



STEM-CP Based Flipped Classroom Model for HOTS of Prospective Elementary School Teacher

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Abstrak

Penelitian ini dilatarbelakangi oleh pengembangan model flipped classroom berbasis STEM-CP yang valid dan layak untuk meningkatkan Higher Order Thinking Skills (HOTS) mahasiswa calon guru sekolah dasar. Penelitian lanjutan diperlukan untuk mengetahui dampaknya terhadap HOTS mahasiswa calon guru sekolah dasar. Tujuan penelitian ini adalah untuk menganalisis pengaruh model Flipped Classroom berbasis STEM-CP terhadap HOTS mahasiswa calon guru. Penelitian ini merupakan penelitian quasi-eksperimen dengan subjek penelitian sebanyak 200 mahasiswa calon guru. Instrumen penelitian yang digunakan adalah tes berpikir tingkat tinggi. Data dikumpulkan melalui pemberian tes kepada subjek penelitian. Teknik analisis data dilakukan dengan uji prasyarat, uji hipotesis, dan uji lanjut menggunakan bantuan SPSS 26. Hasil penelitian menunjukkan bahwa terdapat pengaruh model Flipped Classroom berbasis STEM-CP dalam meningkatkan HOTS mahasiswa calon guru sekolah dasar. Penelitian ini menyimpulkan bahwa model Flipped Classroom berbasis STEM-CP memiliki pengaruh positif dalam meningkatkan Higher Order Thinking Skills (HOTS) mahasiswa calon guru sekolah dasar. Implikasi penelitian ini dapat dijadikan sebagai referensi bagi akademisi untuk meningkatkan HOTS mahasiswa calon guru.

Kata Kunci: Flipped Classroom, STEM-CP, HOTS

Abstract

This research was motivated by the development of a valid and feasible STEM-CP-based flipped classroom model to improve the Higher Order Thinking Skills (HOTS) of prospective elementary school teacher students. Further research is needed to determine the impact on HOTS of elementary school teacher candidates. The purpose of this study was to analyze the effect of the STEM-CP-based flipped classroom model on the HOTS of prospective teacher students. This research is quasi-experimental research with research subjects as many as 200 prospective teacher students. The research instrument used is a higher-order thinking test. Data were collected through administering tests to research subjects. Data analysis techniques are carried out with prerequisite tests, hypothesis tests, and further tests using the help of SPSS 26. The results showed that there was an influence of the STEM-CP-based flipped classroom model in increasing the HOTS of prospective elementary school teacher students. This study concluded that the STEM-CP-based flipped classroom model has a positive influence in improving the Higher Order Thinking Skills (HOTS) of elementary school teacher candidates. The implications of this research can be used as a reference for academics to improve the HOTS of prospective teacher students.

Keywords: Flipped Classroom, STEM-CP, HOTS

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1. INTRODUCTION

Cognitive abilities that require deeper, more complicated thought processes are known as higher-order thinking skills (Nguyễn & Nguyễn, 2017; Nourdad et al., 2018). It involves the capacity to analyze information, evaluate arguments, synthesize ideas, and apply knowledge in real situations. Higher-order thinkers are capable of breaking information into its constituent parts, seeing connections between ideas, and picking out underlying patterns (Eliyasni et al., 2019; Jarvis & Baloyi, 2020). People are also capable of judging information according to standards like accuracy, reliability, and relevancy. Higher-order thinking skills also include the capacity to combine information from various sources, develop a more

thorough understanding, and come up with original solutions to challenging issues. Application skills are another aspect of higher-order thinking, and they are the capacity to apply knowledge and skills to use in various contexts and connect theory to practice (Ahmad et al., 2018; Hariadi et al., 2022). In addition, critical evaluation—the capacity to analyze existing arguments, identify weaknesses and develop more mature viewpoints—is a component of higher-order thinking skills. Critical thinking, creativity, problem-solving, and effective decision-making are all qualities that need higher-order thinking. Therefore, every individual, including prospective elementary school teachers, must develop higher-order thinking skills.

To meet the demands of education in the present period, prospective elementary school teachers must be proficient in higher-order thinking skills. They oversee assisting students in acquiring more sophisticated and flexible thinking abilities. Teachers can create and implement learning experiences that encourage students to think critically, examine information, assess ideas, and make informed decisions using higher-order thinking skills (Belecina & Ocampo Jr, 2018; Priyaadharshini & Vinayaga Sundaram, 2018). Higher-order thinking abilities also enable teachers to inspire students' creativity in problem-solving, alternative solutions, and thinking beyond boundaries. Teachers can establish a learning environment that challenges and inspires students to reach their maximum potential by mastering higher-order thinking skills (Abosalem, 2016; Lu et al., 2021). Higher-order thinking teachers can also use technology and digital resources in the classroom, empowering pupils to meet the challenges of the digital age. Higher-order thinking skills are thus a crucial requirement for potential elementary school teachers to deliver effective and relevant education to pupils in the future.

However, the researchers discovered from the study of the literature that elementary school teacher candidates still had poor higher-order thinking skills (Kenedi, 2018; Ramadhani et al., 2021). Results from the initial assessment of higher-order thinking skills given to prospective primary school teachers, who received an average score of 45.34, placing them in the poor category, support this. This demonstrates the lack of higher-order thinking skills of prospective elementary school teachers. Therefore, a suitable solution is required and can help prospective elementary school teachers develop their higher-order thinking skills.

The implementation of learning that is in line with the characteristics of prospective elementary school teachers and the characteristics of era 4.0 can help to increase their capacity for high-level thinking. The flipped classroom model based on STEM-CP (Science, Technology, Engineering, Mathematics, and Contextual Problems) is one of the learnings that are in line with the characteristics of prospective elementary school teachers and the characteristics of era 4.0. STEM-CP is a method of education that combines context-based problem-solving with the study of science, technology, engineering, and mathematics (Jeong et al., 2019; Widowati et al., 2021). The objective is to give students a comprehensive understanding of these topics and how to apply them in real-life situations (Mutambara & Bayaga, 2021; Sari et al., 2020). This STEM-CP model was created by researchers to use it to help future teachers strengthen their higher-order thinking abilities. This approach was created using scientific methods that were measurable and accountable. Experts have deemed this STEM-CP learning approach valid and feasible, allowing it to be used in the real world.

This STEM-CP learning model is still constrained by the model's feasibility test, though. The efficiency of this STEM-CP learning model in enhancing the critical thinking abilities of prospective primary school teachers needs more investigation. Research related to efforts to increase HOTS of prospective teacher students has begun to be carried out. Previous research examined the influence of digital STEM modules on improving the HOTS abilities of prospective teacher students (Maharcika et al., 2021; Ramadhani et al., 2022). The

results of the research state that there is an influence of the use of STEM-based digital modules on increasing the HOTS of prospective elementary school teachers. Similar research which stated that the effect of project-based models on the thinking abilities of future elementary school teacher students (Klentien & Wannasawade, 2016; Syawaludin et al., 2022). The research results stated that using a project-based model improved the thinking abilities of prospective elementary school teacher students, including higher-level thinking abilities. Previous research examines the influence of problem-based learning integrated with local wisdom on prospective science teacher students' HOTS abilities and scientific attitudes (Hikmawati et al., 2021; Suci et al., 2022). The research results show increased HOTS and scientific perspectives of prospective science teacher students using problem-based learning integrated with local wisdom. Similar research examined the impact of problem-based learning on the HOTS abilities of prospective elementary school teacher students (Darmawan & Hilmawan, 2021; Saepuloh et al., 2021). The results of the research state that applying the problem-based learning model can improve the HOTS abilities of elementary school teacher students. Previous research has developed regarding efforts to strengthen the HOTS abilities of prospective teachers. However, from previous research, increasing the HOTS abilities of future teachers, students still use modules and learning that do not involve technology. This gap in this research uses the STEM-CP learning model, which involves problems in life that are integrated with the use of technology so that this combination of learning will give birth to new innovations in the learning process. The aim of using this model is to increase the HOTS of prospective elementary school teacher students. Therefore, this research aims to determine the influence of the STEM-CP-based flipped classroom model on the higher-order thinking abilities of future elementary school teacher students.

The novelty of this research lies in its focus on examining the influence of the STEM-CP-based flipped class model on the high-level thinking capacity of prospective elementary school teachers in the 4.0 era. Therefore, the goal of this study was to determine how the STEM-CP-based flipped classroom model affected prospective primary school teachers' capacity for higher-order thinking. This research is significant because it can be utilized as an alternative to academics at universities to help prospective elementary school teachers develop their higher-order thinking abilities, which are crucial qualities for elementary school teachers to possess in the 4.0 era. In the 4.0 era, which is defined by the rapid advancement of digital technology, artificial intelligence, and digital transformation, higher-order thinking abilities are crucial (Anita et al., 2022; Eltanahy et al., 2020). The demand for more sophisticated and adaptable skills is growing in the 4.0 era. Prospective elementary school teachers with higher-order thinking skills are better able to handle complex problems that change quickly. Prospective elementary school teachers must be able to analyze, assess, and synthesize information from many sources in the 4.0 era because it is readily available and changing quickly. Finding innovative solutions to complicated problems requires the use of critical and creative thinking skills (Ahmad et al., 2020; Jeong et al., 2019). Higher problem-solving skills are also required in the 4.0 era when prospective elementary school teachers must be able to use their prior knowledge and skills to solve challenges they have never encountered (Anita et al., 2022; Huang et al., 2022). Prospective elementary school teachers with higher-order thinking abilities are also better equipped to handle sudden changes and adapt to a constantly changing environment. Higher-order thinking abilities are a crucial pillar of success today, both personally and professionally, including candidates for elementary school teachers.

2. METHODS

limited control over the independent variables. Subject selection was not carried out randomly, and there was no complete randomization. However, researchers try to control factors influencing the experiment's results. The research design used was a nonequivalent control group design. The non-equivalent control group design is an experimental design in which two groups are compared. The experimental group received treatment, and the control group did not. However, these two groups were not equivalent or equivalent from the start, so there was no randomization. These initial differences must be considered in the analysis of results. 200 students took part in this study. There were two groups of students. 100 students made up the experimental class (a class that received STEM-CP learning), while 100 students made up the control class (a class that received conventional learning). HOTS Grille showed in [Table 1](#).

Table 1. HOTS Grille

Indicator	Sub-Indicator	Item
Critical Thinking Skills	Analyze Arguments	1
	Evaluate Information	2
	Identify Patterns	3
Critical Thinking Skills	Generate New Ideas	4
	Ability to Improvise	5
	Ability to Combine Concepts	6
Logical Thinking Ability O ₃	Deductive Reasoning	7
	Inductive Reasoning	8
	Causal Analysis	9
	Identify Valid and Invalid Arguments	10

[Table 1](#) shows that ten questions will be used to measure the HOTS of prospective elementary school teacher students. Then, the questions were subjected to content and construct validation tests. The content validation test was carried out by two experts and was declared valid. From the results of the construct test carried out by carrying out the product moment test, it was stated that all the questions were reasonable, with a calculated r value more significant than the r table value. The question was also declared reliable with an estimated value of 0.942. SPSS 26 was used to help with the data analysis. Normality tests (Kolmogorov-Smirnov test and Shapiro-Wilk test) were performed as prerequisite tests. According to the normality calculation, the four data received a small value of 0.05, indicating that the data is normal. The homogeneity test was then run as a follow-up to the prerequisites test, yielding a calculated value of sig based on a mean of 0.442. This demonstrated the homogeneity of the data. The paired sample t-test was used to evaluate the hypothesis. Additional testing used an independent t-test.

3. RESULTS AND DISCUSSION

Result

An initial assessment of HOTS skills and action planning served as the basis for the research. While the control class received conventional learning, the experimental class received STEM-CP-based learning. Each class took a test to measure the teachers' higher order thinking abilities after the treatment. Here is a [Table 2](#) of the data.

Table 2. Data Tabulation

	N	Minimum	Maximum	Mean	Std. Deviation
Experimental class pre-test	100	41	49	46.13	2.74
Experimental class post-test	100	79	98	85.23	5.72
Control class pre-test	100	45	54	44.54	2.84
Control class post-test	100	49	56	53.12	1.74
Valid N (Listwise)	100				

Data on the pre-test and post-test results for the control class and experimental class were shown in Table 2. The paired sample t-test was then carried out when it was determined that the data was homogeneous and normally distributed. This test was designed to determine whether the STEM-CP learning model has an impact on the higher-order thinking skills of prospective elementary school teachers. Result The Paired Sample T-Test showed in Table 3.

Table 3. Result The Paired Sample T-Test

		Paired Differences				t	df	Sig. (2-tailed)	
		Mean Difference	Std. Dev	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower				Upper
Pair 1	Experimental Pre-Test - Experimental Post-Test	-40.654	5.765	0.643	-42.637	-34.875	-63.869	99	0.000
Pair 2	Pre-Test Control - Post-Test Control	-1.325	1.642	0.326	-1.436	-1.032	-6.543	99	0.100

Table 3 revealed that Pair 1 had a value of 0.000. It was possible to conclude that there was a difference between the experimental class's average pre-test and post-test because this value was less than 0.05. This suggested a difference between their higher-order thinking skills before using the STEM-CP learning approach and afterward. The independent sample t-test was then used for additional tests. The independent sample t-test sought to determine whether prospective teachers' higher-order thinking abilities differed from those who followed conventional learning. Independent Sample T-test showed in Table 4.

Table 4. Independent Sample T-test

	Levene's Test for Equality of Variances		t-test for Equality of Means			
	F	Sig.	t	df	Sig. (2-tailed)	
HOTS	Equal Variances Assumed	110.298	0.000	67.365	198.000	0.000
	Equal Variances Not Assumed			67.365	121.292	0.000

Table 4 showed that the computed value of the Sig. (2-tailed) was 0.000, which was less than 0.05. This computation showed that there was an average difference between students who studied using the STEM-CP learning model and those who studied using

conventional learning when it came to their higher-order thinking skills. The significant higher-order thinking skills showed in [Table 5](#).

Table 5. Average Score Test

	Class	N	Mean	Std. Deviation	Std. Error Mean
HOTS	Experimental class Post-Test	100	85.23	5.72	0.43
	Control class Post-Test Class	100	53.12	1.74	0.03

According to [Table 5](#), students who studied using the STEM-CP learning model generally scored higher than those who used more traditional teaching methods. This demonstrated how the STEM-CP learning approach improved the higher-order thinking abilities of prospective teachers.

Discussions

The adoption of the STEM-CP learning model had an impact on increasing the higher-order thinking skills of prospective elementary school teachers, according to the data that had been provided. Research on initiatives to enhance prospective teachers' higher-order thinking abilities has started. Previous research indicated that environment-based learning models could enhance prospective teachers' capacity for higher-order thinking ([Ichsan, Sigit, & Miarsyah, 2019](#); [Ichsan, Sigit, Miarsyah, et al., 2019](#)). The usage of technology-based learning, according to previous research was able to enhance prospective teachers' capacity for higher-order thinking ([Polly et al., 2020](#); [Wetzel et al., 2014](#)). Similar research that showed adopting a problem-based learning paradigm with the help of web 2.0 media was able to boost education students' higher-level thinking skills ([Hursen, 2021](#); [Sholihah & Lastariwati, 2020](#)). The use of the Quizizz application, according to similar research, was able to enhance primary school teachers' capacity for higher-order thinking when teaching science ([Nasution & Nasution, 2021](#); [Rizki & Kurniawati, 2022](#)). The application of problem-based learning was able to enhance the higher-level thinking abilities of students preparing to become primary school teachers ([Anazifa & Djukri, 2017](#); [Ismail et al., 2018](#)). The findings of prior studies suggested that different learning models could enhance the higher-level thinking abilities of prospective teachers. It was a novel finding of this study that the STEM-CP learning model might help prospective primary school teachers develop their higher-order thinking skills.

Because the STEM-CP learning model included several key components in the development of higher-order thinking skills, it was able to enhance the higher-order thinking abilities of prospective primary school teachers. First, STEM-CP pushed students to deal with challenging contextual problems. Real-world projects were presented to students that challenged them to use critical, creative, and analytical thinking to come up with solutions. This made it possible for students to cultivate their critical thinking abilities, recognize issues, and create efficient problem-solving strategies ([Hudha & Batlolona, 2017](#); [Sari et al., 2020](#)). Second, prospective elementary school teachers were introduced to problems that combined science, technology, engineering, and mathematics through STEM-CP-based learning. They developed an understanding of how multiple disciplines are interconnected and used what they had learned in appropriate situations. This technique encouraged interdisciplinary thinking, enabled students to look at issues from several angles, and improved their capacity to synthesize information from various disciplines ([Paramita et al., 2022](#); [Primahesa et al., 2023](#)). Third, the STEM-CP learning model promoted group or teamwork among students. They developed their abilities to exchange ideas, interact, and discuss, which helped them understand more STEM concepts and work better in teams to solve challenges. Finally, the STEM-CP learning model included a hands-on feature. Students had the chance to carry out

experiments, projects, or practical exercises that incorporate theory and practice. They could improve their analytical thinking, problem-solving abilities, and critical thinking through this practical experience (Belecina & Ocampo Jr, 2018; Huang et al., 2022).

The STEM-CP learning model offered prospective primary school teachers an exciting and demanding learning environment for developing higher-order thinking skills. STEM-CP was a teaching strategy that combined problem-solving in context with science, technology, engineering, and math. Through application in practical contexts, this method sought to foster a thorough knowledge of STEM topics. STEM-CP promoted the use of interdisciplinary knowledge and problem-solving techniques in educational settings. Students could learn critical thinking, teamwork, creativity, and problem-solving abilities through STEM-CP, as well as have a deeper comprehension of how science and the real world interact. Thus, the STEM-CP method aims to equip students with the necessary knowledge and abilities for a world that is increasingly dominated by science, technology, and innovation. Students could develop their critical, analytical, creative, and problem-solving thinking abilities through the integration of many disciplines, contextual problem-solving, cooperation, and practical experience. So, using STEM-CP increases the higher-order thinking skills of prospective elementary school teacher students.

4. CONCLUSION

According to the test results, there is an average difference between students who study using the STEM-CP learning model and students who learn using traditional learning when it comes to higher-order thinking skills. Students who learn using the STEM-CP learning model typically score higher on average than students who learn using more traditional methods. This demonstrates how the STEM-CP learning model improves the higher-level thinking abilities of prospective teachers.

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