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THE EFFECT OF DIFFERENTIATED LEARNING ON STUDENTS' COMPUTATIONAL THINKING SKILS IN MATHEMATICS LEASSONS

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Abstract

This study aims to analyze the effect of differentiated learning on students' computational thinking skills in mathematics. This research was conducted at MAN Sibolga, located in Sibolga in the odd semester of the 2024/2025 school year. The method used was a quasi-experiment with a pretest-posttest non-equivalent control group design. The sampling technique was carried out using purposive sampling technique, where class XI-A was the experimental class with 26 students, while class XI-F was the control class with 26 students. Data collection regarding students' computational thinking skills used a test instrument consisting of five description items that had gone through the validity and reliability testing process. The indicators of computational thinking ability studied included problem decomposition, abstraction, algorithm thinking, generalization, and debugging. The results showed that students taught with differentiated learning model had higher computational thinking ability compared to students taught using lecture learning model.

Keywords: computational thinking ability, differentiated learning, lecture learning

Abstrak

Penelitian ini bertujuan untuk menganalisis pengaruh pembelajaran berdiferensiasi terhadap kemampuan berpikir komputasi siswa pada pelajaran matematika. Penelitian ini dilaksanakan di MAN Sibolga, yang terletak di Sibolga pada semester ganjil tahun ajaran 2024/2025. Metode yang digunakan adalah kuasi eksperimen dengan desain *pretest-posttest non-equivalent control group design*. Teknik pengambilan sampel dilakukan dengan teknik *purposive sampling,* dimana kelas XI-A sebagai kelas eksperimen dengan 26 siswa, sementara kelas XI-F sebagai kelas kontrol dengan 26 siswa. Pengumpulan data mengenai kemampuan berpikir komputasi siswa menggunakan instrumen tes yang terdiri dari lima butir uraian yang telah melalui proses validitas dan pengujian reliabilitas. Indikator kemampuan berpikir komputasi yang diteliti mencakup *dekomposisi masalah, abstraksi, berpikir algoritma, generalisasi,* dan *debugging*. Hasil penelitian menunjukkan bahwa siswa yang diajar dengan model pembelajaran berdiferensiasi memiliki kemampuan berpikir komputasi yang lebih tinggi dibandingkan dengan siswa yang diajar menggunakan model pembelajaran ceramah.

Kata kunci: kemampuan berpikir komputasi, pembelajaran berdiferensiasi, pembelajaran ceramah

INTRODUCTION

In the 21st century, the world is experiencing rapid progress in technology and information science. In facing increasingly complex challenges, mathematical thinking skills are needed. Computational thinking is one of the skills that students must have (Agustiani, 2022). Computational thinking ability is a cognitive skill that allows students to recognize patterns, divide complex problems into simpler components, design and develop problem-solving strategies, and visualize data through simulations (Mubarokah et al., 2023). These skills are not only needed in computer programming, but also in other fields, such as mathematics (Kharomah et al., 2023). This opinion is in line with Cahdriyana & Richardo

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(2020) saying that mathematics has the ability to introduce and improve students' computational thinking skills (Batul et al., 2022). This indicates that computational thinking skills are important and must be developed.

Computational thinking includes four main skills: problem solving, algorithmic thinking, pattern identification, and abstraction and generalization (Sa’adah et al., 2023). Problem decomposition is the skill to divide complex problems into smaller parts, making them easier to understand and solve (Angeli in Rijal Kamil et al., 2021). Algorithmic thinking means using mathematical processes when solving problems (Fauji et al., 2023). Pattern recognition is the ability of students to identify logical steps used in constructing a solution to a problem (Sa’adah et al., 2023). Abstraction means finding general ideas that can be used to solve problems (Ariesandi et al., 2021). Meanwhile, generalization is the ability to infer new patterns and formulate them in general to solve new problems (Cahdriyana & Richard in Mubarokah et al., 2023). It is very important for students to have these four computational thinking skills so that students can more easily solve math problems (Lee in Kharomah et al., 2023).

In fact, computational thinking skills in Indonesia are still relatively low. Based on the 2018 Program for International Student Assessment (PISA) result, Indonesian students' mathematics ability is ranked 73 out of 78 countries, with an average score of 379, which is much lower than the OECD average score of 489 (OECD, 2019). Then PISA 2022, Indonesian students' math skills experienced a slight improvement, ranking 63 out of 81 countries, with an average score of 366, still below the OECD average of 472 (OECD, 2023). In PISA, computational thinking skills include: designing, using, evaluating and reasoning. This includes pattern recognition, decomposition, determining computational tools that can be used to analyze or solve problems, and defining algorithms as specific parts of the solution (OECD, 2018). This shows that the level computational thinking skills of students in Indonesia are still relatively low (Kharomah et al., 2023).

One of the causes of students' low mathematical computational thinking skills is caused by learning methods that are not interactive, monotonous, and uninteresting (Batul et al., 2022). According to Gadanidis, teachers often focus on learning that requires students to memorize steps to solve mathematical problems. This leads to a decrease in students' computational thinking skills (Angeli & Giannakos in Supiarmo et al., 2021). Students have different characteristics, but intrinsically they have the same ability to understand something (Khristiani et al., 2021).

Differentiated learning is a learning process that allows students to learn material according to their individual abilities, interests and needs (Tomlinson in Khristiani et al., 2021). Differentiated learning contains the idea that each individual has different interests, potentials, and abilities. Therefore, teachers must have the ability to organize and integrate these interests in an appropriate way (Jati et al., 2023). According to Mulbar et al, the purpose of differentiation is generally to organize learning with a focus on students' learning interests, students' readiness to learn, and students' preferences for learning (Muslimin et al., 2022). According to Marliana, there are three differentiation strategies. First is content differentiation, where students are grouped based on their abilities, desires, and talents. Second, process differentiation, where students learn the topic gradually. Finally, product differentiation, where students gain a deeper understanding of the material through the application of relevant learning outcomes (Muhlisah et al., 2023).

A previous study (Muslimin et al., 2022) supports these findings by showing that the application of differentiated learning with a problem-based learning model can help improve stundet learning activities and outcomes. In line with this research, research conducted by (Ultra Gusteti et al., 2022) showed that: (1) the differentiated approach is more interesting and able to improve student learning outcomes; (2) this approach can be combined with learning models that are tailored to students' learning styles, such as *Project Based Learning* (PjBL), *Problem Based Learning* (PBL), and other models; (3) this approach is also effectively applied in learning mathematics because it can meet students' interests, learning styles, profiles, and learning motivation. This shows that differentiated learning can improve students' mathematical thinking skills.

This research is important to do because it can provide information about the average students' computational thinking ability and the most effective learning method to improve students' computational thinking ability. In addition, this research will provide information to educators about how differentiated learning treatment can be used as an alternative method to improve students' computational thinking ability. Therefore, the purpose of this study is to analyze students' computational thinking ability after differentiated learning and also after lecture learning, and to find out the computational thinking ability of students who follow differentiated learning is higher than students who follow lecture learning.

METHODS

This research is a quasi-experimental study conducted in the odd semester of the 2024/2025 academic year. This research design used was a Pretest-posttest non-equivalent control group design, which is a design by giving an initial test and a final test to two groups presented in the following table:

Table 1. Pretest-posttest non-equivalent control group design

Class	Pretest	Treatment	Posttest
Experimental	Y_1	X	Y_2
Control	Y_1	–	Y_2

Source: (Rukminingsih et al., 2020)

Description:

Y_1 : Pretest of experimental class

Y_1 : Prestest of control class

X : Treatment with differentiated learning model

Y_2 : Posttest of experimental class

Y_2 : Posttest control class

In this study, the independent variable is differentiated learning, while the dependent variable is computational thinking ability. This study involved the XI grade students of MAN Sibolga as the research population. There are six grade XI classes in this school with the ability of students in each class has different levels. Therefore, purposive sampling technique was used in the sample determination process. As a result, classes XI-A and XI-F were selected as the samples of this study. The number of students in class XI-A is 26 students, while in class XI-F there are also 26 students.

This study involved two classes, namely classes XI-A and XI-F. Class XI-A was positioned as the experimental class, while class XI-F was positioned as the control class. Class XI-A used differentiated learning model, while class XI-F used lecture learning model. The subject matter taught was composition function and inverse function. Pretest and posttest were conducted at the initial meeting and final meeting in both classes. With data collection techniques in the form of pretests and posttests with descriptive tests totaling 5 items covering indicators of computational thinking skills.

RESULTS AND DISCUSSION

Instrument testing was carried out in the form of validity and reliability tests as follows:

Table 2. Validity Test Results

Question	R count	R table	Information
1	0,788	0,514	Valid
2	0,702	0,514	Valid
3	0,783	0,514	Valid
4	0,752	0,514	Valid
5	0,664	0,514	Valid

Tested all five questions are valid with:

In the first item, the value of r_{count} $(0,788) > r_{table}$ $(0,514)$, in the second item r_{count} $(0,702) > r_{table}(0,514)$, the third item show r_{count} $(0,783) > r_{table}(0,514)$, the fourth item with r_{count} $(0,752) > r_{table}(0,514)$, and in the fifth item r_{count} $(0,664) > r_{table}(0,514)$. All items are valid and can measure students' computational thinking skills.

Table 3. Reliability Test Result

Reliability Statistics	
Cronbach's Alpha	N of Items
.780	5

The value obtained is 0.780, with high reliability criteria because it is in the range of 0.70-0.90. then the items are suitable for use in research and can function as an effective measuring instrument.

After conducting a trial that shows valid and reliable results, the next step is to collect initial data through pretests in experimental and control classes. After the two classes were treated, a posttest was conducted for each class. Then a posttest test was conducted to determine the difference in results between the two classes. This difference analysis was carried out using a parametric statistical test, in the form of a t-test or independent t-test with a confidence level of 95%.

Table 4. Hypothesis Test of Experimental Class and Control Class

Independent Samples Test

			Berpikir_Komputasi Equal variances assumed	Berpikir_Komputasi Equal variances not assumed
Levene's Test for Equality of Variances	F		3,455	
	Sig.		,069	
t-test for Equality of Means	t		-10,095	-10,095
	df		50	47,964
	Significance	One-Sided p	<,001	<,001
		Two-Sided p	,000	,000
	Mean Difference		-60,192	-60,192
	Std. Error Difference		5,963	5,963
	95% Confidence Interval of the Difference	Lower	-72,168	-72,181
		Upper	-48,216	-48,204

Based on the table above, the significant value of the t test is 0,001. This value is lower than the significance standard of 0,05. As a result, this study shows that the differentiated learning model is more effective than the lecture learning model in improving students' computational thinking ability.

The N-Gain Score test was also conducted to determine how effective the application of the differentiated learning model in the experimental class was compared to the lecture learning model in the control class. This is done by looking at the difference in test results before and after the application of the learning model. The N-Gain score test can be done if the significant value $< 0,05$ in the t test can be seen in table 4 above. The following is the N-Gain score test of pretest and posttest of experimental class and control class using SPSS 29:

Table 5. Ngain Score Test Calculation Results

No	Experimental Class N-Gain Score (%)	No	Control Class N-Gain Score (%)
1	80	1	38,46
2	20	2	60
3	88,89	3	66,67
4	94,44	4	63,16
5	25	5	10,53
6	50	6	50
7	88,89	7	50
8	55,56	8	0
9	38,89	9	57,14

10	71,43	10	52,63
11	100	11	52,63
12	100	12	57,89
13	41,18	13	40
14	61,11	14	50
15	94,44	15	42,11
16	83,33	16	66,67
17	14,29	17	80
18	100	18	66,67
19	33,33	19	33,33
20	26,67	20	27,78
21	71,43	21	50
22	50	22	13,33
23	23,53	23	50
24	47,37	24	57,89
25	31,25	25	41,18
26	100	26	33,33
Mean	61,19	**Mean**	46,59
Minimum	14,29	**Minimum**	0
Maximum	100	**Maximum**	80

Based on the results of the N-Gain score test calculation above, the average N-Gain score in the experimental class using the differentiated learning model is $61{,}19\%$, which is classified as quite effective, with the lowest value of $14{,}29$ and the highest value of 100. On the other hand, the average N-Gain score in the control class that applied the lecture learning model was $46{,}59\%$, which was classified as less effective, with the lowest score of 0 and the highest score of 80.

It can be concluded that the application of differentiated learning model proved to be quite effective in improving students' computational thinking ability on the material of composition function and inverse function in class XI MAN Sibolga in the 2024/2025 academic year. In contrast, the lecture learning model shows less effective in improving students' computational thinking skills in the material of composition function and inverse function.

CONCLUSION

There is a difference in the computational thinking ability of students taught with differentiated learning models and lecture learning models in class XI-A and class XI-F MAN Sibolga on composition function and inverse function material. This is based on the findings which state that the results of the t test significance value $(0{,}001) <$ the significance standard

$(0,05)$ which means H_0 is rejected and H_1 is accepted. The computational thinking ability of experimental class students using differentiated learning model is higher than the control class using lecture learning model. This is based on the analysis of hypothesis test results from the pretest and posttest N-Gain score data, which shows that the average computational thinking ability of experimental class students is higher than the average of control class students. Thus, it can be concluded that the differentiated learning model has more effect on students' computational thinking ability than using lecture learning model.

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