspect	
10	I felt more prepared to face teaching challenges in the digital era	3.7
11	This model encouraged me to continue innovating in biology learning	3.6

These positive responses indicated that the interactive microteaching model was practical for improving various aspects of students' teaching competencies, especially in the context of technology integration and creativity development in biology learning. These findings align with those of Tondeur et al. (2012), who emphasized the importance of practical experience in integrating technology during teacher education to enhance prospective teachers' readiness to use technology in the classroom. The interactive microteaching model implemented in this study provides opportunities for students to practice and reflect on technology use in the context of biology learning.

CONCLUSION

Based on the results and discussion, this study concludes that the interactive microteaching model implemented in this research provides opportunities for students to practice and reflect on the use of technology and creativity in the context of biology learning. This was evident from the

significant improvement in students' technology literacy variables after the implementation of the interactive microteaching model that integrated technology and creativity. All technology literacy indicators showed improvements from pretest to post-test. The largest improvement was in the indicator of technological device usage in learning. The other indicators also showed significant improvements. Additionally, significant development was observed in students' creative thinking skills variables, where all indicators showed significant improvement from pre-test to post-test. There was a substantial increase in the creative thinking skills indicator of sensitivity to students' needs. Overall, the results showed significant differences in the technology literacy variables and creative thinking skills among students before and after the implementation of the interactive microteaching model that integrated technology and creativity.

Lecturers should develop interactive microteaching models that comprehensively integrate technology and creativity in the context of biology learning. This model can provide significant opportunities for students to practice and reflect on the use of technology as well as develop their creative thinking skills. Furthermore, development strategies for interactive microteaching models should always consider indicators of technology literacy and creative thinking skills.

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