Sosioedukasi
JURNAL ILMIAH ILMU PENDIDIKAN DAN SOSIAL
ISSN: 2086-6135 E-ISSN: 2541-612x
Volume 15 No. 2. June 2026 https://ejournal.unibabwi.ac.id/index.php/sosioedukasi/index

THE EFFECT OF GEOGEBRA-ASSISTED CREATIVE PROBLEM SOLVING ON COMPUTATIONAL THINKING ABILITY REVIEWED FROM SELF CONFIDENCE

Sri Agustini Dalimunthe[1a*] Yurniwati[2b], Nurjannah[3c]

[a,b,c] Department of Elementary Education, Jakarta State University, Jakarta, Indonesia

[*a]*E-mail:* sri.agustini@mhs.unj.ac.id

(*) Corresponding Author
sri.agustini@mhs.unj.ac.id

ARTICLE HISTORY
Received : 20-05-2026
Revised : 07-06-2026
Accepted : 15-07-2026

KEYWORDS
Creative Problem Solving; computational thinking;

ABSTRACT
Computational thinking is an essential twenty-first-century skill that supports students in identifying problems, analyzing information, and developing systematic solutions. This study investigated the effect of the GeoGebra-assisted Creative Problem Solving (CPS) learning model and self-confidence on elementary school students' computational thinking abilities. The study employed a quantitative experimental method using a 2 × 2 factorial posttest-only control group design. A total of 120 fifth-grade students were selected through cluster random sampling and assigned to experimental and control groups. Data were collected using a computational thinking essay test based on the indicators of decomposition, pattern recognition, abstraction, and algorithm design. The data were analyzed using two-way ANOVA with SPSS software. The results revealed a significant effect of the learning model on students' computational thinking abilities, with students in the GeoGebra-assisted CPS group achieving higher scores than those in the expository learning group. A significant interaction effect was also found between the learning model and self-confidence, indicating that students with high self-confidence benefited more from the GeoGebra-assisted CPS model. These findings suggest that integrating CPS and GeoGebra can be an effective strategy for enhancing computational thinking abilities in elementary mathematics learning while supporting students' confidence in problem-solving activities.

INTRODUCTION

The role of mathematics has become increasingly important in the modern era alongside rapid technological development. Mathematical competence is needed not only for performing calculations and analysis in everyday life but also for preparing students to become active and productive citizens in the future (Turgut & Turgut, 2020). Therefore, every child should be provided with adequate opportunities and support to learn mathematics effectively (Allen et al., 2020).

Mathematics learning in elementary schools is expected to develop students' reasoning, problem-solving, and communication skills. Students need to understand mathematical concepts, identify patterns and relationships, construct logical arguments, and communicate their ideas effectively (Widiyatmoko et al., 2021). These competencies are closely related to computational thinking, which has emerged as one of the essential skills required in the twenty-first century (Jiang & Li, 2021).

Computational thinking, introduced by Wing (2006), refers to the ability to formulate problems and develop systematic solutions using concepts derived from computer science. Rather than thinking like a computer, computational thinking emphasizes logical and structured problem-solving processes (Durak & Saritepeci, 2018; Grover & Pea, 2013). According to Wing (2008), computational thinking consists of four main components: decomposition, pattern recognition, abstraction, and algorithm design. These components enable learners to analyze complex problems, identify relevant information, generalize patterns, and develop efficient solution procedures.

Despite its importance, previous studies have reported that many students still encounter difficulties in applying computational thinking during mathematics learning. Students often rely on trial-and-error approaches and struggle to connect mathematical concepts with real-world situations (Durak & Saritepeci, 2018; Tang et al., 2020). Consistent with these findings, a preliminary assessment conducted on 64 elementary school students revealed that although students attempted to understand problems and formulate solutions, they frequently experienced conceptual misunderstandings, selected inappropriate information, and applied unsystematic solution strategies. Interview results further indicated that students had difficulty interpreting contextual mathematical problems, particularly when mathematical concepts were represented through unfamiliar everyday language.

Various studies have investigated the effects of learning models and digital media on students' computational thinking skills. However, research examining the integration of the Creative Problem Solving (CPS) learning model with GeoGebra to support computational thinking in elementary mathematics remains limited. In addition, previous studies have predominantly focused on cognitive outcomes, while affective factors that may influence students' success in solving computational problems have received less attention. One such factor is self-confidence, which plays an important role in encouraging students to explore ideas, persist in problem-solving processes, and communicate their reasoning effectively.

The CPS model provides a structured framework that encourages students to identify problems, generate creative alternatives, evaluate solutions, and implement appropriate actions (Treffinger et al., 2008). Meanwhile, GeoGebra offers dynamic visual representations that help students understand mathematical concepts, explore relationships among objects, and solve problems more meaningfully (Handayani et al., 2022). The integration of CPS and GeoGebra is therefore expected to create a learning environment that facilitates the development of computational thinking while supporting students' confidence in solving mathematical problems.

Based on these considerations, this study aims to investigate the effectiveness of the GeoGebra-assisted Creative Problem Solving learning model in supporting elementary school students' computational thinking abilities by considering self-confidence as an important affective factor. The findings are expected to contribute to the development of innovative mathematics learning strategies that foster both cognitive and affective aspects of student learning.

METHOD

Research Methods

This research uses an experimental method. Experimental research identifies independent, dependent, and confounding variables as well as shows how randomization and statistical aspects of the experiment must be conducted. The main goal of experimental design is to establish a cause-and-effect relationship between independent and dependent variables (Miller et al., 2020; Roger et al., 2009). The experimental design used is a posttest-only control group design, the research sample is selected randomly after that a test after the pretest treatment is likely not needed when randomization is used and a large number of students and/or teachers are involved (Gribbons & Herman, 1997; Shadish & Cook, 2002). In addition, this study employed a 2 × 2 factorial design involving two factors, namely

the learning model (GeoGebra-assisted CPS and conventional learning) and self-confidence level (high and low). Therefore, the study examined both the main effects of each factor and their interaction effect on students' computational thinking ability. The structure of this design involves the formation of two groups: the experimental group (receiving treatment) and the control group (without prior treatment).
The structure of this design can be explained through the following table:

Table 1 Experimental Design

Group	Treatment	Post-Test
R	X	O1
R	-	O2

The sample was selected using the purposive sampling method from an elementary school, East Jakarta. The population consists of fifth-grade students at SDN Rawamangun 12. The sample was selected using a cluster random sampling technique, in which intact classes were randomly selected from the available fifth-grade classes. This procedure was conducted to ensure consistency with the experimental design and to minimize selection bias. The purposive sampling method is used to select specific classes (A, B, C, and D) that are representative of the student population in terms of academic achievement and demographics. This method ensures that the sample accurately reflects the population characteristics and allows for a targeted assessment of the intervention's effectiveness.

The implementation of the GeoGebra-assisted CPS Learning Model in this study uses four learning stages which are explained in Table 2 below:

Table 2 GeoGebra-Assisted CPS Learning Model Syntax

Syntax	GeoGebra Characteristics	Activity Description
Clarify Problem	Integration of Representation	Students are directed to understand the problem comprehensively, identify important information, and determine relevant relationships. The use of GeoGebra supports the integration of representations, so that students can observe problems through interconnected displays of images, graphs, and calculations. Direct manipulation of objects on the screen helps students understand mathematical concepts more clearly, such as the relationship between side length, perimeter, and area of flat shapes.
Generate Ideas	Open-ended, learning by doing, and interactivity	Students perform divergent thinking to generate various solutions without early judgment. GeoGebra supports this stage through open-ended, learning by doing, and interactivity traits, so that students can experiment, modify shapes or functions, and observe the direct consequences of each change.
Develop Solution	Abstraction	Students select, develop, and refine the best ideas. GeoGebra supports this process through abstraction, so that students can model problems mathematically, test various scenarios, and visualize complex solutions to support decision making.
Implement & Evaluate	Reflection, interactive dynamics, and generalization	Students apply the selected solution, evaluate the results, and revise if necessary. GeoGebra supports through reflection, interactive dynamics, and generalization, so that students can visually assess results, try alternatives, and understand principles that can be generalized.

Data and Data Sources

SJP Sosioedukasi
JURNAL ILMIAH ILMU PENDIDIKAN DAN SOSIAL
ISSN: 2086-6135 E-ISSN: 2541-612x
Volume 15 No. 2. June 2026 https://ejournal.unibabwi.ac.id/index.php/sosioedukasi/index

The research instrument used is a computational thinking ability test in the form of essay questions. There are eight essay question items covering the concepts of area and perimeter of flat shapes. This test is designed to evaluate computational thinking skills. This test is given after treatment to both groups, both the experimental group and the control group, without distinction, and the test preparation is based on indicators of computational thinking ability which include: a) decomposition; b) abstraction; c) pattern recognition; d) algorithm design. Before the test questions are given, validity and reliability are tested by experts in the field of mathematics. Content validity was assessed by expert judgment involving mathematics education experts and elementary mathematics practitioners who evaluated the relevance, clarity, and suitability of each item with the computational thinking indicators. In addition, an analytic scoring rubric was developed for each indicator, with scores ranging from 0–4 points depending on the completeness and accuracy of students' responses.

Data Collection Techniques

The results of the validity test show that the computational thinking problem is declared feasible and can be used in research, then a trial is conducted on fifth-grade students who have studied the material on the area of flat shapes to determine the difficulty index. After the question trial, eight questions were declared valid with a "medium" question difficulty category and "sufficient" question discriminating power so that those eight questions are used because they have met the important requirements in experimental research. The quality of experimental research is considered in terms of its reliability and validity. Reliability refers to the extent to which measurements or experimental procedures produce consistent interpretations of the construct to be measured (Miller et al., 2020). The reliability of the instrument was examined through a pilot test prior to the main study and analyzed using Cronbach's Alpha coefficient. The obtained reliability coefficient indicated that the instrument had acceptable internal consistency and was suitable for measuring students' computational thinking ability.

Data Analysis

Data analysis is carried out using a t-test with SPSS statistical software to compare the average scores between the two groups, by ensuring data normality and homogeneity before conducting an independent t-test (Flannelly et al., 2015; Mcdonald, 2009). Because this study involved two factors, namely learning model and self-confidence, hypothesis testing was conducted using a two-way ANOVA to examine the main effects and interaction effects between variables. Furthermore, Tukey's post hoc test was employed to identify significant differences among groups when the ANOVA results showed statistical significance.

RESULTS AND DISCUSSION

The results in this study were obtained from the computational thinking ability test conducted on two groups: the experimental group (using the GeoGebra-Assisted CPS Learning Model) and the control group (using the expository model). The following is a description of the analysis of the test results:

Table 3 Descriptive Statistics Data

Learning Method	Self Confidence	Mean	Std. Deviation
GeoGebra-assisted CPS	High	80.94	4.646
	Low	47.61	3.238
	Total	64.28	17.358
Expository	High	47.89	5.465
	Low	66.56	4.273
	Total	57.22	10.629
Total	High	64.42	17.492
	Low	57.08	10.308
	Total	60.75	14.725

SJP Sosioedukasi
JURNAL ILMIAH ILMU PENDIDIKAN DAN SOSIAL
ISSN: 2086-6135 E-ISSN: 2541-612x
Volume 15 No. 2. June 2026 https://ejournal.unibabwi.ac.id/index.php/sosioedukasi/index

To facilitate interpretation of the statistical results, the group codes used in the analysis are defined as follows: A1B1 = GeoGebra-assisted CPS with high self-confidence, A1B2 = GeoGebra-assisted CPS with low self-confidence, A2B1 = Expository learning with high self-confidence, and A2B2 = Expository learning with low self-confidence.

Table 3 above shows that the post-test score of the experimental class is higher compared to the control class, with an average computational thinking ability of 64.28. More specifically, students who learned through the GeoGebra-assisted CPS model and possessed high self-confidence obtained the highest mean score (80.94), indicating that the combination of an innovative learning environment and positive self-belief may provide optimal conditions for developing computational thinking ability. Before conducting the hypothesis test, a data normality test and a homogeneity test were conducted. If the data is normally distributed, parametric statistical techniques can be used; Conversely, if the data is not normally distributed, nonparametric statistical techniques can be used. The initial step is to analyze data normality using the Kolmogorov-Smirnov test, the results of which are listed in Table 4 below.

Table 4 Normality Test Results

Learning Method	Self Confidence	Statistic	df	Sig. Score	H0
GeoGebra-Assisted CPS	High	0.921	30	0.134	Accepted
	Low	0.920	30	0.127	Accepted
Expository	High	0.914	30	0.100	Accepted
	Low	0.936	30	0.250	Accepted

From Table 4, it is found that the normality test produces a significance value. This shows that the data from both groups come from normally distributed populations. The next step is to check whether both groups have homogeneous variances. The homogeneity test is carried out using the Levene test. The results of the homogeneity test are in Table 5 below:

Table 5 Homogeneity Test Results

Levene Statistic	df1	df2	Sig. Score	H0
2.431	3	68	0.073	Accepted

After the data is declared to meet the prerequisites, then a two-way ANOVA test is conducted to determine the effect of the learning model, self-confidence, as well as the interaction between the two on students' computational thinking abilities. The following are the results of the two-way ANOVA test using SPSS 26:

Table 6 Two-Way Anova Results

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	14032.056a	3	4677.352	233.277	<.001
Intercept	265720.500	1	265720.500	13252.461	<.001
A	968.000	1	968.000	48.278	<.001
B	896.056	1	896.056	44.690	<.001
A * B	12168.000	1	12168.000	606.863	<.001

A : Learning Model B : Self Confidence A * B : Interaction of learning model and self confidence

After obtaining the results of the two-way ANOVA test which indicates a significant difference, then the analysis is continued with an advanced test (post hoc) using the Tukey test. The Tukey test is conducted to determine which groups have a significant difference in average computational thinking ability. The following are the results of the Tukey test using SPSS 26:

Table 7 Tukey Test Calculation Results

(I) POSHOC	(J) POSHOC	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval (Lower Bound)	95% Confidence Interval (Upper Bound)
A1B1	A2B1	33.06*	1.493	<.001	29.12	36.99
A1B2	A2B2	-18.94*	1.493	<.001	-22.88	-15.01

Sosioedukasi
JURNAL ILMIAH ILMU PENDIDIKAN DAN SOSIAL
ISSN: 2086-6135 E-ISSN: 2541-612x
Volume 15 No. 2. June 2026 https://ejournal.unibabwi.ac.id/index.php/sosioedukasi/index

The results of the Tukey test show that there is a significant difference between the A1B1 and A2B1 groups as well as between the A1B2 and A2B2 groups with a significance value of <0.001. This shows that the learning model and self confidence provide an effect on students' computational thinking abilities. The mean difference of 33.06 points between A1B1 and A2B1 indicates that students with high self-confidence benefited substantially more from the GeoGebra-assisted CPS model than from expository learning. Likewise, the significant difference between A1B2 and A2B2 suggests that the learning model contributes to computational thinking development even among students with lower self-confidence levels. These findings confirm the significant interaction effect identified in the two-way ANOVA results.

The Effect of the GeoGebra-Assisted CPS Learning Model on Computational Thinking Ability

Learning using the GeoGebra-assisted CPS model provides a positive effect on students' computational thinking abilities. This can be seen during the learning process, where students become more active in understanding problems, exploring various possible solutions, and arranging settlement steps systematically. The CPS model provides an opportunity for students to think creatively and logically in solving mathematical problems, while GeoGebra helps students visualize abstract concepts to become more concrete and easy to understand. These findings are in line with the research of Chytas et al. (2024) which states that the use of GeoGebra in mathematics learning is able to support the development of computational thinking ability through exploration, visualization, and interactive problem-solving activities.

At the stage of understanding the problem (understanding the problem), students try to identify important information from the problem given by the teacher through various mathematical representations such as graphs, pictures, symbols, and visual simulations using GeoGebra. Students can observe the relationship between mathematical objects directly through the dynamic features of GeoGebra so that abstract concepts become easier to understand. This activity helps students develop decomposition ability in computational thinking, namely the ability to break down complex problems into simpler parts. The research of Putri and Pasaribu (2025) shows that GeoGebra is effectively used as an interactive visualization media capable of improving students' understanding of mathematical concepts. From a computational thinking perspective, the visualization features of GeoGebra help students identify relevant elements of a problem and separate them into smaller components, thereby strengthening decomposition skills. Rather than processing information simultaneously, students can focus on each component step-by-step through dynamic representations.

Figure 1 Student Activities Using GeoGebra in CPS Learning

The use of multi representations in the GeoGebra-assisted CPS model also helps students understand the relationships between mathematical concepts more deeply. Students can use verbal, numerical, symbolic, or graphical representations in explaining the obtained solutions. Through these various forms of representation, students find it

SJP Sosioedukasi
JURNAL ILMIAH ILMU PENDIDIKAN DAN SOSIAL
ISSN: 2086-6135 E-ISSN: 2541-612x
Volume 15 No. 2. June 2026 https://ejournal.unibabwi.ac.id/index.php/sosioedukasi/index

easier to recognize patterns and arrange problem-solving strategies systematically. The multi representation approach helps students perform abstraction on important information so that it supports students' computational thinking abilities. These findings are consistent with the research of Dewi et al. (2023) which shows that computational thinking-based learning assisted by GeoGebra helps students understand mathematical concepts more structurally and systematically. The ability to move between multiple representations also supports pattern recognition because students can observe similarities, differences, and recurring mathematical relationships from different perspectives. At the same time, abstraction is strengthened when students learn to focus on essential mathematical information while ignoring irrelevant details contained in contextual problems.

At the action planning stage (planning for action), students determine the best strategy based on the results of the exploration and discussion that have been carried out. GeoGebra is used to test and verify the solutions obtained by students through visual simulations. This activity helps students develop abstraction ability, namely the ability to select important information and ignore irrelevant information in solving mathematical problems. In addition, students also find it easier to understand the relationships between concepts because they can see changes in mathematical objects directly when parameters are modified. The opportunity to test different alternatives and immediately observe their consequences encourages students to evaluate solution procedures critically, which is closely related to algorithm design in computational thinking. Students learn not only to obtain answers but also to construct efficient and logical sequences of steps.

The GeoGebra-assisted CPS model also encourages students to actively discuss and work together in groups. Students exchange ideas, provide arguments, and evaluate solutions together with their group mates. These interactions help students develop critical, logical, and systematic thinking skills in compiling problem solving. Student-centered learning makes the learning process more meaningful because students are involved directly in discovering concepts and problem solutions. This collaborative process may also explain why students with high self-confidence achieved better outcomes. Students who possess stronger self-confidence tend to participate more actively in discussions, express ideas without hesitation, and persist when encountering difficulties, thereby maximizing the benefits offered by the CPS learning environment.

At the solution implementation stage (implementing the solution), students apply the chosen settlement strategy to solve the contextual problem given by the teacher. Students use GeoGebra to present the results of the settlement in the form of graphs, diagrams, or other visual simulations. The use of these interactive media makes learning more interesting and helps students understand mathematical concepts more deeply. The research of Rani and Antony (2026) shows that the use of GeoGebra effectively improves students' mathematical problem-solving abilities because students can explore various alternative settlements visually and interactively.

Figure 2 Solution Implementation Using GeoGebra in CPS Learning

The results of the study show that students who learn using the GeoGebra-assisted CPS model have better computational thinking abilities compared to students who learn using expository learning. Students become more capable of identifying problems, recognizing patterns, performing abstractions, and arranging settlement steps

SJP Sosioedukasi
JURNAL ILMIAH ILMU PENDIDIKAN DAN SOSIAL
ISSN: 2086-6135 E-ISSN: 2541-612x
Volume 15 No. 2. June 2026 https://ejournal.unibabwi.ac.id/index.php/sosioedukasi/index

systematically. This happens because the CPS model provides an opportunity for students to actively build their own knowledge through the process of exploration and problem solving, while GeoGebra helps students understand mathematical concepts visually and interactively. Thus, the combination of the CPS model and GeoGebra is able to create innovative, active mathematics learning, and supports the optimal development of students' computational thinking abilities. These findings suggest that the effectiveness of the GeoGebra-assisted CPS model is not merely attributable to technology integration, but also to the way visualisation, exploration, interactivity, and collaborative problem-solving collectively facilitate the development of decomposition, pattern recognition, abstraction, and algorithm design as core components of computational thinking.

CONCLUSION

Based on the analysis and discussion, it can be concluded that the GeoGebra-assisted CPS learning model has a significant positive effect on students' computational thinking abilities. Students who learned through the GeoGebra-assisted CPS model achieved higher computational thinking scores than those who learned through the expository model. The findings also indicate a significant interaction between the learning model and self-confidence, showing that the effectiveness of the GeoGebra-assisted CPS model is influenced by students' self-confidence levels. Students with high self-confidence demonstrated the most optimal computational thinking performance.

These findings suggest that the integration of CPS and GeoGebra provides meaningful learning experiences through problem exploration, visualisation, and systematic solution development, thereby supporting the development of decomposition, pattern recognition, abstraction, and algorithm design skills. Therefore, the GeoGebra-assisted CPS model can be considered an effective alternative for mathematics learning, particularly in elementary school classrooms that aim to strengthen students' computational thinking abilities.

For educational practice, teachers are encouraged to implement the GeoGebra-assisted CPS model in mathematics topics that involve problem solving and visual representation, while simultaneously fostering students' self-confidence through collaborative activities, guided exploration, and opportunities to express ideas.

This study was conducted within a limited sample and context; therefore, future research is recommended to involve broader participant characteristics and investigate strategies for strengthening students' self-confidence as well as the long-term impact of the GeoGebra-assisted CPS model on computational thinking and other mathematical competencies.

REFERENCES

Allen, C. E., Froustet, M. E., LeBlanc, J. F., Payne, J. N., Priest, A., Reed, J. F., Worth, J. E., Thomason, G. M., Robinson, B., & Payne, J. N. (2020). National Council of Teachers of Mathematics. *The Arithmetic Teacher*, 29 (5), 59. https://doi.org/10.5951/at.29.5.0059

Chytas, C., van Borkulo, S. P., Drijvers, P., Barendsen, E., & Tolboom, J. L. J. (2024). Computational Thinking in Secondary Mathematics Education with GeoGebra: Insights from an Intervention in Calculus Lessons. *Digital Experiences in Mathematics Education*, 10 (2), 228–259. https://doi.org/10.1007/s40751-024-00141-0

Dewi, H. L., Lya, S., Pramesti, D., Salisa, N., & Ainun, N. (2023). Development of Geometry Module Based on Computational Thinking Assisted by GeoGebra. *EduMa: Mathematics Education Learning And Teaching*, 12 (1), 88–100.

Durak, H. Y., & Saritepeci, M. (2018). Analysis of the relation between computational thinking skills and various variables with the structural equation model. *Computers and Education*, 116 , 191–202. https://doi.org/10.1016/j.compedu.2017.09.004

Flannelly, K. J., Jankowski, K. R. B., Flannelly, L. T., Flannelly, K. J., Jankowski, K. R. B., & Flannelly, L. T. (2015). Measures of Variability in Chaplaincy , Health Care , and Related Research Research Methodology . 4726 (November). https://doi.org/10.1080/08854726.2015.1054671

Gribbons, B., & Herman, J. (1997). *True and Quasi-Experimental Designs*. 5 (14), 3–5.

Grover, S., & Pea, R. (2013). Computational Thinking in K-12: A Review of the State of the Field. *Educational Researcher*, 42 (1), 38–43. https://doi.org/10.3102/0013189X12463051

Hamdi, S., Suganda, I. A., & Hayati, N. (2018). Developing higher-order thinking skill (HOTS) test instrument using Lombok local cultures as contexts for junior secondary school mathematics. *REID (Research and Evaluation in Education)*, 4 (2), 126–135. https://doi.org/10.21831/reid.v4i2.22089

Handayani, E. D., Kusnawati, E., Sari, N. M., Yaniawati, P., & Zulkarnaen, M. I. (2022). Implementation of geogebra-assisted creative problem-solving model to improve problem solving ability and learning interest students. *Al-Jabar : Jurnal Pendidikan Matematika*, 13 (1), 33–48. https://doi.org/10.24042/ajpm.v13i1.11341

Jiang, B., & Li, Z. (2021). Effect of Scratch on computational thinking skills of Chinese primary school students. *Journal of Computers in Education*, 8 (4), 505–525. https://doi.org/10.1007/s40692-021-00190-z

Mcdonald, J. H. (2009). *Handbook Of Biological Statistics Second Edition*.

Miller, C. J., Smith, S. N., & Pugatch, M. (2020). Experimental and quasi-experimental designs in implementation research. *Psychiatry Research*, 283 (June 2019), 112452. https://doi.org/10.1016/j.psychres.2019.06.027

Putri, F. P., & Pasaribu, R. L. (2025). Kajian Literatur Sistematis : Efektivitas Penggunaan GeoGebra sebagai Media Visualisasi Interaktif terhadap Pemahaman Konsep Bangun Ruang. *Jurnal Ilmiah Matematika Dan Pendidikan Matematika*.

Rani, T. P., & Antony, R. (2026). Efektifitas Penggunaan GeoGebra dalam Meningkatkan Pemecahan Masalah Matematis. *Jurnal Pendidikan MIPA*, 15 , 1551–1560.

Roger, E., & Krik. (2009). *Experimental Design*.

Shadish, W. R., & Cook, T. D. (20002). *Modern Descriptions of Experiments The Kuhnian Critique Modern Social Psychological Critiques Science and Trust Implications for Experiments A World Without Experiments or Causes?*

Tang, X., Yin, Y., Lin, Q., Hadad, R., & Zhai, X. (2020). Assessing computational thinking: A systematic review of empirical studies. *Computers and Education*, 148 (May 2019), 103798. https://doi.org/10.1016/j.compedu.2019.103798

Treffinger, D. J., Selby, E. C., & Isaksen, S. G. (2018). Understanding individual problem-solving style: A key to learning and applying creative problem solving. *Learning and Individual Differences*, 18 (4), 390–401. https://doi.org/10.1016/j.lindif.2007.11.007

Turgut, S., & Turgut, İ. G. (2020). Me while i am learning mathematics: Reflections to elementary school students' drawings. *International Electronic Journal of Elementary Education*, 13 (1), 139–154. https://doi.org/10.26822/iejee.2020.179

Widiyatmoko, A., Utaminingsih, S., & Santoso. (2021). Android-based math learning to improve critical thinking. *Journal of Physics: Conference Series*, 1823 (1), 6–13. https://doi.org/10.1088/1742-6596/1823/1/012091

Wing, J. M. (2006). 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