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The Influence of Initial Mathematical Ability and Realistic Mathematical Education on Computational Thinking and Learning Independence of Junior High School Students

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Abstrak

Tujuan penelitian ini untuk menganalisis: Perbedaan kemampuan berpikir komputasional siswa yang diajar dengan menggunakan PMR dan Pembelajaran Langsung; Perbedaan kemandirian belajar siswa yang diajar dengan menggunakan PMR dan Pembelajaran Langsung; Interaksi antara model pembelajaran dan KAM terhadap kemampuan berpikir komputasional siswa; Interaksi antara model pembelajaran dan KAM terhadap kemandirian belajar siswa. Populasi dalam penelitian ini seluruh siswa kelas VIII SMP Negeri 29 Medan dan sampel dalam penelitian ini adalah siswa kelas VIII-6 dan VIII-7 dengan mengambil dua kelas (kelas eksperimen dan kelas kontrol) sebanyak 60 siswa. Instrumen yang digunakan terdiri dari tes kemampuan berpikir komputasional dan skala kemandirian belajar. Data dianalisis dengan uji ANAVA dua jalur. Berdasarkan hasil analisis tersebut diperoleh: Kemampuan berpikir komputasional siswa di kelas PMR lebih tinggi daripada kelas pembelajaran langsung; Kemandirian belajar siswa di kelas PMR lebih tinggi dari pada kelas pembelajaran langsung; Tidak terdapat interaksi antara model pembelajaran dan KAM terhadap kemampuan berpikir komputasional; Tidak terdapat interaksi antara model pembelajaran dan KAM terhadap kemandirian belajar siswa. Berdasarkan hasil penelitian ini, disarankan agar pembelajaran dengan PMR dijadikan alternatif bagi guru untuk meningkatkan kemampuan berpikir komputasional dan kemandirian belajar siswa.

Kata Kunci: *PMR, Kemampuan Berpikir Komputasional, Kemandirian Belajar.*

Abstract

The purpose of this study is to analyze: (1) differences in students' computational thinking abilities taught using PMR and Direct Learning; (2) differences in the learning independence of students who are taught using PMR and Direct Learning; (3) the interaction between the learning model and KAM on students' computational thinking skills; (4) the interaction between the learning model and KAM on student learning independence. The population in this study is all students of grade VIII of SMP Negeri 29 Medan and the sample in this study is students of grades VIII-6 and VIII-7 by taking two classes (experimental class and control class) as many as 60 students. The instruments used consisted of a test of computational thinking ability and a scale of learning independence. The data was analyzed by the two-track ANAVA test. Based on the results of the analysis, it was obtained: (1) students' computational thinking ability in the PMR class is higher than in the direct learning class; (2) the learning independence of students in the PMR class is higher than in the direct learning class; (3) there is no interaction between the learning model and KAM on computational thinking skills; (4) there is no interaction between the learning model and KAM on student learning independence. Based on the results of this study, it is suggested that learning with PMR be used as an alternative for teachers to improve students' computational thinking skills and learning independence.

Keywords: *PMR, Computational Thinking Ability, Learning Independence*.

A. Introduction

Mathematics is a required subject in formal education and plays a major part in education. Mathematics as a science helps improve human existence, according to (J., 2016). Mathematics is a science studied at all levels of education, from basic to higher education, and has objectives based on its function and application. Students should study math for several reasons (Ismail Hanif Batubara, Sahat Saragih, Elmanani Simamora, E Elvis Napitupulu, 2022) . Math is used to think clearly and logically, solve common issues, see patterns and relate them to experience, develop creativity, and become conscious of cultural processes. Math should be taught to students because: a) it is always used in everyday life; b) all fields of study require appropriate mathematical skills; c) it is a strong, concise, and clear means of communication; d) it can be used to present information in various ways; e) it improves logical abilities, accuracy, and spatial awareness; and f) it allows students to try to solve difficult problems. Because problem-solving involves computational thinking, mastering mathematics requires it(Saragih, S., & Habeahan, 2014).

According to (Chan, S. L.C & Sumintono, 2020), computational thinking abilities help address frequent patterns in logical calculation. According to (Afrilianto, M & Rosyana, 2014) , computational thinking involves problem-solving via novel thinking. (Barr, D., 2019) defined computational thinking as problem-solving and implementation using efficient and effective processes. According to the concepts above, computational thinking skills use regular calculation patterns to answer issues in efficient, logical ways.

This demonstrates that kids require continuing computational thinking training. Students need computational thinking abilities much as reading, writing, and math (Mohaghegh, D. M., & McCauley, 2019). Learners of computational thinking can tackle complicated and open issues using abstract, algorithmic, and logical reasoning. Computational thinking is employing algorithms and software tools to solve problems from data input. This is not computer thinking, but calculating as thinking to generate calculus issues and build excellent computing answers (algorithm form) or explain why solutions cannot be found (Wing, 2016). Computational thinking is new. Seymour Papert introduced computational thinking in 1980.

In mathematics, computational thinking abilities need a thorough understanding of numerous mathematical elements, according to (Weintrop, D., 2016). (Wing, 2016) list the markers of computational thinking skills as measures of students' ability to use computational problem-solving principles: 1) Problem decomposition is the process of simplifying complex problems so they can be understood, solved, developed, and assessed independently, making it easier to understand ideas, solve complex problems, and build large systems; 2) Pattern recognition is the process of identifying general patterns or characteristics to develop solutions and solve problems. General patterns or characteristics can be used to find the best solution to a problem and learn how to solve certain types of problems; 3) Abstraction means deciding which information from an object to store and ignore so students can create models or representations to solve problems more easily without losing anything important. Selecting a suitable system model is crucial. Different representations simplify different tasks; 4) An algorithm involves precisely stating the processes to solve a problem. Repeatedly solving the same issue requires algorithms. Number patterns are a computational thinking-related math topic. Number patterns are one of the basis of mathematics, thus students must understand them to acquire other subjects. Students will first evaluate the number pattern material to learn about the issue and what they wish to solve.

Based on this approach, students may learn to breakdown issues into simpler ones. This approach works well for recognizing daily structure. Students will learn to abstract when tackling relevant issues from this recognition process. Additionally, students will learn to solve problems using algorithmic thinking. The four primary computational thinking capabilities are decomposition, pattern identification, abstraction, and algorithmic reasoning. Researchers in class VIII-8 SMP Negeri 29 Medan found that students are passive and reluctant to ask questions about the material explained by the teacher, making direct learning model learning outcomes meaningless. Students don't comprehend the teacher's principles since they only listen. Students' poor mathematics grasp hinders computational reasoning.

Based on the results of students' answers, at the decomposition stage, students have not been able to change complex problems into simpler ones, but students cannot write down important information from the problem. Students should be able to write down one by one information from the problem such as there are 9 rows of chairs. The first row has 8 chairs, the second row has 12 chairs, the third row has 11 chairs, the fourth row has 15 chairs, the fifth row has 14 chairs and so on following the same pattern. Furthermore, at the pattern recognition stage, students have not been able to identify patterns that can be used to solve problems. This can be seen from the way students find number patterns to find out the number of chairs in the 9th row. At the abstraction stage, students have not been able to identify important information in the problem and ignore irrelevant information, students should have written down important information in the problem. At the algorithm stage, students can reach a solution by clearly identifying the steps to be taken in solving the problem, but the results obtained by students are still wrong. Students answer that the backmost chair is 17 chairs, the result should be 20 chairs in row nine. The results of students' answers show that students are not yet capable of computational thinking.

Some 15 children had extremely weak computational thinking scores. The less group has 10 pupils. Five pupils are plenty. Thus, pupils' beginning mathematics skills (KAM) affect their extremely weak computational thinking ability score. This example divides students' KAM into high, medium, and low. KAM-based grouping is used to determine whether the learning model and KAM affect students' computational thinking and learning independence. (Islahiyah et al., 2021)agrees that students' KAM to acquire new concepts relies on their prior knowledge and cognitive frameworks. Student KAM is utilized to construct learning groups in this research. Learning independence affects learning achievement. According to (Fitria, A. D., Mustami, M. K., Taufiq, 2017), people with high learning independence learn better, can monitor, assess, and organize their learning, save time on assignments, and manage learning and time efficiently. (Sumarmo, 2016) defines learning independence as attentive self-design and monitoring of cognitive and emotional processes in academic tasks. Thus, student learning independence is crucial to mathematics learning because it involves careful self-design and monitoring of cognitive and affective processes, allowing students to evaluate, save, and manage learning time efficiently.

Learning independence must be a concern in the learning process, because based on the research results of (Febriyanti, F., & Imami, 2021), it was revealed that students' learning independence in mathematics is still very low, so efforts are needed to improve self-regulated learning so that the desired learning goals and make students successful in their learning. The results of the study by (Sari, N. W., & Nur, 2023) stated that students do not yet have optimal learning independence. This is due to the lack of students' desire to learn mathematics and always depend on others to complete math assignments. During learning, most students do not have the initiative to learn on their own. Students tend to wait to be told by the teacher to do practice questions, even though if students understand the importance of learning for themselves, students will not wait to be told by their teachers to do questions as practice. Based on observations that have been conducted on students in grades VIII-8 at SMP Negeri 29 Medan by providing a learning independence questionnaire in the form of a closed questionnaire scale containing 30 statement items with the following answer choices: (5) always (SL), (4) often (SR), (3) sometimes (KD), (2) rarely (JR) and (1) never (TP). The average percentage results based on learning independence indicators are respectively 32.44 for the evaluation indicator of task progress (self-evaluating); 45.78 for the indicator of organizing lesson materials (organizing and transforming); 43.50 for the indicator of making learning plans and goals (goal setting and transforming); 45.88 for the indicator of seeking information; 33.75 for the indicator of organizing the learning environment (environmental); 42.90 for the indicator of repeating and remembering (rehearsing and memory); 40.63 for the indicator of asking for help from friends, teachers and adults (seeking per, teacher, adult assistance); and 30.42 for the indicator of repeating previous assignments/tests (review test/work).

The questionnaire findings on class VIII-8 pupils' learning independence, with an average of 39.41%, indicate reduced independence. This shows that students' independence in learning must be improved, and one factor that affects this is the learning model used, which affects students' attitudes in acting. By making students active and requiring them to express their opinions in a discussion environment, this model will train students to speak in public. This will make students brave in all situations, increasing their learning independence. Researchers interviewed one of the mathematics teachers at SMP Negeri 29 Medan and found that: 1) The learning model is less interesting; 2) Teachers explain and provide more information about the material; 3) Students are passive and do not dare to express opinions or ask questions; 4) Students find it difficult to accept mathematics lessons; and 5) Low repeat exam results in the previous semester. The incompleteness of these mathematical learning outcomes demonstrates that many pupils struggle with computational thinking and learning independence.

This shows that it is necessary to improve students' computational thinking skills and learning independence. One factor that influences these skills and independence is the learning model used, which affects students' attitudes in acting. A learning model that makes students active and requires them to express their opinions in a discussion atmosphere will train students to be used to spe This will make kids bold in all circumstances, improving their computational thinking and learning independence. The direct learning model involves teachers teaching students new concepts or skills. (Hamzah Ali, 2013) states that the direct instruction learning model measures fundamental abilities, content comprehension, and self-concept. Direct learning is teacher-centered, according to (Kardi, S & Nur, 2020). To use the direct learning paradigm, instructors must show the skills and information students will gain progressively. (Aulia, N., Nurmawati, N., & Andhany, 2020) list the phases of direct learning as: 1) delivering goals and preparing students, 2) demonstrating knowledge and abilities, 3) training, and 4) checking comprehension and offering feedback. 5) Offering more training and application.

Direct learning helps distribute learning content. However, this paradigm has certain drawbacks. One of the biggest disadvantages of direct learning is the absence of opportunity for pupils to think critically and creatively. The major emphasis on presenting content in one direction, pupils tend to be passive consumers of information without much engagement in the process of finding new knowledge. This may impair kids' computational reasoning.

Thus, a diversity of learning models that accommodate student variances and promote computational thinking abilities are needed to increase learning. These skills may be improved using Realistic Mathematics Education. Realistic Mathematics Education is student-centered. (Siagian, M. D., & Sembiring, 2018) said realistic mathematics can use the environment to create student-centered learning activities like exploration, experiments, discussions, and others to reveal natural phenomena or daily activities. RME uses realism and a student-friendly environment to help children learn math and attain math education objectives better than before, according to (Soedjadi, 2014). (Laurens, T., Adolfina, F. B., Rafafy, J. B., & Leasa, 2017) define RME as learning that starts with real problems, prioritizes process skills (math), discussion and collaboration, and is interactive (peer tutors) to empower students to experiment individually and in groups. PMR prioritizes process skills, which is a concern for pupils, according to numerous viewpoints. PMR helps students rediscover and rebuild mathematical ideas by linking them with the actual world to improve their knowledge. PMR will demonstrate how mathematics applies to daily life. Students will create all these studies. Problem solution does not have to be unique or the same for every kid. PMR has been found to improve students' computational thinking in many studies.

In line with the research of (Batul, F. A., 2022), (Supiarmo, M. G., 2022) and (Khasanah, 2018) stated that computational thinking skills can increase after implementing PMR compared to students who are not given the application of PMR. This can be seen from each indicator of students' computational thinking skills in line with the PMR steps. Based on the description above, to see the effect of direct learning models and PMR on computational thinking skills and learning independence, the researcher has conducted a study entitled.

B. Research Method

This study is quasi-experimental. The control group in this design cannot adequately control external factors that may impact the experiment (Sugiyono, 2018). This design was devised to alleviate the problem in choosing the control group. This investigation was done at SMP Negeri 29 Medan, Jl. Medan Tembung District, Medan City, North Sumatra. This study was done in the 2024/2025 first semester. In the 2024/2025 academic year, 250 students were in class VIII at SMP Negeri 29 Medan in 8 classes. The population is selected due to its non-homogeneous distribution, with class IX students accepted based on exam scores and class VII and VIII students accepted through zoning, affirmation, parent/guardian transfer, and achievement. Class VIII-7 with 30 students was the experimental class for PMR therapy and class VIII-8 with 30 students was the control class for direct learning treatment.

There are two variables in this study, namely the dependent variable and the independent variable. The dependent variable is a variable that is influenced by the existence of the independent variable. While the independent variable is a variable that influences or causes changes in the emergence of the dependent variable. In this study, the dependent variables are computational thinking skills (Y_1) and learning independence (Y_2), while the independent variables are PMR (X_1) and direct learning (X_2).

Pre-post-test Control Group Design was employed in this research. Sugiyono (2015) states that in the Pre-test-Post-test Control Group Design, two groups are randomly chosen and given an initial ability test to determine the first conditional difference between the experimental and control groups. The Pre test-Post test Control Group Design study design, according to Sugiyono (2016), is as follows.

Table 1. Research Design

Class	Initial Abilities	Treatment	Final Ability
Experiment	O_1	X	O_2
Control	O_3	-	O_4

C. Result and Discussion

Description of Students' Computational Thinking Ability Results

The computational thinking ability test was conducted at the end of learning with the same type of questions in 2 class groups. The final test (posttest) was attended by 60 students divided into 2 classes, namely the experimental class consisting of 30 students and the control class consisting of 30 students. Based on data from the posttest results, the lowest score (x_{min}) the highest score ((x_{maks})), the average score ($\bar{x}$), and the standard deviation (SD) for the experimental group and the control group were obtained as shown in Table 2 below

Table 2. Post-Test Results Data for Computational Thinking Ability

Class	Ideal Score	Data *Post Test*			
		x_{min}	x_{maks}	$\bar{x}$	SD
Experimental (PMR)	100	70	95	80,50	6,78
Control (Direct Learning)		67	88	76,39	5,52

From Table it can be seen that the minimum posttest score of students' computational thinking ability in the experimental group is higher (70) compared to the control group (67), the maximum score of students' computational thinking ability in the experimental group is also higher (95) than the control class (88). Likewise, the average posttest score of students' computational thinking ability for the experimental group (80.50) is higher than the average posttest of students for the control group (76.39).

Computational Thinking Ability Normality Test

The Kolmogorov Smirnov test at a sig. was used to test the normality and homogeneity of the computational thinking ability test results of students taught using PMR (experimental class) and direct learning (control class) before conducting the average difference test.

The test criteria used are if the sign value. > 0.05, then H_0 is accepted, which means the sample comes from a normally distributed population and if the sign value. < 0.05, then H_a is accepted, which means the sample comes from a non-normally distributed population. The summary results of the calculation of the normality of the computational thinking ability test using SPSS 26 are presented in Table 3 below.

Table 3. Results of Normality of Computational Thinking Ability

Tests of Normality				
	Class	Kolmogorov-Smirnov[a]		
		Statistic	df	Sig.
Computational Thinking Ability Post Test	Experimental Post Test (PMR)	.127	30	.200*
	Control Post Test (Direct Learning)	.138	30	.148

The Kolmogorov Smirnov normalcy test in Table shows that the experiment has a significance value of 0.200 and the control class 0.148. This shows that the significance value for the experimental class, 0.200> 0.05, and the control class, 0.148> 0.05, are greater than the significance level, indicating that the data for both sample classes comes from a population with normal distribution data. The results of the ANOVA calculations on computational thinking ability results can be seen in table 4 below.

Table 4. Results Of Two-Way ANOVA Calculations On The Results Of The Computational Thinking Ability Test

Tests of Between-Subjects Effects					
Dependent Variable: Computational Thinking Skills					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	2099.797[a]	5	419.959	62.450	.000
Intercept	281170.231	1	281170.231	41811.253	.000
Learning Model	164.611	1	164.611	24.478	.000
Early Mathematical Ability	1805.977	2	902.989	134.278	.000
Learning Model * KAM	29.490	2	14.745	2.193	.121
Error	363.137	54	6.725		
Total	371884.000	60			
Corrected Total	2462.933	59			

a. R Squared = .853 (Adjusted R Squared = .839)

The learning model has a significance value of 0.000 (sig.<0.05) as shown in Table 4. Thus, H_0 in statistical hypothesis 1 is rejected and H_a is accepted, indicating that PMR students are better at computational thinking than Direct Learning students. Thus, PMR and direct learning vary significantly in computational thinking abilities. Influences are natural or man-made factors that cause an event to occur and may be anticipated in one way or another (Sudjana, 2005). This suggests PMR and direct learning affect computational thinking abilities significantly. The learning model * KAM has a significance value of 0.121, therefore for hypothesis test 3, H_0 is accepted, indicating that starting mathematical competence and the learning model do not affect students' computational thinking abilities.

Description of the Results of the Student Learning Independence Questionnaire

Based on data from the results of the student learning independence questionnaire, the lowest score (x_{min}), highest score (x_{maks}), average score $(\bar{x})$ and standard deviation (SD) were obtained for the experimental group and control group as shown in Table 5 below.

Table 5. Data on the Results of the Student Learning Independence Questionnaire

Class	Ideal Score	Questionnaire Data			
		x_{min}	x_{maks}	$\bar{x}$	SD
Experimental (PMR)	100	71	94	81,74	6,55
Control (Direct Learning)		67	85	75,60	5,05

From Table 5 it can be seen that the minimum score of the student learning independence questionnaire in the experimental group is higher (71) compared to the control group (67), the maximum score of the student learning independence questionnaire in the experimental group is also higher (94) than the control class (85). Likewise, the average score of the student learning independence questionnaire for the experimental group (81.74) is higher than the average student questionnaire for the control group (75.60).

Normality Test of Student Learning Independence

Before conducting the average difference test, a prerequisite test was first conducted, including a normality and homogeneity test of the results of the student learning independence questionnaire taught using PMR (experimental class) and direct learning (control class). The normality test is intended to see whether the data from the student learning independence questionnaire is normally distributed or not. This normality test uses the Kolmogorov Smornov test with a significance level of 0.05. The summary results of the normality calculation of the student learning independence questionnaire using SPSS 26 are presented in Table 6 below.

Table 6. Results of the Normality Test of the Student Learning Independence Questionnaire

Tests of Normality				
Class		Kolmogorov-Smirnov[a]		
		Statistic	df	Sig.
Learning Independence Questionnaire	Experimental Learning Independence Questionnaire (PMR)	.111	30	.200*
	Control Learning Independence Questionnaire (Direct Learning)	.139	30	.143

The Kolmogorov Smirnov normalcy test in Table 6 showed that the experimental class had a significance value of 0.200 and the control class 0.143. This shows that the significance value for the experimental class, 0.200> 0.05, and the control class, 0.143> 0.05, are greater than the significance level, indicating that the data for both classes comes from a normally distributed population.

Discussion

SMP Negeri 29 Medan's study featured two classes: the experimental class utilizing PMR in VIII-6 and the control class using direct learning in VIII-7. Two-way ANOVA showed that the learning model's significance value on computational thinking skills was 0.000, rejecting H_0 and accepting H_a. This means that at a 95% confidence level, PMR students' computational thinking skills were higher than those in the direct learning class. Thus, PMR and direct learning vary significantly in computational thinking abilities. After treatment, descriptive data analysis showed that PMR-taught students had greater computational thinking abilities than direct learners. The average posttest scores in the experimental class were 80.50 while the control class was 76.39.

According to the research, pupils in the experimental class responded quicker to learning than in the control class. PMR (experimental class) promotes student-centered learning with real-world challenges and group learning, which helps students recall more than teacher-centered courses. SMP Negeri 29 Medan's study featured two classes: the experimental class utilizing PMR in VIII-6 and the control class using direct learning in VIII-7. From two-way ANOVA, the significance value for the learning model on computational thinking skills was less than 0.05, which was 0.000, so H_0 was rejected and H_a was accepted, indicating that PMR students had higher computational thinking skills than direct learners at a 95% confidence level. Thus, PMR and direct learning vary significantly in computational thinking abilities. After treatment, descriptive data analysis showed that PMR students had greater computational thinking abilities than direct learning students. The average posttest scores in the experimental class are 80.50 while the control class is 76.39.

According to the research, pupils in the experimental class responded quicker to learning than in the control class. PMR, the experimental class, promotes student-centered learning with real-world challenges and group learning, which helps students recall more than the control class, which stresses teacher-centered learning.

D. Consclusion

Based on the results of data analysis, findings and discussions that have been presented in the previous chapter, several conclusions were obtained related to the implementation of learning using PMR and direct learning on computational thinking skills and students' learning independence at SMP Negeri 29 Medan. Some of the conclusions obtained are; Students' computational thinking skills in the PMR class are higher than in the direct learning class. Students' learning independence in the PMR class is higher than in the direct learning class. There is no interaction between initial mathematics ability (high, medium, low) and learning models on students' computational thinking skills at SMP Negeri 29 Medan. There is no interaction between initial mathematics ability (high, medium, low) and learning models on students' learning independence at SMP Negeri 29 Medan.

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