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The Effect of Project Based Learning (PJBL) Model on Elementary School Students' Computational Thinking Skills

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Abstract
The low level of computational thinking skills among elementary school students in Indonesia poses a major challenge in 21st-century education. This study aims to analyze the effect of the Project Based Learning (PjBL) model on students' computational thinking skills. The research method used was a quantitative experiment with a pretest-posttest control group design. The research subjects consisted of two classes: an experimental class using the PjBL model and a control class using conventional methods. Data collection techniques included tests and observation. The t-test results showed a significant difference with a significance value of 0.000 < 0.05. The average post-test score of the experimental class was 82.13, while the control class was 68.75. Thus, the PjBL model is proven to be effective in improving elementary school students' computational thinking skills.

Keywords: *Project Based Learning; Computational Thinking; Elementary School*

A. Introduction

The rapid development of information technology in the 21st century requires the world of education to prepare students with high-level thinking skills, including critical thinking, problem solving, creativity, and computational thinking (Alawiyyah & Arifuddin, 2024; González-Pérez & Ramírez-Montoya, 2022; Meng et al., 2023). These skills are an integral part of 21st-century competencies needed to face global challenges and the dynamics of modern life. One of the internationally recognized indicators

used to measure students' thinking skills is the Programmed for International Student Assessment (PISA), which, according to the OECD, "measures 15-year-olds'ability to use their reading, mathematics and science knowledge and skills to meet real-life challenges. However, the results of the 2022 Programmed for International Student Assessment (PISA) survey showed that Indonesian students' abilities in mathematical literacy and computational thinking were still relatively low. According to the OECD, (2024) The average mathematics score of Indonesian students only reached 366, far below the average for OECD countries which is at 472. Only around 18% of students are able to reach level 2 or above in mathematical literacy, which means that most students have difficulty in understanding and solving basic problems. His condition indicates that the majority of students have not yet developed basic logical and algorithmic thinking skills. The situation is exacerbated by the predominantly teacher-centered learning approach in elementary schools, which offers limited opportunities for students to engage independently in contextual problem-solving. Research shows that Indonesian students often struggle with understanding and modeling context-based problems, partly because many teachers rely on directive instruction, completing contextual tasks for students and limiting their autonomy (directive teaching approach) in solving real-life mathematical problems. (Azizia et al., 2023; Hidayat et al., 2021; Ramadhani et al., 2021).

Computational thinking (CT) skills are widely recognized as crucial in facing the challenges of the digital age, as they foster critical, logical, creative, and problem-solving abilities. In line with this, research by Erwinsyah et al., (2025). highlights that CT serves as an essential competency for integrating digital literacy with scientific problem-solving, thereby contributing to the achievement of SDG 4 on quality education. This finding reinforces the urgency of CT not only as a fundamental 21st-century skill but also as a key strategy to enhance the quality of science education. Nevertheless, the limited implementation of CT in schools indicates the need for strategic efforts to systematically integrate it into the curriculum.. According to Wing, (2008) Computational thinking is defined as a problem-solving process that involves decomposition, pattern recognition, abstraction, and algorithm design. This ability is not limited to the field of information technology, but is also relevant in mathematics and science learning, especially in the context of elementary education (Ioannidou et al., 2011). According to the Alawiyyah & Arifuddin, (2024) Computational thinking ability refers to the ability to direct actions to solve problems in a systematic manner that is based on the application of appropriate problem-solving approaches and problem analysis. Unfortunately, several studies show that elementary school students in Indonesia still have low computational thinking skills, which is caused by the limited application

of problem-solving-based learning and innovative approaches in the classroom (Rahayu et al., 2023; Ye et al., 2023).

The Project Based Learning (PjBL) learning model has emerged as an alternative that is believed to be able to improve students' computational thinking skills According to the research by Rita Iva Fatmala et al., (2025), this classroom action study demonstrates that Project-Based Learning (PjBL), when adapted to student differentiation in physics learning, is effective in enhancing computational thinking skills. The achievement score increased significantly from 22.8% (very low category) in the first cycle to 88.57% (high category) in the third cycle. Furthermore, the n-gain value also improved, shifting from the medium category (0.40 and 0.52) to the high category (0.71). PjBL model is a learning approach that emphasizes exploratory activities through real and collaborative projects, and provides space for students to actively participate in building knowledge (Simbolon & Koeswanti, 2020). According to (Rahmawati et al., 2024) In the context of elementary education, the Project Based Learning model has been proven to be able to improve students' critical and creative thinking skills, as well as technology and information literacy.Several previous studies also support the effectiveness of the Project Based Learning model. Research by Apsoh et al., (2023) shows that PjBL can improve the creative thinking skills of grade IV elementary school students. Similarly, a study conducted by Nida Winarti et al., (2022) concluded that the Project Based Learning model increases students' engagement and critical thinking through a project assignment approach.

However, there is still little research that explicitly links the Project Based Learning model with strengthening computational thinking skills, especially in the context of elementary school students. This study reveals that although teachers recognize the importance of computational thinking (CT), there remains considerable confusion regarding its implementation in elementary schools. Many teachers lack sufficient understanding of CT indicators and face difficulties in designing CT-oriented questions as well as integrating them with technology. This condition highlights a significant gap between the conceptual acknowledgment of CT's value and its effective practical implementation at the elementary education level (Abidin et al., 2023). This study was conducted in two elementary schools in Cirebon City, namely SDN Mega Eltra and SDN Karya Winaya. These two schools were selected purposively because they have similar student characteristics and have collaborated in implementing educational programs based on learning innovation. Grade IV from each school was used as a sample, with one class as an experimental group and the other as a control group.

This study aims to analyze the effect of the Project Based Learning model on elementary school students' computational thinking skills. The novelty of

this study lies in the explicit measurement of computational thinking skills based on four main indicators (decomposition, pattern recognition, abstraction, and algorithms) in the context of project-based mathematics learning. In addition, this study provides a practical contribution in addressing the challenges of low mathematical literacy and problem solving of Indonesian students as reflected in the PISA report.

B. Research Methods

According to Creswell & Creswell, (2018), quantitative research involves interrelated variables and is explained through hypotheses regarding the direction and magnitude of the relationship between variables. This study aims to determine the effect of the Project Based Learning (PjBL) learning model on students' computational thinking skills. This research uses a quantitative approach with a quasi-experimental method. Quantitative data were collected through a 7-item essay test based on computational thinking indicators and structured observation sheets with a rubric to assess students' engagement and application of computational thinking skills during learning. The design used is Nonequivalent Control Group Design, which is a design of two groups (experimental and control) selected without random assignment and each given a pretest and posttest. Only the experimental group received treatment in the form of implementing the PjBL model, while the control group did not, so that the comparison of the pretest and posttest results in the two groups can show the effectiveness of the intervention given.

This study was conducted in two elementary schools located in Karyamulya Village, Kesambi District, Cirebon City, namely Mega Eltra Elementary School located at Jl. Mahoni Raya No.V and Karya Winaya Elementary School located at Jl. Kandang Perahu No.4A. The sampling technique used was random sampling in order to obtain a representative sample of the population as a whole. The number of samples in this study was 55 fourth-grade students, consisting of 26 students from Mega Eltra Elementary School as the control group and 29 students from Karya Winaya Elementary School as the experimental group who received treatment in the form of implementing the Project-Based Learning (PjBL) learning model so that it is possible to analyze the influence of the model objectively and measurably. The data collection technique in this study was carried out through participatory observation to directly understand the activities and problems related to the influence of the Project Based Learning learning model on students' computing abilities, as well as through tests in the form of pretests and posttests to measure students' cognitive abilities before and after the treatment was given.

C. Results and Discussion

1. Implementation of Project Based Learning Model in Learning

This study aims to determine the effect of implementing the PjBL model on elementary school students' computational thinking skills. The research activities were carried out in two educational units, namely SDN Karya Winaya and SDN Mega Eltra, using an experimental design involving two groups, namely the experimental group and the control group.

Learning with the Project Based Learning model was carried out in three meetings. In the first meeting, the teacher conveyed the learning objectives, explained the PjBL model, and conducted a pretest. Students were then guided to prepare a project plan in groups, starting from choosing a topic, designing work steps, to dividing roles. The second meeting focused on project implementation. Students worked together in groups to collect data, compile products, and apply computational thinking principles. The teacher acted as a facilitator who provided direction and motivation. The third meeting was filled with a presentation of project results, a question and answer session, and an assessment based on certain criteria. The activity was closed with a learning reflection and posttest to measure the improvement in students' computational thinking skills.

Table 4.1
Statistic Deskriptif

Descriptive Statistics

	N	Range	Minimum	Maximum	Mean		Std. Deviation	Variance
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic
Pretes_ekperimen	26	37	22	59	37.42	1.962	10.005	100.094
Postes_ekperimen	26	41	45	86	63.38	1.948	9.932	98.646
Pretes_kontrol	26	26	14	40	26.54	1.609	8.204	67.298
Postes_Kontrol	26	52	30	82	49.35	2.792	14.238	202.715
Valid N (listwise)	26							

Based on the results of the descriptive analysis, the experimental group that received treatment with the *Project Based Learning* (PjBL) learning model showed a significant increase in computational thinking skills. The average pre-test score in this group was 37.42, increasing to 63.38 in the post-test, with a relatively stable standard deviation from 10.01 to 9.93. The stability of the standard deviation indicates that the increase in students' abilities occurred evenly. Meanwhile, the control group that followed conventional learning also experienced an increase in scores, from an average pre-test of 26.54 to 49.35 in the post-test. However, the increase in the standard deviation from 8.20 to 14.24 indicated irregularities in the achievement of

student learning outcomes. These findings indicate that the PjBL model is not only more effective in improving students' computational thinking skills, but also provides more evenly distributed learning outcomes compared to conventional learning models.

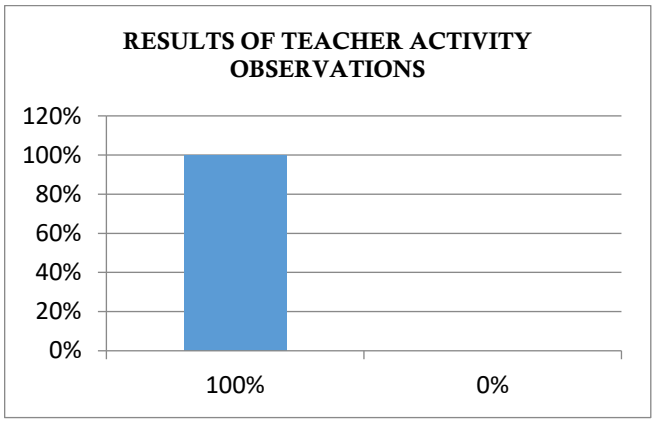

Figure 1. 1 Observation Results of Teacher Activities

Based on the observation results displayed in the bar chart, teacher activities in implementing the Project Based Learning (PJBL) model across three meetings—from formulating essential questions, planning and carrying out the project, monitoring the process, to assessing and reflecting on the outcomes—were carried out very well, reaching 100% implementation. The implementation of this structured Project Based Learning model is in line with the findings of research by Shin et al., (2021) emphasizing that PjBL allows students to learn through direct experience, apply ideas, and solve complex problems, which greatly supports the development of computational thinking skills. This shows that the implementation of the PjBL model is running optimally and in accordance with its basic principles, namely project-based learning that requires active student involvement in completing meaningful tasks. The suitability of this implementation is a supporting factor in achieving better learning outcomes.

2. Students' Computational Thinking Skills

The increase in computational thinking skills was clearly seen in students in the experimental class. The average pretest score in the experimental class was 26.5 and increased to 63.9 in the posttest. In contrast, the control class only increased from 38.0 to 49.3. Thus, there was an increase of 38.0 points in the experimental class, compared to 11.3 points in the control class.

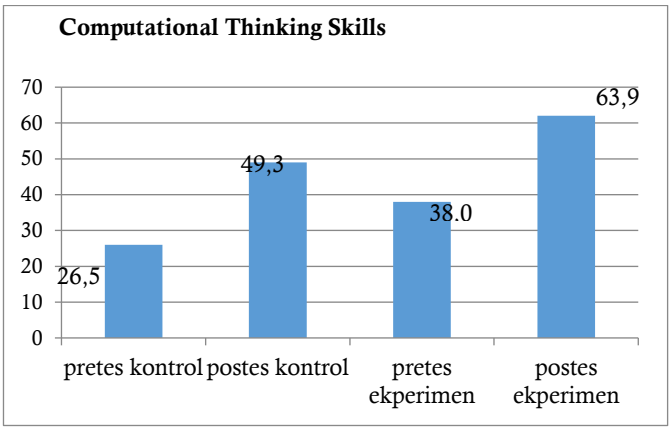

Figure 4. 2 Experimental and Control Pretest-Posttest Value Diagram

The application of the Project Based Learning (PjBL) model has been proven to significantly improve elementary school students' computational thinking skills. The results of the pretest and posttest showed that the average score of students in the experimental class increased from 26.5 to 63.9, or an increase of 38.0 points. Meanwhile, the control class only increased by 11.3 points. This increase is not only seen quantitatively but also qualitatively through the results of student work that shows better abilities in problem decomposition, pattern recognition, algorithm design, and abstraction.

Computational thinking skills are very important to develop since elementary school age because they are related to logical, systematic, and structured thinking. Based on Piaget's cognitive development theory, students at the concrete operational stage are able to think logically about real things. This is in line with the computational thinking approach, which emphasizes problem-solving through structured steps. Therefore, the contextual project-based PjBL model is able to support the development of computational thinking skills optimally according to the child's developmental stage. This finding strengthens the opinion of Aisy & Hakim, (2023), that computational thinking in the context of mathematics is closely related to problem-solving skills and constructing logical patterns. Through PjBL, students are encouraged to be active, think critically, and apply concepts in real terms, thus supporting the development of high-level thinking skills.

3. The Influence of the PjBL Model on Computational Thinking Skills

The influence of the project-based learning model on computational thinking skills can be seen through statistical tests. Statistical analysis The normality test (Sig = 0.200) and the homogeneity test (Sig = 0.061) were normally distributed and homogeneous, indicating

that the PjBL model significantly influenced improving computational thinking skills.

The Project-Based Learning (PjBL) model is a learning approach that emphasizes the active involvement of students through real projects that are relevant to everyday life. The PjBL model has been proven to support the development of computational thinking skills such as decomposition, pattern recognition, abstraction, and algorithms because of the active involvement of students in challenging and meaningful contextual projects. According to Aisy & Hakim,(2023a) emphasized that computational thinking is the process of compiling algorithm-based solutions. PJBL supports this process through systematic and collaborative activities. This is in line with research conducted by Ahmad et al., (2024), measuring the extent of the influence of the project-based learning and problem solving models on the creative thinking skills and computational thinking skills of elementary school students. The results showed that students who followed the Project Based Learning model obtained an average computational thinking skill score of 77.09, higher than the problem solving model (73.18) and conventional learning (62.18).

4. **Analysis of differences in students' computational thinking skills between using the Project Based Learning Model and the conventional model**

Table 4. 2
Uji Hipotesis

Independet sampel T test									
	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Equal variances assumed	3.669	.061	-4.388	52	.000	-14.511	3.307	-21.146	-7.876

Equal variances not assumed			-4.330	43.980	.000	-14.511	3.351	-21.266	-7.756

Based on the results of statistical analysis, there is a significant difference between the group of students who apply the PJBL model and those who use the conventional model. The significance value (sig. 2-tailed) of 0.000 indicates that the difference is not a coincidence, but rather the result of differences in the learning methods applied. Students who are taught using conventional methods tend to be more passive in the learning process, only receiving information from the teacher and working on questions repeatedly without understanding the underlying concepts. On the other hand, students who learn with the Project Based Learning (PJBL) learning model are more active, think critically, and creatively because they are directly involved in every stage of the learning process.

Students who follow conventional learning tend to be passive and lack contextual learning experiences. Learning is more teacher-centered and focuses on repeating questions. In contrast, the PjBL model emphasizes real learning experiences, active involvement, and problem solving. This supports the development of high-level thinking skills, as emphasized in the theories of constructivism and Discovery Learning. In Ardianti et al., (2021) linked Dewey's philosophy of "learning by doing" as the basis for PJBL which gives students the freedom to work together creatively on projects that are relevant to the real world.

In the control class that applies the conventional method, the learning process still takes place traditionally and is centered on the teacher. The teacher dominates learning activities with lecture methods and giving practice questions. In such an atmosphere, students only act as passive recipients of information, who tend to memorize formulas and procedures without really understanding the context or application of the material. As a result, when faced with open or contextual problems, students have difficulty developing independent solution strategies. This has an impact on the low increase in students' computational thinking skills, as indicated by the relatively low posttest results compared to the experimental class. In contrast, students in the experimental class using the PjBL learning model are actively involved in the learning process. They not only listen to the teacher's explanation, but are also involved in designing and completing real projects that are directly related to the

material being studied, in this case number patterns. The projects given, such as making beaded bracelets based on number patterns, encourage students to apply decomposition skills, recognize patterns, compile algorithm steps, and make generalizations from their observations.

Through this process, students not only understand the concept in depth, but also develop 21st-century skills such as critical thinking, problem solving, communication, and collaboration. They discuss, share tasks in groups, and present their work in front of the class. This activity provides space for students to think systematically and creatively in facing challenges. This is in line with research conducted by Pranata et al., (2024) at SDN 01 Parakansalak, the results of the study showed that students who studied with the model at SDN 01 Parakansalak, the results of the study showed that students who studied with the Project Based Learning model had a significant increase in computational thinking skills compared to students who studied conventionally. Thus, conventional learning has proven to be less effective in developing computational thinking skills because of its one-way and less contextual nature. Meanwhile, the PjBL model is able to create an active, meaningful, and challenging learning atmosphere, resulting in a more significant increase in computational thinking skills.

C. Conclusion

This study confirms that the Project-Based Learning (PjBL) model is effective in improving elementary school students' computational thinking skills, particularly in decomposition, pattern recognition, abstraction, and algorithm design. The implementation of PjBL over three meetings ran optimally, with 100% teacher activity in accordance with the syntax, creating active and meaningful learning while fostering 21st-century skills. Therefore, PjBL is recommended as an alternative strategy in mathematics learning to enhance students' computational thinking and problem-solving abilities.

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Bibliography

Abidin, Z., Herman, T., & Wahyudin, W. (2023). The Computational Thinking in Elementary School in the Indonesia New Curriculum: A Teacher's Perspective. *Sekolah Dasar: Kajian Teori Dan Praktik Pendidikan*, *32*(2), 178. https://doi.org/10.17977/um009v32i22023p178-185

Ahmad, Z., Lasmawan, I. W., & Margunayasa, I. G. (2024). PENGARUH MODEL PROJECT BASED LEARNING DAN MODEL PROBLEM

SOLVING TERHADAP KEMAMPUAN BERPIKIR KREATIF DAN KETERAMPILAN COMPUTATIONAL THINKING SISWA SD. *Jurnal Ilmiah Pendidikan Citra Bakti*, *11*(2), 369–382. https://doi.org/10.38048/jipcb.v11i2.3446

Aisy, A. R., & Hakim, D. L. (2023a). Kemampuan Berfikir Komputasi Matematis Siswa SMP Pada Materi Pola Bilangan. *Didactical Mathematics*, *5*(2), 348–360. https://doi.org/10.31949/dm.v5i2.6083

Aisy, A. R., & Hakim, D. L. (2023b). Kemampuan Berpikir Komputasi Matematis Siswa SMP Pada Materi Pola Bilangan. *Jurnal Didactical Mathematics*, *5*(2), 348–360.

Alawiyyah, S., & Arifuddin, A. (2024). *Developing Student Worskshet Based on Open Ended Problem to Improve Mathematical Problem Solving Abilities*. *10*, 43–49.

Apsoh, S., Setiawan, A., & Marsela, M. (2023). Pengaruh Model Project Based Learning Terhadap Kemampuan Berpikir Kritis Siswa. *JUPEIS : Jurnal Pendidikan Dan Ilmu Sosial*, *2*(3), 174–185. https://doi.org/10.57218/jupeis.vol2.iss3.783

Ardianti, R., Sujarwanto, E., & Surahman, E. (2021). DIFFRACTION: Journal for Physics Education and Applied Physics Problem-based Learning: Apa dan Bagaimana. *DIFFRACTION: Journal for Physics Education and Applied Physics*, *3*(1), 27–35. http://jurnal.unsil.ac.id/index.php/Diffraction

Azizia, A. J., Kusmaryono, I., Maharani, H. R., & Arifuddin, A. (2023). Students' Computational Thinking Process in Solving PISA Problems of Change and Relationship Content Reviewed from Students' Self Efficacy. *Eduma : Mathematics Education Learning and Teaching*, *12*(1), 112. https://doi.org/10.24235/eduma.v12i1.13132

Creswell, J. W., & Creswell, J. D. (2018). Research Design : Qualitative, Quantitative, and Mixed Methods Approaches + a crash course in statistics. In *Research Defign: Qualitative, Quantitative, and Mixed M ethods Approaches* (p. 304).

Erwinsyah, A., Yusuf, F. M., Laliyo, L. A. R., Mursalin, & Riumkina, I. (2025). RESEARCH TRENDS OF COMPUTATIONAL THINKING FOR ADVANCING SUSTAINABLE DEVELOPMENT GOALS (SDGs) IN SCIENCE LEARNING: BIBLIOMETRIC ANALYSIS. *Jurnal Pendidikan IPA Indonesia*, *14*(2), 337–350. https://doi.org/10.15294/jpii.v14i2.23645

González-Pérez, L. I., & Ramírez-Montoya, M. S. (2022). Components of Education 4.0 in 21st century skills frameworks: systematic review. *Sustainability*, *14*(3), 1493.

Hidayat, H., Duskri, M., Zubainur, C., & Munzir, S. (2018). Analysis of Student Ability in Solving PISA-Like Math Problems: a case study in SMPN 8 Banda Aceh, Indonesia. *International Journal of Scientific Research and*

Management, *6*. https://doi.org/10.18535/ijsrm/v6i12.m01

Ioannidou, A., Bennett, V., Repenning, A., Koh, H., & Basawapatna, A. (2011). Computational Thinking Patterns Human Creativity and the Power of Technology: Computational Thinking in the K-12 Classroom". *2011 Annual Meeting of the American Educational Research Association (AERA)*, *2*. http://www.agentsheets.com

Meng, N., Dong, Y., Roehrs, D., & Luan, L. (2023). Tackle implementation challenges in project-based learning: a survey study of PBL e-learning platforms. In *Educational technology research* …. Springer. https://doi.org/10.1007/s11423-023-10202-7

Nida Winarti, Maula, L. H., Amalia, A. R., Pratiwi, N. L. A., & Nandang. (2022). PENERAPAN MODEL PEMBELAJARAN PROJECT BASED LEARNING UNTUK MENINGKATKAN KEMAMPUAN BERPIKIR KRITIS SISWA KELAS III SEKOLAH DASAR. *Jurnal Cakrawala Pendas*, *8*(3), 552–563. https://doi.org/10.31949/jcp.v8i3.2419

OECD. (2024). PISA 2022 Results (Volume III): Creative Minds, Creative Schools, PISA. *Factsheets*, *I*, 1–9. https://www.oecd-ilibrary.org/education/pisa-2022-results-volume-i_53f23881-en%0Ahttps://www.oecd.org/publication/pisa-2022-results/country-notes/germany-1a2cf137/

Pranata, A., Lyesmaya, D., & hamdani maula, L. (2024). *PENGARUH MODEL PEMBELAJARAN PROJECT BASED LEARNING TERHADAP KEMAMPUAN BERPIKIR KOMPUTASI PADA PELAJARAN BANGUN DATAR SISWA KELAS V*. *09*, 3142–3148.

Rahayu, R., Lyesmaya, D., & Maula, L. H. (2023). Analisis Kemampuan Berpikir Komputasi Siswa Sekolah Dasar Berbasis Bebras Task. *Pendas :Jurnal Ilmiah Pendidikan Dasar*, *8*(1), 219–234. https://journal.unpas.ac.id/index.php/pendas/article/view/7079

Rahmawati, A. N., Rosanawati, I. M. R., & Sadino. (2024). *Implementasi Model Project Based Learning (PjBL) untuk Meningkatkan Keaktifan dan Hasil Belajar Siswa pada Pembelajaran Matematika*.

Ramadhani, S. P., Zulela, M. S., & Fahrurrozi, F. (2021). Analisis kebutuhan desain pengembangan model ipa berbasis project based learning untuk meningkatkan berpikir kritis siswa di sekolah dasar. *Jurnal Basicedu*. https://jbasic.org/index.php/basicedu/article/view/1047

Rita Iva Fatmala, Putut Marwoto, & Ellianawati, E. (2025). Improving Computational Thinking Skills Through The Implementation of Project-Based Learning According to Student Differentiation in Physics Learning. *Physics Communication*, *9*(1), 40–45. https://doi.org/10.15294/pc.v9i1.927

Shin, N., Bowers, J., Krajcik, J., & Damelin, D. (2021). Promoting computational thinking through project-based learning. *Disciplinary and Interdisciplinary*

Science Education Research, *3*, 1–15.

Simbolon, R., & Koeswanti, H. D. (2020). Comparison of Pbl (Project Based Learning) models with Pbl (Problem Based Learning) models to determine student learning outcomes and motivation. *International Journal of …*. https://ejournal.undiksha.ac.id/index.php/IJEE/article/view/30087

Wing, J. M. (2008). Computational thinking and thinking about computing. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, *366*(1881), 3717–3725. https://doi.org/10.1098/rsta.2008.0118

Ye, H., Liang, B., Ng, O. L., & Chai, C. S. (2023). Integration of computational thinking in K-12 mathematics education: a systematic review on CT-based mathematics instruction and student learning. *International Journal of STEM Education*, *10*(1). https://doi.org/10.1186/s40594-023-00396-w