International Journal of Education, Vocational and Social Science
https://e-journal.citakonsulindo.or.id/index.php/IJEVSS
E-ISSN : 2963 4954
IJEVSS

The Interaction of Problem Based Learning Assisted by Manipulative Media and Mathematical Disposition on the Computational Thinking Ability of Elementary School Students

Lailatul Afifah Suherman
Departement of Elementary Education, Jakarta State University, Indonesia
Yurniwati
Department of Elementary Education, Jakarta State University
Nurjannah
Department of Elementary Education, Jakarta State University

Corresponding Author: lailatul.afifah@mhs.unj.ac.id

Abstract

Computational thinking ability is one of the 21st-century skills that needs to be developed since elementary school. This study aims to analyze the interaction between Problem Based Learning (PBL) assisted by manipulative media and mathematical disposition on the computational thinking ability of elementary school students. The study used a quantitative method with a quasi-experimental 2×2 treatment by level design using a posttest-only control group design. The research sample consisted of 128 fifth-grade elementary school students in Tamansari District, Bogor Regency, selected through a cluster random sampling technique. The analysis was conducted on 70 students who were grouped into high and low mathematical dispositions using the extreme group technique of the top 27% and bottom 27%. Data were collected through a computational thinking ability test and a mathematical disposition questionnaire, then analyzed using two-way ANOVA and followed by the Tukey Post Hoc test. The results of the study showed that there was a significant interaction between the learning model and mathematical disposition on students' computational thinking ability ($p < 0.001$). Students with high mathematical disposition obtained better computational thinking ability through PBL assisted by manipulative media compared to the expository model. Conversely, for students with low mathematical disposition, the expository model provided better results. These findings indicate that the selection of a learning model needs to consider students' mathematical

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

disposition.

Keywords: Computational Thinking, Problem Based Learning, Manipulative Media, Mathematical Disposition.

INTRODUCTION

The development of the 21st century demands students to have various skills necessary to face the increasingly complex challenges of life and the world of work. According to Trilling and Fadel (2009), these skills are fundamental elements that act as keys in supporting the lifelong learning process as well as the development of creative works. Creative thinking, critical thinking and problem solving, communication, and collaboration are 21st-century skills (Muthmainnah et al., 2023), as well as computational thinking (Silva et al., 2021).

Computational thinking was first introduced by Seymour Papert (1980) then popularized by Wing (2006) and defines computational thinking as a way of thinking that uses the basic concepts of computer science to solve problems, build systems, and understand human behavior. In line with that, Aho (2012) also defines computational thinking as the thought processes involved in formulating problems so their solutions can be represented as computational steps and algorithms. In other words, computational thinking is a problem-solving ability that utilizes computer science concepts to formulate problems, analyze information, systematically arrange completion steps, and produce effective and efficient solutions. This ability is not only needed in the field of technology, but is also relevant for various disciplines, including mathematics. Weintrop (2016) explains that computational thinking is a problem-solving practice that can be applied in mathematics and science learning. Computational thinking is a form of developing the thinking process that involves the thinking ability itself (Hariyani et al., 2024). The purpose of computational thinking is to help students become more skilled in solving problems by using computational concepts in practical situations, as well as allowing students to understand how systems work, recognize patterns and create innovative solutions (Barr, 2011). Computational thinking must be possessed by students, because in the process, problem solving does not only focus on solving the problem but how the solving process is (Sanapiah & Aziz, 2021).

In the context of basic education, computational thinking ability has an important role because it helps students develop logical, systematic, critical, and creative thinking skills from an early age. This ability includes several main components, namely decomposition, pattern recognition, abstraction, and algorithms that students can use in solving various mathematical

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

problems. This is in line with what was stated by Kemendikdasmen (2025) that computational thinking teaches students to solve problems systematically and efficiently by conducting the process of decomposition (breaking large problems into small parts), pattern recognition, abstraction, and algorithms that help students understand and handle digital challenges. Therefore, the development of computational thinking ability needs to be a concern in the mathematics learning process in elementary schools so that students are not only able to master concepts, but also able to use them to solve problems effectively.

Nevertheless, various research results indicate that the computational thinking ability of elementary school students is still classified as low. Based on research that has been conducted by Rahayu et al. (2023), it shows that students' computational thinking ability is still low, this is indicated by the scores obtained being still below the average, especially in the aspects of pattern recognition, algorithmic thinking, and abstraction. Another research conducted by Aunurrahim (2024) shows that students' decomposition ability is still relatively lacking, which is an aspect of computational thinking ability. This is in line with the data results of the Bebras Task Challenge conducted in 2024 for the SD/MI level (equivalent to grades 4-6) it was found that out of all participants throughout Indonesia totaling 12,706 students, only 2,530 or 19% of students were able to complete the bebras computational thinking challenge in the form of non-programming questions designed to test the way students think in solving problems logically, systematically, and efficiently without having to write code. The questions are presented in the form of stories or illustrations covering four main components, namely decomposition, pattern recognition, abstraction and algorithmic thinking (Bebras Indonesia, 2024).

One learning alternative that has the potential to develop computational thinking ability is Problem Based Learning (PBL). The PBL model is student-centered learning by making problems the starting point of learning (Hmelo-Silver & Barrows, 2006; Torp & Sage, 1998). PBL is a learning model where students learn to solve relevant and challenging problems, which are usually taken from real or contextual situations (Hendriko et al., 2024). Through the process of identifying problems, finding information, developing various alternative solutions, and evaluating problem-solving results, students gain the opportunity to develop higher-order thinking skills (Arends, 2012; Tan, 2002). These characteristics are in line with the computational thinking process which requires students to break complex problems down into simpler parts, find patterns, perform abstraction, and arrange completion steps systematically.

The effectiveness of PBL in developing computational thinking ability can be strengthened through the use of manipulative media. Moyer (2001) defines manipulative media as real objects

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

used by teachers to help students understand mathematical concepts through direct experience, physical interaction, and concrete representation of abstract ideas. The benefits of manipulative media are fostering learning motivation, providing learning stimulus, and helping students visualize abstract mathematical concepts so that they are easy to understand (Farhana et al., 2022). Manipulative media provides a concrete learning experience thus helping students understand abstract mathematical concepts (Nurhasanah et al., 2025). The use of manipulative media allows students to conduct direct exploration, observe relationships between objects, and build understanding through real experiences. Thus, the integration of PBL and manipulative media not only encourages active student involvement in learning, but also helps students develop computational thinking abilities through more meaningful problem-solving activities.

However, the successful application of a learning model is not only influenced by external factors in the form of models and learning media, but is also influenced by internal student factors (Prasetyo et al., 2025). One of the internal factors thought to influence computational thinking ability is mathematical disposition. Kilpatrick and Findell (2001) in Hutajulu et al. (2019) explain that mathematical disposition is the tendency to see mathematics as something that can be understood, feel mathematics as something useful, believe that diligent effort and perseverance in learning mathematics will yield results, act as an effective learner and as a doer of mathematics itself. Students who have a high mathematical disposition generally show self-confidence, perseverance, interest, and a positive attitude towards learning mathematics. Conversely, students with a low mathematical disposition tend to be less motivated and give up easily when facing learning difficulties (Huda & Syafmen, 2021; Marbán, 2016).

Previous research has shown that computational thinking ability can be improved through various learning approaches, such as that conducted by Noviyanti et al. (2023) by applying the Differentiated Learning Model to improve students' computational thinking ability, Agustini et al. (2024) who applied the Game Based Learning Model with Educational Games to improve computational thinking skills, as well as the selection of media in the form of scratch applications (Gao & Hew, 2022), audible books media (Alim et al., 2022), and robotics programming (Noh, 2020). These various studies indicate that computational thinking ability can be improved through various learning models and media. Based on the literature review, previous studies mostly examined the effect of specific learning models or media on computational thinking ability separately. However, no research has been found that simultaneously analyzes the interaction between Problem Based Learning assisted by manipulative media and mathematical disposition on the computational thinking ability of elementary school students. Therefore, the purpose of

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

this study is to analyze how mathematical disposition influences the effectiveness of Problem Based Learning assisted by manipulative media in developing the computational thinking ability of elementary school students. Furthermore, the research question proposed in this study is whether there is an interaction between Problem Based Learning assisted by manipulative media and mathematical disposition on the computational thinking ability of elementary school students.

RESEARCH METHODOLOGY

This study used a quantitative method with a quasi-experimental design in the form of a 2×2 treatment by level design using a posttest-only control group design aimed at analyzing the interaction of the learning model and mathematical disposition on the computational thinking ability of elementary school students (Djaali, 2020; Kadir, 2018). The independent variable in this study is the learning model consisting of Problem Based Learning (PBL) assisted by manipulative media and the expository learning model. The moderator variable is mathematical disposition grouped into high mathematical disposition and low mathematical disposition, while the dependent variable is students' computational thinking ability. The 2x2 treatment by level design is presented in Table 1.1 below:

Table 1.1 2x2 treatment by level design

Learning Model (A) / Mathematical Disposition (B)	PBL assisted by Manipulative Media (A1)	Expository (A2)
High (B1)	A1B1	A2B1
Low (B2)	A1B2	A2B2

Description:

A1 = Group of students learning through the PBL model assisted by manipulative media

A2 = Group of students learning through the expository model

B1 = Group of students with high mathematical disposition

B2 = Group of students with low mathematical disposition

A1B1 = Group of students learning through the PBL model assisted by manipulative media and having a high mathematical disposition

A1B2 = Group of students learning through the PBL model assisted by manipulative media and having a low mathematical disposition

A2B1 = Group of students learning through the expository model and having a high mathematical disposition

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

A2B2 = Group of students learning through the expository model and having a low mathematical disposition

The study was conducted on fifth-grade students of public elementary schools (SDN) in Tamansari District, Bogor Regency, in the even semester of the 2025/2026 academic year. The research sample was determined using the cluster random sampling technique. Based on the lottery results, two classes were designated as the experimental class that received Problem Based Learning assisted by manipulative media and the other two classes as the control class that received expository learning. The total research sample was 128 students consisting of 62 students in the experimental class and 66 students in the control class.

The research instruments consisted of a computational thinking ability test and a mathematical disposition questionnaire. The computational thinking ability test was in the form of essay questions compiled based on four indicators of computational thinking, namely decomposition, pattern recognition, abstraction, and algorithms. Before being used, the test instrument went through a validation process by experts and a trial to determine the validity, reliability, difficulty level, and discriminating power of the questions. The mathematical disposition questionnaire used a five-level Likert scale developed based on indicators of self-confidence, interest and curiosity, flexibility, and reflection in mathematics learning. The results of the product moment validity test showed that all question items were in the valid category with validity coefficients ranging from 0.42–0.81. The Cronbach's alpha reliability of the computational thinking ability test was in the high category with a coefficient of 0.87. Meanwhile, the mathematical disposition questionnaire had a reliability coefficient of 0.91, which belongs to the very high category.

This study used a posttest-only control group design, therefore the research procedure began with giving treatment to the experimental class and control class for eight meetings. At the end of the treatment, students were given a computational thinking ability test to measure the ability obtained after participating in the learning and a mathematical disposition questionnaire. Based on the questionnaire scores obtained, students were then grouped into high and low mathematical disposition categories for the purpose of treatment by level analysis. The grouping of mathematical disposition was done based on the questionnaire scores obtained by students after the data collection process, then students were grouped into high and low mathematical disposition categories using the extreme group technique (top 27% and bottom 27%). Out of the 128 students who became the research sample, the treatment by level analysis was conducted on

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

the high and low mathematical disposition groups using the extreme group technique of the top 27% and bottom 27%. Based on this technique, 70 students were obtained, consisting of 35 students in the high disposition group and 35 students in the low disposition group.

Furthermore, the research data were analyzed descriptively and inferentially. Descriptive analysis was used to determine the overview of computational thinking ability in each research group. Before testing the hypotheses, the data were first tested for prerequisites in the form of normality and homogeneity. After the prerequisite tests were met, hypothesis testing could be performed. This study used a hypothesis test in the form of a two-way ANOVA test corresponding to the 2x2 treatment by level factorial design with the help of the Jamovi 2.6.26 application. This hypothesis test was chosen to identify whether there is a significant difference between the means of two or more groups influenced by two factors (testing main effects and interaction effects). Next, the analysis was continued by performing the Tukey Post Hoc Test, which is to determine the simple effect. This test is often used when there is a significant difference between groups in the ANOVA test and one wants to evaluate specific differences between pairs of groups.

RESEARCH RESULTS

Data Description

Based on the research that has been conducted, the computational thinking ability scores from each research group were obtained. The summary in the form of a descriptive analysis of the research results is explained in the following table:

Table 2 Summary of students' computational thinking ability scores

Mathematical Disposition (B)	Learning Model (A)	Maximum Score	Minimum Score	Mean
High (B1)	PBL manipulative (A1)	100	72	85.9
	Expository (A2)	78	44	65.4
Low (B2)	PBL manipulative (A1)	75	50	65.9
	Expository (A2)	97	53	75.9

Table 2 shows that the highest mean score for computational thinking ability was obtained by the group of students who had a high disposition and learned with the PBL model assisted by manipulative media. Meanwhile, the lowest mean score for computational thinking ability was obtained by the group of students who had a high disposition and learned with the expository

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

model.

Furthermore, before conducting hypothesis testing with a 2-way ANOVA, the data were first subjected to normality and homogeneity tests as prerequisite tests. The results of the normality and homogeneity tests, both in groups and combined, obtained a p-value of more than the α level = 0.05, and it can be concluded that the entire data are normally distributed and homogeneous. Thus, the data have met the prerequisite tests and can be continued with parametric tests.

The results of hypothesis testing using two-way ANOVA are presented in the following table.

Table 3 Results of the two-way ANOVA test

	Sum of Squares	df	Mean Square	F	p
A	481	1	481	4.34	0.041
B	394	1	394	3.56	0.064
A * B	4036	1	4036	36.44	<.001
Residuals	7311	66	111		

Description:
A = Learning Model
B = Mathematical Disposition
A * B = Interaction of learning model and mathematical disposition

Interaction of Learning Model and Mathematical Disposition on Computational Thinking Ability

Based on Table 1.3 in the A * B section, it shows a p-value of 0.001 < 0.05, meaning there is an interaction between the learning model and mathematical disposition. Figure 1.1 below shows the interaction between the two variables.

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

International Journal of Education, Vocational and Social Science
https://e-journal.citakonsultindo.or.id/index.php/IJEVSS
E-ISSN : 2963 4954
IJEVSS

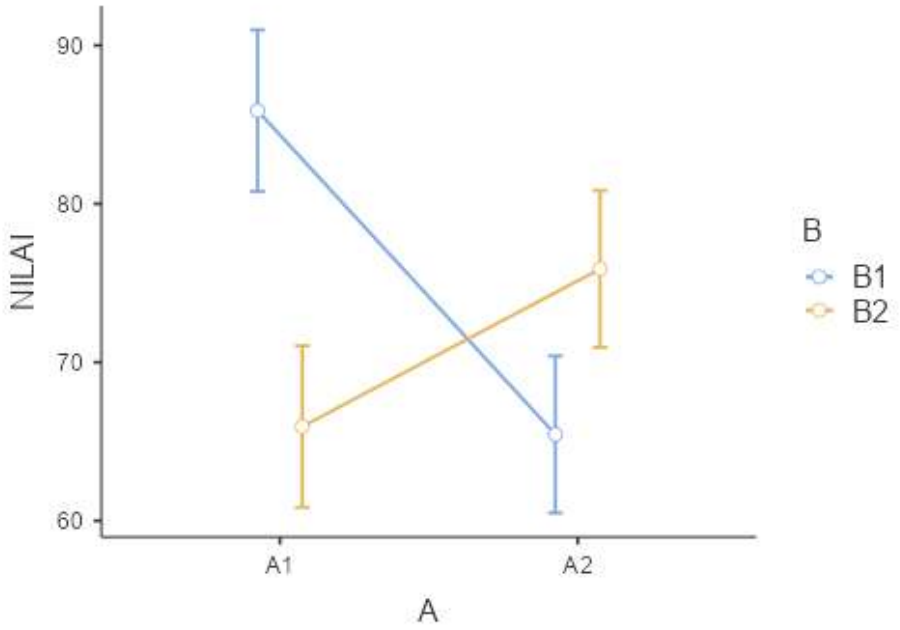


Figure 1 Result of A*B Interaction

Figure 1.1 shows the differences in students' computational thinking ability in each group. The highest mean score was obtained by the group of students learning with the PBL model assisted by manipulative media and having a high mathematical disposition. Conversely, the lowest mean score was found in the group of students learning with the expository model and having a high disposition. As for the group of students who had a low disposition and learned with the expository model, they had a higher computational thinking ability compared to the group of students who had a low disposition and learned with the PBL model assisted by manipulative media.

Based on the information shown in the figure, it can be concluded that the PBL model, expository model, low mathematical disposition, and high mathematical disposition jointly affect computational thinking ability. In other words, there is an interaction between the learning model and mathematical disposition on computational thinking ability. This interaction shows that the effectiveness of a learning model in developing computational thinking ability is highly dependent on the level of mathematical disposition possessed by students.

The Tukey Post Hoc Test was conducted after it was known that there was an interaction

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

between the two variables; this was done to determine the differences in the computational thinking ability of students with different levels of mathematical disposition with the PBL learning model assisted by manipulative media and the expository model. The results are summarized in Table 1.5 below

Table 5 Results of the Tukey post hoc test

Comparison					Mean difference	SE	df	t	Ptukey
A1	B1	-	A1	B2	19.941	3.61	66.0	5.524	<.001
A1	B1	-	A2	B1	20.438	3.56	66.0	5.742	<.001
A1	B1	-	A2	B2	9.993	3.56	66.0	2.808	0.032
A1	B2	-	A2	B1	0.497	3.56	66.0	0.140	0.999
A1	B2	-	A2	B2	-9.948	3.56	66.0	-2.795	0.034
A2	B1	-	A2	B2	-10.444	3.51	66.0	-2.977	0.021

There is a Difference in Computational Thinking Ability Based on the Learning Model for Students with High Mathematical Disposition

Table 1.5 shows the difference between groups A1B1 and A2B1 with a p-value of 0.001 < 0.05, meaning there is a mean difference between the two groups. The mean difference value between the two groups is 20.438. A positive mean difference means that the mean of group A1B1 is higher than group A2B1. It is known that the mean of the group of students who have a high mathematical disposition and learn through the PBL model assisted by manipulative media is 85.9, while the mean of the group of students who have a high mathematical disposition and learn through the expository model is 65.4. This means that there is a difference in the mean computational thinking ability of students with a high mathematical disposition who apply the PBL model assisted by manipulative media and the expository model. Therefore, it is concluded that the computational thinking ability of students learning with the PBL model assisted by manipulative media is higher than students learning using the expository model for students who have a high mathematical disposition.

There is a Difference in Computational Thinking Ability Based on the Learning Model for Students with Low Mathematical Disposition

The results of the Tukey post hoc test presented in Table 4.5 also show a difference in students with a low mathematical disposition, namely between group A1B2 and group A2B2. The

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

significance value obtained from the two groups is 0.034 < 0.05. The mean difference value between the two groups is -9.948. A negative mean difference means that the mean of group A1B2 is lower than group A2B2. It is known that the mean of the group of students who have a low mathematical disposition and learn through the PBL model assisted by manipulative media is 65.9, while the mean of the group of students who have a low mathematical disposition and learn through the expository model is 75.9. This means that there is a difference in the mean computational thinking ability of students with a low mathematical disposition who apply the PBL model assisted by manipulative media and the expository model. So it can be concluded that the computational thinking ability of students learning with the PBL model assisted by manipulative media is lower than students learning using the expository model for students who have a low mathematical disposition.

DISCUSSION

The results of the study show that there is an interaction between the learning model and mathematical disposition on the computational thinking ability of elementary school students. Descriptively, students who have a high mathematical disposition and learn using Problem Based Learning (PBL) assisted by manipulative media obtained the highest mean computational thinking ability compared to the other groups. Conversely, for students with a low mathematical disposition, expository learning actually produced a higher mean computational thinking ability compared to PBL assisted by manipulative media. This pattern indicates a cross-over interaction, which is a condition when the effect of a learning model differs depending on the student's mathematical disposition level.

According to Hmelo and Silver (2004), PBL is learning that places students at the center of learning activities through authentic problem solving. In this process, students are required to identify problems, collect information, formulate hypotheses, test alternative solutions, and reflect on the results obtained. These activities are in line with the computational thinking components, which include decomposition, pattern recognition, abstraction, and algorithms. Computational thinking is a thought process for formulating problems and compiling solutions systematically so that they can be executed effectively (Wing, 2006). Thus, the characteristics of PBL theoretically provide a broad space for the development of computational thinking abilities.

In addition, the use of manipulative media also strengthens students' thinking processes. Moyer (2001) explains that manipulative media are concrete objects that allow students to build mathematical understanding through direct experience. The use of manipulative media helps

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

students represent abstract concepts to be more real, thereby facilitating the process of exploration and problem solving. In the context of computational thinking, manipulative media allows students to observe patterns, simplify complex information, and develop completion steps more systematically.

However, the effectiveness of PBL assisted by manipulative media is apparently influenced by students' mathematical disposition. Kilpatrick and Findell (2001) refer to mathematical disposition as the tendency to view mathematics as something meaningful, useful, and the belief that diligent effort will result in success. Mathematical disposition includes self-confidence, perseverance, interest, curiosity, and flexibility in mathematical thinking. Students with a high mathematical disposition tend to show persistence when facing challenges, do not give up easily, and have intrinsic motivation to find solutions to the given problems. This condition explains why students with a high mathematical disposition achieve better results when learning using PBL assisted by manipulative media.

The complex stages of PBL require the active involvement of students, the ability to work independently or collaboratively, as well as perseverance in exploring various alternative problem-solving solutions. Students who have a high mathematical disposition are more prepared to face these demands so they are able to utilize the learning experience in PBL to develop computational thinking abilities optimally. Conversely, students with a low mathematical disposition tend to experience difficulties in participating in problem-based learning processes that require high learning independence. Low self-confidence, lack of perseverance, and the tendency to avoid challenges can cause students to experience obstacles when they have to identify problems and devise their own resolution strategies. In such conditions, more structured expository learning allows students to obtain clearer directions from the teacher so that the cognitive load experienced is lower. Therefore, students with a low mathematical disposition actually show better computational thinking abilities when learning through the expository model.

The results of this study are in line with the productive disposition theory proposed by Findell et al. (2001), namely that success in learning mathematics is not only influenced by cognitive aspects but is also influenced by students' affective tendencies toward mathematics. A positive mathematical disposition allows students to persevere in the face of difficulties and view challenges as opportunities to learn. Conversely, a low mathematical disposition can hinder students' involvement in complex learning activities.

Furthermore, research conducted by Agustini et al. (2025) shows that the application of PBL has a positive influence on the computational thinking ability of elementary school students.

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

Students learning through PBL acquire higher computational thinking abilities compared to students learning using conventional learning. Similar findings were also reported by Jupriyanto et al. (2026) who found that PBL significantly improved the computational thinking ability of elementary school students in science learning. The structured problem-solving process in PBL provides an opportunity for students to develop the abilities of decomposition, pattern recognition, abstraction, and algorithms more optimally. In addition, research conducted by Hafifah et al. (2026) shows that the integration of PBL with various forms of representation in mathematics learning is effective in improving the computational thinking ability of elementary school students. These findings strengthen the assumption that learning which provides an active problem-solving experience is capable of developing students' computational thinking skills.

The research results regarding mathematical disposition also support the findings of this study. Huda and Syafmen (2021) explain that students who have a high mathematical disposition tend to show better perseverance, self-confidence, and learning motivation compared to students with a low mathematical disposition. These characteristics are highly necessary in learning that requires independent exploration and problem solving such as PBL.

CONCLUSION

This study concludes that there is an interaction between the learning model and mathematical disposition on the computational thinking ability of elementary school students. Students with high mathematical disposition obtained better computational thinking ability through the application of Problem Based Learning assisted by manipulative media compared to the expository model. Conversely, students with low mathematical disposition showed higher computational thinking ability through the expository model compared to PBL assisted by manipulative media. These findings indicate that the selection of learning models needs to consider the students' mathematical disposition so that the development of computational thinking ability can take place optimally. In other words, the PBL model, the expository model, low mathematical disposition, and high mathematical disposition jointly affect computational thinking ability.

REFERENCES

Agustini, K. T., Suparta, I. N., & Ardana, I. M. (2024). Meningkatkan Keterampilan Berpikir Komputasi Menggunakan Game Edukasi dengan Model Game Based Learning. *Jurnal Media Dan Teknologi Pendidikan*, *4*(4).

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

Agustini, N. P. D. S., Agustika, G. N. S., & Alit, K. (2025). *The Effect of Problem Based Learning Model on Computational Thinking Ability of Fifth Grade Elementary School Students*.

Aho, A. V. (2012). Computation and computational thinking. *Computer Journal*, *55*(7), 833–835. https://doi.org/10.1093/comjnl/bxs074

Alim, J. A., Hermita, N., Fendrik, M., & Oktaviani, C. (2022). Pengaruh Penggunaan Media Audible Books Terhadap Kemampuan Computation Thinking Siswa Di Sekolah Dasar. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *11*(4), 3727–3735.

Arends, R. (2012). *LEARNING TO TEACH, NINTH EDITION* (9th ed.). McGraw-Hill.

Aunurrahim, M., & Madani, F. (2024). ANALISIS KEMAMPUAN BERPIKIR KOMPUTASI SISWA KELAS V SEKOLAH DASAR DITINJAU DARI KECEMASAN MATEMATIKA. *… Seminar Nasional Pendidikan …*. https://e-journal.unmas.ac.id/index.php/Prosemnaspmatematika/article/view/8881

Barr, V. (2011). Bringing computational thinking to K-12: What is involved and what is the role of the computer science education community? *ACM Inroads*, *2*(1), 48–54. https://doi.org/10.1145/1929887.1929905

Djaali. (2020). *METODOLOGI PENELITIAN KUANTITAIF* (B. S. Fatmawati (ed.); 1st ed.). Bumi Aksara.

Farhana, S., Amaliyah, A., Safitri, A., & Anggraeni, R. (2022). Analisis persiapan guru dalam pembelajaran media manipulatif matematika di sekolah dasar. *Matematika*, *1*(5).

Findell, B., Swafford, J., & Kilpatrick, J. (2001). *Adding it up: Helping children learn mathematics*. National Academies Press.

Gao, X., & Hew, K. F. (2022). Toward a 5E-based flipped classroom model for teaching computational thinking in elementary school: Effects on student computational thinking and problem-solving …. *Journal of Educational Computing …*. https://doi.org/10.1177/07356331211037757

Hafifah, D. N., Marini, A., & Yurniwati, Y. (2026). The Effect of Integrated Problem-Based Learning with Multiple Representations on Elementary School Students' Computational Thinking Skills in Mathematics. *EduBase: Journal of Basic Education*, *7*(1), 52–60.

Hariyani, L., Yurniwati, Y., & Utami, A. D. (2024). The Effect Of Discovery Learning In Mathematics Learning On Computational Thinking In Terms Of Self-Regulated Learning (Srl) In Student. *Jurnal Elementaria Edukasia*, *7*(2), 2801–2814.

Hendriko, N., Syafriandi, S., Armiati, A., & Jamaan, E. Z. (2024). PRAKTIKALITAS E-MODUL BERBASIS PROBLEM BASED LEARNING UNTUK MENINGKATKAN KEMAMPUAN PEMECAHAN MASALAH MATEMATIS SISWA. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*,

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

13(3), 870–884.

Hmelo-Silver, C. E. (2004). Problem-based learning: What and how do students learn? *Educational Psychology Review*, *16*(3), 235–266.

Hmelo-Silver, C. E., & Barrows, H. S. (2006). Goals and strategies of a problem-based learning facilitator. *Interdisciplinary Journal of Problem-Based Learning*, *1*(1), 4.

Huda, N., & Syafmen, W. (2021). The Relationship between Students' Mathematical Disposition and Their Learning Outcomes. *Journal of Education and Learning (EduLearn)*, *15*(3), 376–382.

Hutajulu, M., Wijaya, T. T., & Hidayat, W. (2019). The effect of mathematical disposition and learning motivation on problem solving: an analysis. *Infinity Journal*, *8*(2), 229–238.

Indonesia, B. (2024). *Bebras Indonesia*. https://bebras.or.id/v3/

Jupriyanto, J., Sari, Y., & Mukti, F. D. (n.d.). Enhancing elementary students' computational thinking through problem-based learning in science education. *DWIJA CENDEKIA: Jurnal Riset Pedagogik*, *10*(1), 29–40.

Kadir. (2018). *Statistika Terapan Konsep, Contoh dan Analisis Data dengan Program SPSS/Lisrel dalam Penelitian* (3rd ed.). Rajawali Pers.

Kementerian Pendidikan Dasar dan Menengah. (2025). Pembelajaran koding dan kecerdasan artifisial: Pada pendidikan dasar dan menengah. In T. K. P. K. dan Pembelajaran (Ed.), *Proceedings of the National Academy of Sciences* (Vol. 3, Issue 1, pp. 1–15). Pusat Kurikulum dan Pembelajaran & Pusat Standar dan Kebijakan Pendidikan Badan Standar, Kurikulum, dan Asesmen Pendidikan Kementerian Pendidikan Dasar dan Menengah Republik Indonesia. http://dx.doi.org/10.1016/j.bpj.2015.06.056%0Ahttps://academic.oup.com/bioinformatics/article-abstract/34/13/2201/4852827%0Ainternal-pdf://semisupervised-3254828305/semisupervised.ppt%0Ahttp://dx.doi.org/10.1016/j.str.2013.02.005%0Ahttp://dx.doi.org/10.10

Marbán, J. M. (2016). Matemáticas y dominio afectivo. *Investigación En Educación Matemática XX*, 69–74.

Moyer, P. S. (2001). Are we having fun yet? How teachers use manipulatives to teach mathematics. *Educational Studies in Mathematics*, *47*(2), 175–197.

Muthmainnah, A., Pertiwi, A. D., & Rustini, T. (2023). Peran Guru Dalam Mengembangkan Keterampilan Abad 21 Siswa Sekolah Dasar. *Jurnal Ilmiah Wahana Pendidikan*, *9*(4), 41–48.

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

Noh, J. (2020). Effects of robotics programming on the computational thinking and creativity of elementary school students. *Educational Technology Research and Development*, *68*(1), 463–484. https://doi.org/10.1007/s11423-019-09708-w

Noviyanti, N., Yuniarti, Y., & Lestari, T. (2023). Pengaruh pembelajaran berdiferensiasi terhadap kemampuan computational thinking siswa sekolah dasar. In *Prima Magistra: Jurnal Ilmiah Kependidikan*. http://e-journal.uniflor.ac.id/index.php/JPM/article/download/2806/1811

Nurhasanah, F. A., Yurniwati, Y., & Zakiah, L. (2025). Implementasi Model Discovery Learning berbantuan Media manipulative untuk meningkatkan Kemampuan Berpikir Spasial siswa dalam Pembelajaran Matematika di Sekolah Dasar. *Social, Humanities, and Educational Studies (SHES): Conference Series*, *8*(3).

Papert, S. (1980). Computers for children. *Mindstorms: Children, Computers, and Powerful Ideas*, 3–18.

Prasetyo, Y., Yurniwati, Y., & Nurjannah, N. (2025). Pengaruh Model Pembelajaran Flipped Problem Based Learning Terhadap Kemampuan Berpikir Kritis Siswa. *Cetta: Jurnal Ilmu Pendidikan*, *8*(1), 183–194.

Rahayu, R., Lyesmaya, D., & ... (2023). Analisis Kemampuan Berpikir Komputasi Siswa Sekolah Dasar Berbasis Bebras Task. *Pendas: Jurnal Ilmiah …*. https://journal.unpas.ac.id/index.php/pendas/article/view/7079

Sanapiah, S., & Aziz, L. A. (2021). Analisis kemampuan computational thinking mahasiswa dalam menyelesaikan masalah matematika. *Media Pendidikan Matematika*, *9*(1), 34–42.

Silva, R., Fonseca, B., Costa, C., & Martins, F. (2021). Fostering computational thinking skills: A didactic proposal for elementary school grades. *Education Sciences*, *11*(9), 518.

Tan, O. S. (2002). *Problem-based learning: More problems for teacher education*.

Torp, L., & Sage, S. (1998). *Problems as possibilities: Problem-based learning for K-12 education*. Ascd.

Trilling, B., & Fadel, C. (2009). *21st century skills: Learning for life in our times*. John Wiley & Sons.

Weintrop, D. (2016). Defining Computational Thinking for Mathematics and Science Classrooms. *Journal of Science Education and Technology*, *25*(1), 127–147. https://doi.org/10.1007/s10956-015-9581-5

Wing, J. M. (2006). Computational thinking. In *Communications of the ACM* (Vol. 49, Issue 3, pp. 33–35). https://doi.org/10.1145/1118178.1118215

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License