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Elementary school students computational thinking skills in learning-based 3D-Geometry problem

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ABSTRACT

This research is motivated by the importance of computational thinking skills for elementary school students. This research must be carried out because, so far, the development of computational thinking in Indonesia has only been carried out in high schools. This study aims to investigate how elementary school students' computational thinking skills in learning 3D Geometry. The research method used was quasi-experimental with a pure post-test design of the 31 elementary school students selected using a purposive technique- sampling. Constructive, content, and empirically validated calculus tests served as research tools. According to this study's results, elementary school students' computational thinking skills were significantly improved by learning from 3D-Geometry problems, and the average score was ranked high at 67.48 points. In this way, knowledge based on 3D-Geometry issues can be applied to developing computational thinking skills in elementary school students.

Keywords: Computational Thinking Skill, Elementary School, Learning-Based 3D-Geometry problem

ABSTRAK

Penelitian dilatar belakangi oleh pentingnya kemampuan berpikir komputasional bagi siswa sekolah dasar. Penelitian ini harus dilakukan karena selama ini pengembangan berpikir komputasional di Indonesia baru dilakukan pada sekolah menengah. Tujuan penelitian ini adalah untuk mempelajari bagaimana kemampuan berpikir komputasional siswa sekolah dasar dalam pembelajaran pecahan. Metode penelitian yang digunakan adalah kuasi eksperimen dengan desain post-test only desain pada 31 siswa sekolah dasar yang dipilih dengan teknik purposive. Instrumen penelitian yang digunakan adalah soal tes kemampuan berpikir komputasi yang telah divalidasi konstruk, isi dan empiris. Hasil penelitian ini menunjukkan bahwa kemampuan berpikir komputasi siswa sekolah dasar pada pembelajaran berbasis masalah pecahan meningkat signifikan dan berada pada kategori tinggi dengan skor rata-rata 67,48. Dengan demikian pembelajaran berbasis masalah pecahan dapat diterapkan untuk mengembangkan keterampilan berpikir komputasi siswa sekolah dasar.

Kata Kunci: Kemampuan Berpikir Komputasi, Sekolah Dasar, Pembelajaran Berbasis Masalah Geometri 3 Dimensi

INTRODUCTION

Computational thinking skills are a subject that is an essential topic in facing continuous challenges as a fundamental or basic competency today (Doleck et al., 2017). This is in line with the opinion of Wing (2014) that computational thinking is one of the skills that must be possessed so that students can compete in the advancing times. Seymour Papert first introduced computational thinking in 1980 (Zahid, 2020). Meanwhile, in 2020 the Ministry of Education and Culture launched two new competencies in Indonesian children's learning system: computational thinking and compassion (CNBC Indonesia, 2020). This was conveyed directly by the Head of the Ministry of Education and Culture's Center for Curriculum and Learning, Awaluddin Tjalla, that these two competencies are needed for Indonesian children. This is because computational thinking is a mental process to train students to solve complex problems. Computational thinking is not only for skills in terms of computers, but these skills are essential skills that everyone needs to read, write, and count (Czerkawski & Lyman, 2015; Sanford & Naidu, 2016). According to Lee et al. (2014), this computational skill is believed to be one of the solutions that can stimulate students to think logically, structured, and systematically. In computational thinking, students will solve problems, design systems, and understand human behavior by describing basic concepts about something.

Seymour Papers was the first to introduce computational thinking skills in 1980 (Zahid, 2020). According to him, computational thinking is a set of cognitive skills that allow students to identify patterns, break complex problems into small steps, organize and create a series of steps to provide solutions, and build data representations through simulations (Amelia, 2020). This aligns with Mufida's (2018) opinion that computational thinking is a series of processes involving skills and techniques to solve problems. Computational skills are increasingly important globally for a greater understanding of the conceptual development of problem-solving. Following this need, computational thinking in recent years has become an integrated part of the school curriculum in several countries, such as Finland, Estonia, the United Kingdom, and Israel, which are just some examples of countries whose governments seek to integrate computational and coding skills as new literacies and to support students in creative problem-solving tasks (Maharani et al., 2020). Therefore, computational thinking ability is necessary for someone, especially students, to face the challenges of the 21st century. In addition, computational thinking can also stimulate students to think creatively in solving problems (Angeli & Giannakos, 2020).

Meanwhile, the development of computational thinking skills in Indonesia is still not implemented, although Indonesia joined an organization called Bebras Indonesia in 2016. Bebras Indonesia has an activity that can change how people think to be able to think computationally. Bebras Indonesia is managed by the Indonesian Computing Olympiad Team (TOKI) in partnership with regional universities coordinating schools (Fu'adi, 2018). The ability to think computationally still needs attention. This can be seen from the results of the PISA (Programme for International Student Assessment) in 2018, which shows that Indonesian students obtained results of 379 in mathematics, while the average score of PISA is 489 (OECD, 2019). In general, the characteristics of PISA questions are similar to those of computational thinking skills (Amelia, 2020). If seen from the PISA results in 2018, the computational thinking skills of Indonesian students are still below average. Therefore, the development of computational thinking skills must be followed-up immediately.

The action chosen to develop computational thinking skills is 3-dimensional geometry problem-based learning, whose activities include: orienting a problem to students; organizing students to learn; independent and group investigations; developing and presenting solutions or works and exhibitions; and analyzing and evaluating the problem-solving process. This model was chosen because problem-based learning emphasizes problem-solving activities in education (Eismawati et al., 2019). Furthermore, they also stated that problem-based learning is one of the suitable alternatives to develop students' thinking skills because all students are actively involved in education and are associated with everyday problems. This aligns with the opinion that problem-based learning can support Higher Order Thinking Skills (HOTS) in problem-oriented learning (Sastriani, 2017). In addition, the problem-based learning model becomes a learning model design based on computational thinking and is relevant to the demands of the 2013 curriculum (Surahman et al., 2020).

Some studies that have been conducted related to the development of computational thinking skills include Amelia (2020), who applied cooperative problem-based learning to mathematical computational thinking skills, and Rafli (2020), who implemented computational thinking learning on graphs with a problem-based learning model—Kwon et al. (2021) Integrating problem-based learning in elementary computer science education. Shin et al. (2021) Promoting computational thinking through project-based learning.

These two studies have not touched the subject of elementary school students trying to lay mathematical science's foundations and joints. Several studies outside Indonesia have started implementing learning that develops computational thinking skills in K-12 students, such as (Lee et al., 2011; Grover & Pea, 2013; Yadav & Stephanson, 2016, Zaharin et al., 2018). Based on the background-related issues and the importance of computational thinking skills for elementary school students, this study intends to examine the computational thinking skills of elementary school students in problem-based learning of 3-dimensional geometry.

METHOD

This study uses a quantitative approach with a quasi-experimental type. The research design chosen was the pretest post-test without a control group design. This quasi-experimental research is used to determine the improvement of students' computational thinking skills in problem-based learning of 3-dimensional geometry in elementary school.

The purposively selected sample participants in this study were fifth-grade students in one of the elementary schools in Cikampek District, Karawang, with several predetermined considerations, namely: 1) The fifth-grade students are students at a higher grade level who are capable of thinking at a higher level; 2) Assist the school program in preparing students to take the Minimum Competency Assessment (Asesmen Kompetensi Minimum; AKM) exam, and can be a training for the students to improve computational ability; 3) Not hamper the school program in preparing the final exam for students; 4) Participate in pretest and post-test activities, and be involved during the treatment. The number of samples used was 31 students.

The test instrument is in the form of a description question which is used to measure the ability of computational thinking related to 3-dimensional buildings. The preparation of test questions is based on indicators of computational thinking ability that will be achieved, namely providing simple explanations, building skills, making further explanations, and determining strategies and tactics to solve problems (Angeli & Giannakos, 2020). Tests collect data on student learning outcomes before (pretest) and after problem-based learning of 3-dimensional geometry (post-test).

Table 1. Indicators of Computational Thinking Questions (Angeli & Gianakos, 2020)

Ability indicator	Competency Indicator
Decomposition	Students can identify and describe problems more simpler.
Abstraction	Students can make problems by eliminating parts that are not needed.
Generalization	Students can mention general patterns/formulas from the equations/differences in the problems.
Algorithms	Students can determine the most effective and logical steps to develop a solution to a given problem.
Debugging	Students can identify suitability/non-compliance in the process of solving problems and fixing them.

Before being given to students, the instrument has been validated constructively, content, and empirically until it is declared to be able to measure students' computational thinking ability related to 3-dimensional geometry material. The data that has been collected is analyzed with descriptive and inferential statistics until the conclusion is obtained whether, after the treatment of problem-based learning 3-dimensional geometry, students' computational thinking ability has changed. The hypothesis to be tested is a significant increase in the computational thinking ability of elementary school students after getting a 3-dimensional geometry problem-based learning treatment. Furthermore, regression analysis determines the effect of a 3-dimensional geometry problem-based learning variable on computational thinking skills.

RESULT AND DISCUSSION

This study began on May 19, 2022, by observing one of the elementary schools in the Cikampek District. This 3-dimensional geometry problem-based learning study was conducted as many as six meetings (6x2x35 minutes) of learning and 2 test meetings (pretest and post-test) with 3-dimensional geometry problem-based learning which was arranged to determine the ability of computational thinking related to the material of cube and cuboid. Pretest and post-test activities are carried out with an estimated time of 60 minutes. Details of the applied learning are described in Table 2.

Table 2 Learning Description Results

Meeting	Description
1	The material discussed at the first meeting was the elements and attributes of the cube. In this meeting, students were still adjusting to learning by using the problem-based learning model. Most students were still confused about solving the worksheet (LKS) related to problem-solving by thinking computationally. Based on the worksheet (LKS) score results, the students have not been able to show an understanding of all indicators of computational thinking skills.
2	The material discussed was the elements and attributes of the cuboid. In this meeting, students understood the learning using the problem-based learning model. Students do not understand the problems presented in the worksheet (LKS) related to problem-solving by thinking computationally. Based on the worksheet (LKS) score results, the students could show little understanding of some indicators of computational thinking skills, such as indicators of decomposition and abstraction. Students have not understood other indicators of computational thinking skills.

Meeting	Description
3	The material discussed was determining the volume of the cube by using unit cubes. At this meeting, students were accustomed to, and better understood the learning using the problem-based learning model. As seen from the worksheet (LKS) score in this third meeting, students have little knowledge of solving problems by thinking computationally. However, students still need to be stimulated and clarify the meaning of the problems presented. This was because the problems presented in this meeting were more complex than in the previous session. So that students only show an understanding of some indicators, such as indicators of decomposition and abstractions. Students still need to practice more computational thinking skills on indicators of generalization, algorithms, and evaluation (debugging).
4	The material discussed was to determine the volume of the cuboid by using the unit cubes. In this meeting, students were already accustomed to and better understood the learning using a problem-based learning model. Based on the results of the worksheet (LKS) score in this 4th meeting, students already understand how to find the solutions to problems by thinking computationally, but students still need to be stimulated and clarify the meaning of the problems presented. Some students have made progress in reflecting the understanding of several indicators, such as indicators of decomposition, abstraction, generalization and debugging. Students must still practice more computational thinking skills on generalization indicators and algorithms.
5	The material discussed was problem-solving regarding the volume of cubes and cuboids using the standard units. Students were already accustomed to and better-understood learning using problem-based learning models at this meeting. Based on the results of the worksheet score at this 5th meeting, students already understand how to find solutions to problems using computational thinking skills, but students still need to be stimulated and clarify the meaning of the presented problems. Most students have made progress in reflecting on the understanding of several indicators, such as indicators of decomposition, abstraction, generalization, algorithms, and debugging. Students still need to practice more computational thinking skills, especially on indicators of conception and algorithms.
6	The material discussed was solving problems about the volume of cubes and cuboids using standard units. Students were already accustomed to and better understood learning using a problem-based learning model at this meeting. Based on the result of the worksheet score at this 6th meeting, students already understand how to find solutions to problems using computational thinking skills, but students still need to be stimulated to clarify the meaning of the presented problems. Most students have made progress in reflecting on the understanding of several indicators, such as indicators of decomposition, abstraction, generalization, algorithms, and debugging. Students still need to practice more on computational thinking skills, especially on the algorithm's indicator.

After several treatments for the experimental group, the data from the pre-test and post-test results were processed and analyzed. The descriptive analysis of the pretest and post-test scores of computational thinking skills of elementary school students in problem-based learning of 3-dimensional geometry is described in Table 3.

Based on table 3, the average pretest and post-test scores of students who took part in learning with the problem-based learning model are much different from the post-test score, with a difference of more than 28 points. The average pretest score doesn't reach half of the ideal maximum score. This shows students' computational thinking skills were low before participating in 3-dimensional geometry problem-based learning. But after being given the treatment, the skills increased significantly, with the average post-test score having more than 10 points of the ideal median. Meanwhile, the maximum score was also obtained at the post-test, increasing sharply with a difference of 20 points from the pretest score. Similarly, the minimum score increased by 15 points and exceeded the median.

Table 3. Description of pretest and post-test scores of computational thinking skills of elementary school students.

IMS = 40	Class	Score		Average	SD
		Highest	Lowest		
	Pretest	19	7	11,93	3,129
	Post-Test	39	22	30,70	4,836
NGain		95,45	40,00	67,848	15,371

Description:
IMS = Ideal Maximum Score
SD = Standard Deviation

Furthermore, regression analysis determines the effect of a 3-dimensional geometry problem-based learning variable on computational thinking skills. Before processing the data, select the form of the regression equation. The data processing results with the help of the SPSS software are obtained in Table 4.

Based on Table 4, the constant value of 17.777 means that if there is no treatment of the problem-based learning mode, the value of computational thinking skills is 17.777. While the value of the regression coefficient β of 1.083 means that with every addition of one unit for the problem-based learning treatment, the ability to think computationally will increase by 1.083. The acquisition of these values results in a regression equation Y = 17,777 + 1,083X

Table 4 Coefficient Test Results and General Form of the Regression Equation

e		***Unstandardized Coefficients***	
		B	***Std. Error***
1	(*Constant*)	17,777	2,569
	Pretest	1,083	0,208

The regression significance test is carried out to determine whether the influence between the two variables to be measured is significant. The regression test hypothesis of this study is as follows:

H0: μ0 = μ1, The problem-based learning model does not significantly affect students' computational thinking skills in experimental and control classes.

H1: μ0 ≠ μ1, The problem-based learning model significantly affects students' computational thinking skills in experimental and control classes.

The hypothesis testing criteria used are if the sig. Value is more significant than 0.05, then H0 is accepted, meaning that the problem-based learning model has no significant effect on students' computational thinking skills in experimental and control classes. And if the sig. Value is smaller than 005, then H0 is rejected, which means that the problem-based learning model significantly affects students' computational thinking skills in experimental and control classes. The data processing results with the help of the SPSS are obtained in Table 5.

Table 5 Simple Linear Regression Significance Test Results Hasil

Test	*Sig.*	**Significant Level**	**Description**
Regression	0,000	0,05	H_0 is rejected

Based on Table 5, the sig. A value of 0.000 < 0.05 is obtained, so according to the decision-making criteria in the equation Y = 17.777 + 1.083X, H0 is rejected. It can be concluded that the problem-based learning model has a significant effect on students' computational thinking skills.

The coefficient of determination test is conducted to determine the influence of the problem-based learning model on computational thinking skills. The coefficient determination equals the R Square value from the Model Summary table in the SPSS output. The following are the results of the coefficient of determination test for the problem-based learning model on students' computational thinking skills in experimental and control classes.

Table 6 The Coefficient of Determination Test Results of Problem-Based Learning Model on Students' Computational Thinking Skills Hasil Uji

Model	**R**	***R Square***	***Adjusted R Square***	***Std. The error in the Estimate***
1	0,701	0,491	0,473	3,512

From Table 6, information can be obtained from the problem-based learning model on students' computational thinking skills in experimental and control classes: the relationship's magnitude or correlation (R) is 0.701. At the same time, the coefficient of determination (R Square) is only 0.491. Thus, it can be concluded that the effect of the problem-based learning model on students' computational thinking skills is 49.1%.

After the experimental class was given treatment by conducting learning with a problem-based learning model, the results of the data analysis showed that the subjects of this study, based on the average score, experienced an increase in computational thinking skills ability. The data obtained states that the data is usually distributed with a significance level in the experimental class of 0.372. Furthermore, the improvement test looked at the N-Gain score in the control and practical courses. The result of the signification value obtained is 0.628, which means that a significant increase in computational thinking skills is obtained based on the problem-based learning treatment of 3-dimensional geometry. This confirms that the problem-based learning model is based on a problem used to develop high-level thinking skills in solving a problem.

The effect of the problem-based learning model on computational thinking skills is proven by simple linear regression test analysis. Based on the results of the regression significance test to determine the significance or not of the influence between the two variables to be measured, the sig value of 0.000 < 0.05, then according to the decision-making criteria, H0 is rejected, and it can be concluded that the problem-based learning model has a significant effect on students computational thinking skills.

After it is known that both variables have a significant effect, the coefficient of determination test is then carried out to determine the magnitude of the influence of the problem-based learning model on computational thinking skills. The coefficient of determination (R Square) obtained is 0.491

or 49.1%. This implies that the influence of the problem-based learning model on students' computational thinking skills is 49.1%. At the same time, the impact of other factors (variables not studied) is 50.9%.

Based on the explanation of the analysis, it can be concluded that the problem-based learning model has a linear relationship to computational thinking skills and is proven to have an influence of 49.1% on mathematics learning about 3-dimensional geometry of grade V elementary school students. This is in line with the opinion of Surahman et al. (2020), who state that knowledge is relevant to the demands of the 2013 curriculum and can train computational thinking skills, one of which is the problem-based learning model. Similarly, the previous study that has been conducted on the use of problem-based learning models to improve students' computational thinking skills includes a survey conducted by Amelia (2020) which was carried out on class VIII students of MTs Islamiyyah Ciputat South Tangerang which examined the cooperative problem-based learning model on students computational thinking skills. In that study, the results showed that the class treated with the collaborative problem-based learning model was high in call indicators. The most considerable computational thinking skill in the experimental class was in the composition indicator, followed by other hands: abstraction, algorithm, debugging, and generalization. It can be said that learning with a cooperative problem-based learning model can develop students' mathematical computational thinking skills. This shows that the problem-based learning model is a good enough model to be used to train students' computational thinking skills. Similar results were also found in the study of Chen (2017); Kwon et al. (2021); Shin et al. (2021), and Jonasen, T. S., & Gram-Hansen, S. B. (2019), which convinced researchers to conduct problem-based learning to improve computational thinking skills.

CONCLUSION

The computational thinking skills of elementary school students who received Learning-Based 3D are better than those who received conventional learning. However, the improvement of computational thinking skills in the experimental and control classes is at the same level, which is in the high category. This research has succeeded in applying mathematics learning to develop computational thinking skills in 3D geometry material with good results so tat further analysis can be carried out on other materials in various classes (high medium, and low) in elementary schools.

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