The Effect of STEM-ESciT-based Mobile Learning in Improving the Creativity Thinking Ability of Preservice Teachers

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Abstract: Creative thinking is one of the abilities a person must have in the 21st century. Unfortunately, the data shows Indonesian student graduates have low creative thinking ability. Higher Education as graduate producers is required to produce graduates with 21st-century abilities, one of which is the ability to think creatively. Therefore, this research aims to determine the effect of STEM-ESciT-based Mobile Learning on improving pre-service teachers' creative thinking ability. This research used a quasi-experimental method with a pre-test, post-test control group design approach. In this research, the samples were divided into two groups: the experimental group using the STEM-ESciT-based learning model and the control group using the conventional learning model. Sixty-four samples were used in this research, with equal distribution between the two groups. Data were collected through essay tests, and data analysis was conducted using a t-test. The results showed that the use of STEM-ESciT-based learning media had a significant effect on student creativity. In addition, the pre-test and post-test results showed a more significant improvement compared to the conventional learning model.

Keywords: Creativity Thinking, Mobile Learning, Preservice Teachers, STEM-ESciT

INTRODUCTION

Creative thinking is one of the abilities a person must have in the 21st century. This ability is the ability to develop, convey new ideas, be open and carry out activities responsively (Aini et al., 2020). Creativity is often defined by a person's ability to make or create something new (Bujor & Avasilcai, 2016). Indeed, creativity depends on one's creative thinking in developing new ideas. Unfortunately, the data shows

Indonesian student graduates have low creative thinking skills (Sumarni & Kadarwati, 2020).

Higher Education graduates are required to produce graduates with 21st-century skills, one of which is the ability to think creatively. Unfortunately, the learning system used has not been able to have a significant impact on these abilities (Rasulova, 2020). Therefore, a media or learning approach that can improve creative thinking skills is needed.

Mobile learning media is an innovation in the learning process that aligns with technological developments. The benefits of the media can increase motivation in the learning process so that what the teacher wants to convey can be received by students (Fujiawati & Raharja, 2019). In addition, the collaboration of the STEM-ESciT approach can improve students' creativity skills. The STEM approach is very relevant to the 21st-century education curriculum (Ainulluluah et al., 2022). Then, the conceptualization of ESciT, where educators can integrate entrepreneurial thinking and science process skills in producing innovative products, can foster students' thinking patterns more creatively (Lynch et al., 2021).

Several studies have been conducted on using mobile learning, STEM, and ESciT in science learning. Rumadani Sagala et al. (2019) reported that relevant STEM-ESCiT learning can produce optimal learning and improve student understanding. In their research, Sumarni & Kadarwati (2020), in their research said that ethno-STEM project-based learning showed a significant effect on improving students' critical and creative thinking skills. Furthermore, Sirajudin et al. (2021) also reported that STEM can be used as an alternative approach to enhancing students' creative thinking skills. Finally, Kim et al. (2020) reported that the use of mobile technology in an academic context directly impacts students' higher-order thinking skills, in addition to their learning effort and active engagement in the subject.

From the explanations above, it can be concluded that mobile learning and STEM and ESciT approaches have advantages that can be utilized to improve students' creativity. However, until now, no one has combined these three concepts. Therefore, this research investigates the effect of STEM-ESciT-based mobile learning media on students' creativity ability.

METHOD

This research used a quasi-experimental method with a pre-test, post-test control group design approach. In this design, two groups are randomly selected and then given a pretest to assess the initial state and determine whether there is a significant difference between the experimental and control groups. The pretest results are good if the experimental group scores show no significant difference. In this research, the sample was divided into two groups: the experimental group using the STEM-ESCiT-based

learning model and the control group using the conventional learning model. Table 1 shows the design of this research.

Table 1.

Research Design

Group	Pre-test	Treatment	Post-test
Experimental	O_1	X	O_3
Control	O_2	-	O_4

Information

X: Experimental group treatment

O_1: Experimental group pre-test

O_2: Control group pre-test

O_3: Experimental grouppost-test

O_4: Control group post-test

This study, 64 pre-service students were sampled as research subjects, with an even distribution between the experimental and control groups. Our research data was obtained through an essay test consisting of ten questions. Using an essay test as a measuring tool was chosen because it allowed us to deeply explore students' creativity in applying the STEM-ESCiT concept. In addition, to analyze the data obtained, we relied on the t-test. This statistical approach provides a solid framework to measure the significant difference between the two groups in improving students' creativity ability after the STEM-ESCiT-based learning intervention.

RESULT AND DISCUSSION

Result

Creativity Thingking Ability

Students' creative thinking ability refers to their ability to generate new ideas, innovative solutions, and original thinking in a learning context. It involves students' ability to look at a problem or situation from multiple perspectives, to think outside conventional boundaries, and to apply their creative thinking to given tasks or issues. Table 2 displays the pre-test and post-test results for students' creative thinking skills in the experimental and control groups.

Table 2.

Data on pre-test and post-test results of student's creative thinking skills

Group	Pre-tets		Post-test	
	average	SD	average	SD
Experiment	45.291	10.213	84.973	9.421
Control	46.871	7.243	78.219	8.902

The average pre-test score in the "Experiment" group was 45.291, with a standard deviation (SD) of 10.213. After learning with STEM-ESCiT-based media, the average post-test score increased to 84.973, with an SD of 9.421. These results indicate that students in the experimental group experienced a significant increase in creative thinking skills.

Meanwhile, in the "Control" group, the average pre-test score was 46.871, with an SD of 7.243. Then, the average post-test score was 78.219, with an SD of 8.902. Although students in the control group also experienced increased scores from the pre-test to the post-test, this increase may not be as significant as that of the experimental group. This may indicate that the STEM-ESCiT-based learning intervention in the experimental group was more effective in improving creative thinking skills than the control group.

Normality Test

The normality test is carried out to assess whether a normal distribution exists in the two samples taken. This normality test utilizes the students' pre-test scores that have been given. Information regarding the normality test results can be referred to in Table 3.

Table 3.

Sample normality test

No	Group	Shapiro- Wilk (Sig)	Conclusion
1	Experiment	0.142	Normal
2	Control	0,092	Normal

The results of the normality test analysis conducted using the Shapiro-Wilk test method show that the significance value (Sig.) for both samples exceeds 0.05. The experimental class has a significance value (Sig.) of 0.142, while the control class has a significance value (Sig.) 0.092. From the results of this Shapiro-Wilk test reading, it can be concluded that both samples from the experimental and control classes have a distribution that follows a standard pattern.

Homogeneity Test

The homogeneity test, in this case using Levene's test, was used to assess the homogeneity between the experimental and control samples in the study. The results of this test indicated that both samples had a significant level of homogeneity, with a significance value (Sig.) of 0.081, which exceeded the significance threshold set at 0.05. Thus, this finding indicates that both samples have similar characteristics, so comparisons between the two can be made without considering inhomogeneity as a factor affecting the study results.

Hypothesis Test

Hypothesis testing was conducted after ensuring that both sample groups had normal and homogeneous data distribution. The hypothesis testing method applied in this study is the t-test, which aims to reveal whether the application of STEM-ESCiT-based learning media significantly impacts students' creative thinking skills. The data used in this analysis are the test results of students' creative thinking abilities from the experimental and control groups, which are then analyzed at a significance level of 5%. Table 4 contains the findings of the hypothesis analysis

Table 4.

Comparative test result data

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Result Test	Equal variances assumed	2.198	.061	2.195	64	.000	8.61597	1.60494	4.78940	15.24453
	Equal variances not assumed			2.195	64.319	.000	8.61597	1.60494	4.68840	15.54080

Table 4 illustrates the results of Levene's test, which shows that the F count is 2.198 with a significance level of 0.061. This result implies that the variance difference is insignificant as the significance value is more significant than 0.05 (0.061 > 0.050). Therefore, the data used in the analysis is assumed to have comparable variances under the Equal variances assumption. Based on this assumption, the calculated t value in this data is 2.195, which is significantly greater than the t table value (t_{count} = 2.195 > t_{table} = 1.670). This result indicates that the alternative hypothesis (H_a) is acceptable, while the null hypothesis (H_0) is rejected. Furthermore, the significance level of this data ranged from 0.000 to 0.050, indicating a significant difference between the experimental and control groups in terms of the average score of students' creative thinking ability on the test.

Discussion

STEM-ESCiT-based mobile learning has become an increasingly relevant topic in education. This article examines the effect of this innovative learning approach in improving student teachers' creative thinking skills. Creative thinking is essential in an educational context, as creative teachers can inspire and motivate students to think more broadly and deeply (Jia et al., 2019). STEM-ESCiT-based mobile learning, which integrates science, technology, engineering, mathematics, and entrepreneurial science thinking, provides an ideal foundation for honing this creative thinking ability (Siew, 2023).

The importance of this approach is also reflected in the research results. The data obtained in this study showed that student teachers who participated in STEM-ESCiT-based mobile learning experienced significant improvement in their creative thinking skills. This is an encouraging finding, as it confirms the effectiveness of mobile learning in enhancing student creativity, which can be applied in future teaching contexts.

The difference can be attributed to several relevant factors. First, using interactive and STEM-based mobile learning technology allows students to participate in the learning process actively. This will enable them to explore various concepts practically, encouraging creative thinking and more profound problem-solving (Wongta et al., 2021). In addition, using STEM-ESCiT in learning helps students develop critical and analytical thinking skills. These skills provide a strong foundation for creative thinking, as students can explore and integrate new ideas with existing knowledge (Bao & Koenig, 2019).

Furthermore, it is important to note that this approach allows for more contextualized teaching, where students can see the connections between STEM concepts in real-life situations. This creates space for them to design creative solutions to problems encountered in the real world (Simeon et al., 2020). In the context of conventional approaches, there are limitations regarding interactivity and contextualization of learning. More traditional learning methods may centre more on information delivery, while STEM-ESCiT-based mobile learning focuses more on a well-rounded learning experience.

The results of this study are also in accordance with a study conducted by Adlim et al. (2015), which concluded that STEM learning modules that integrate entrepreneurship have very good quality. The use of STEM has brought improvements in science process skills and positive entrepreneurial attitudes in students. Similarly, the research results by Winda and Suhery (2019) also confirmed the positive impact of STEM learning integrated with Problem-Based Learning (PBL) on chemistry education students at Sriwijaya University. STEM learning is one of the practical tools for developing 21st-century skills (Permanasari, 2016). Therefore, combining STEM strategies with other learning methods is needed to support this learning orientation. The researcher chose the ESciT research method based on the ESD approach to integrate with STEM learning methods.

However, the success of mobile learning is not just dependent on technology. The role of instruction and learning design is also critical. To achieve maximum results, careful planning and adequate instructional design are required. Integrating technology with learning materials and appropriate methods is the key to the effectiveness of mobile learning (Emre, 2019). In the student teachers' context, curriculum development incorporating STEM elements and creativity in mobile learning will play a central role in producing optimal results (Eltanahy et al., 2020).

In addition, it is crucial to recognize that challenges in using STEM-ESCiT-based mobile learning also exist. Technology accessibility is an essential factor that needs to be considered. Building infrastructure and providing adequate access to technology is crucial in ensuring that mobile learning is accessible to all student teachers without

exception (Setiawan et al., 2023). This requires cooperation between educational institutions, government, and technology providers.

CONCLUSION

Research on the Effect of STEM-ESCIT-based mobile learning in improving the creative thinking ability of prospective teacher students has been successfully conducted. Data analysis showed significant differences between the group that received learning through STEM-ESCiT-based mobile learning media and the group that applied conventional methods. This difference can be explained by several factors, including the use of interactive technology, the development of critical and analytical thinking skills, and the contextuality of learning in the STEM-ESCiT approach. The findings highlight the potential of this innovative approach in improving pre-service teachers' creative thinking skills and demonstrate the superiority of STEM-ESCiT-based mobile learning over conventional methods in educational contexts. These results reinforce the importance of technology integration in curriculum development and teaching methods in education.

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References

Adlim, A., Saminan, S., & Ariestia, S. (2015). Pengembangan modul STEM terintegrasi kewirausahaan untuk meningkatkan keterampilan proses sains di SMA Negeri 4 Banda Aceh. Jurnal Pendidikan Sains Indonesia (Indonesian Journal of Science Education), 3(2), 112–130.

Aini, A., Mukhlis, M., Annizar, A., Jakaria, M., & Septiadi, D. (2020). Creative thinking level of visual-spatial students on geometry HOTS problems. 1465(1), 012054.

Ainulluluah, A., Boeriswati, E., Rahmawati, Y., & Setiawan, B. (2022). Systematic Literature Review: Improving Self Regulated Learning Through The Flipped Classroom Model Based on Interactive E-Books. Jurnal Basicedu; Vol 6, No 3 (2022): June Pages 3200-5500. https://doi.org/10.31004/basicedu.v6i3.2853

Bao, L., & Koenig, K. (2019). Physics education research for 21st century learning. Disciplinary and Interdisciplinary Science Education Research, 1(1), 1–12.

Bujor, A., & Avasilcai, S. (2016). The creative entrepreneur: A framework of analysis. Procedia-Social and Behavioral Sciences, 221, 21–28.

Eltanahy, M., Forawi, S., & Mansour, N. (2020). Incorporating entrepreneurial practices into STEM education: Development of interdisciplinary E-STEM model in high school in the United Arab Emirates. Thinking Skills and Creativity, 37, 100697.

Emre, D. (2019). Prospective teachers' perceptions of barriers to technology integration in education. Contemporary Educational Technology, 10(4), 381–398.

Fujiawati, F. S., & Raharja, R. M. (2019). Analisis Kesiapan Mahasiswa Pendidikan Seni Mengaplikasikan Pembelajaran Berbasis Online (E-Learning & Mobile Learning). Jurnal Pendidikan Dan Kajian Seni, 4(2), 150–164. https://doi.org/10.30870/jpks.v4i2.6924

Jia, X., Li, W., & Cao, L. (2019). The role of metacognitive components in creative thinking. Frontiers in Psychology, 10, 2404.

Kim, H. J., Yi, P., & Hong, J. I. (2020). Students' academic use of mobile technology and higher-order thinking skills: The role of active engagement. Education Sciences, 10(3), 47.

Lynch, M., Kamovich, U., Longva, K. K., & Steinert, M. (2021). Combining technology and entrepreneurial education through design thinking: Students' reflections on the learning process. Technological Forecasting and Social Change, 164, 119689.

Permanasari, A. (2016). STEM education: Inovasi dalam pembelajaran sains. 3, 23–34.

Rasulova, Z. (2020). Conditions and opportunities of organizing independent creative works of students of the direction Technology in Higher Education. International Journal of Scientific and Technology Research, 9(3), 2552–2155.

Sagala, R., Rofiqul, U., Thahir, A., Saregar, A., & Wardani, I. (2019). The effectiveness of stem-based on gender differences: The impact of physics concept understanding. European Journal of Educational Research, 8(3), 753–761.

Setiawan, B., Winarno, A., & Iasha, V. (2023). Immersive Virtual Reality: Unlocking Students' Elementary School Science Literacy. Science and Education, 4(9), 281–288.

Siew, N. M. (2023). Socioscientific Issues Approach on Entrepreneurial Science Thinking among Fifth Graders: Socioscientific Issues Approach on Entrepreneurial Science Thinking. 18(2), 812–821.

Simeon, M. I., Samsudin, M. A., & Yakob, N. (2020). Effect of design thinking approach on students' achievement in some selected physics concepts in the context of STEM learning. International Journal of Technology and Design Education, 1–28.

Sirajudin, N., & Suratno, J. (2021). Developing creativity through STEM education. 1806(1), 012211.

Sumarni, W., & Kadarwati, S. (2020). Ethno-stem project-based learning: Its impact to critical and creative thinking skills. Jurnal Pendidikan IPA Indonesia, 9(1), 11–21.

Winda, Z., Suhery, T., & Desi, D. (2019). Hasil Belajar Mahasiswa dalam Pembelajaran Modul Larutan Elektrolit dan Sifat Koligatif Larutan Berbasis STEM-

Problem Based Learning Program Studi Pendidikan Kimia. Jurnal Penelitian Pendidikan Kimia: Kajian Hasil Penelitian Pendidikan Kimia, 6(1), 12–17.

Wongta, J., Grosseau, C., Yachulawetkunakorn, C., Watthana, C., & Wongwatkit, C. (2021). Effects of a collaborative STEM-based orientation approach on senior high-school students' creativity and operacy. International Journal of Mobile Learning and Organisation, 15(1), 71–106.