e-ISSN: 2964-1446
p-ISSN: 2962-0570
Vol. 3, No. 3, Agustus 2024

Indonesian Journal of Teaching and Learning
http://journals.eduped.org/index.php/intel

Learning Style Factors in Achieving Mathematical Computational Thinking Ability in Mathematics Education Students

Lilis Marina Angraini[1], Arcat[2], Sohibun[3]
[1]Mathematics Education, Universitas Islam Riau, Pekanbaru
[2,3]Mathematics Education, Universitas Pasir Pengaraian, Pekanbaru

Info Artikel

Riwayat Artikel:

Diterima 19 April 2024
Revisi 17 Mei 2024
Diterima 12 June 2024

Kata Kunci:

Computational Thinking;
Mathematical Thinking;
Learning Style.

ABSTRAK

Gaya belajar mengacu pada metode yang digunakan siswa dalam menyerap dan memproses informasi. Penelitian ini bertujuan untuk melihat faktor gaya belajar terhadap pencapaian kemampuan berpikir komputasi matematis mahasiswa pendidikan matematika pada mata kuliah Struktur Aljabar. Metode penelitian ini adalah metode korelasional dengan pendekatan kuantitatif. Subjek penelitian adalah seluruh mahasiswa pendidikan matematika yang mengambil mata kuliah Struktur Aljabar pada tahun ajaran 2023/2024 sebanyak 34 mahasiswa. Metode pengumpulan data yang digunakan meliputi: (1) tes berpikir komputasi; (2) kuesioner; dan (3) dokumentasi. Data penelitian diolah dengan uji statistik korelasi Product Moment. Hasil penelitian diperoleh korelasi positif sebesar 0,44 yang menunjukkan bahwa terdapat hubungan positif antara gaya belajar dengan berpikir komputasional pada siswa yang diamati. Artinya, secara keseluruhan, individu yang memiliki gaya belajar lebih efektif atau intensif juga cenderung memiliki kemampuan berpikir komputasional yang lebih baik.

ABSTRACT

Learning styles refer to the methods students use in absorbing and processing information. This study aims to look at learning style factors in the achievement of mathematical computational thinking skills of mathematics education students in the Algebraic Structure course. This research method is a correlational method with a quantitative approach. The research subjects were all mathematics education students who took the Algebraic Structure course in the 2023/2024 academic year as many as 34 students. The data collection methods used include: (1) computational thinking test; (2) questionnaire; and (3) documentation. The research data were processed with the Product Moment correlation statistical test. The results obtained a positive correlation of 0.44 which indicates that there is a positive relationship between learning styles and computational thinking in the observed students. That is, overall, individuals who have a more effective or intensive learning style also tend to have better computational thinking ability.

Penulis Koresponden:

Lilis Marina Angraini
Universitas Islam Riau
Jalan Kaharuddin Nasution Number 113 Pekanbaru, Riau
lilismarina@edu.uir.ac.id

How to Cite: Angraini, Arcat, and Sohibun. (2024). Learning Style Factors in Achieving Mathematical Computational Thinking Ability in Mathematics Education Students. *Indonesian Journal of Teaching and Learning, 3*(3), 136-147, https://doi.org/10.56855/intel.v3i3.1104

INTRODUCTION

Computational thinking has become a trend in various research studies. A study by Roussou & Rangoussi, (2020) stated that computational thinking has recently been getting its attention significant and has been the focus of many studies aimed at identifying superiority and relevance. The same thing happens in education, as is mentioned by Bocconi et al., (2016), where in the last decades, computational thinking has been interesting increasing attention in the field of education. It generates a lot of academic literature and implementation initiatives in both the public and private sectors. One of the aspects of implementation that stands out is in learning mathematics at school as well as university. Although computational thinking is a core concept in many fields of computer science, this concept has attracted significant attention in recent years skills that need to be discovered and strengthened better than ever before.

According to Israel et al., (2015); Park & Green, (2019), computational thinking is an explicit skill and can be demonstrated through two main steps, namely abstracting the problem and automating the solution. On the other hand, according to Angeli et al., (2016); Csizmadia et al., (2015); Kale et al., (2018); Lee et al., (2023), computational thinking is a thought process involves elements such as abstraction, generalization, decomposition, algorithmic thinking, and debugging. In general, mathematical computational thinking can be interpreted as a directed thinking to develop solutions to complex problems, by following a series of structured and formal steps (Anderson, 2016; Barr et al., 2011). Think of mathematical computing involves skills and techniques that often solve problems into smaller parts, recognizing patterns and abstracting information, as well Formulate algorithms to solve problems and generalize them.

Computational thinking is a very important ability for all students, as mentioned in several studies such as (Araujo et al., 2019; Deng et al., 2020; Li et al., 2020; Liu et al., 2021; Repenning et al., 2016; Ribeiro Silva et al., 2018; Tofel-grehl & Richardson, 2018; Valovičová et al., 2020; Vinayakumar et al., 2018; Voogt et al., 2015; Yang et al., 2020; Zahilah Mohamed Zaki et al., 2019). Computational thinking is strategically important in solving various problems and has special applications in mathematics, science, and engineering (Dagienė et al., 2017; Hinterplattner et al., 2020; Taslibeyaz et al., 2020). Computational thinking can be said to be similar to mathematical thinking, involving beliefs, and problem solving (Rich et al., 2020; Shute et al., 2017). According to Mohaghegh & Mccauley, (2016); Nordby et al., (2022) in the context of mathematics, computational thinking includes activities that focus on skills and process-oriented activities. Meanwhile, (Kallia et al., 2021; Urhan, 2022) emphasizes three important aspects of computational thinking that are discussed in mathematics education, namely problem solving, cognitive processes, and transposition. Based on the above opinion, it can be concluded that mathematical computational thinking is a process of solving problems by breaking down problems into simpler ones that include several cognitive processes.

According to Maharani et al., (2019) solving a problem through computational thinking can be seen from the following indicators: (1) Abstraction : students can decide on an object to use or reject, which can be interpreted as separating important information from information that is not used ; (2) Generalization : the ability to formulate solutions in a general form so that they can be applied to different problems, can be interpreted as the use of variables in solving solutions ; (3) Decomposition : the ability to break down complex problems into simpler ones that are easier to understand and solve ; (4) Algorithmic : the ability to design step by step an operation/action how the problem is solved ; (5) Debugging : the ability to identify, remove, and correct errors.

One of the factors that influence mathematical ability is learning style. According to Astuti et al., (2021) the difference in learning style lies in the difference in how to receive and convey a message material. Learning style is the easiest technique for students to receive and process information provided so that it is easier to understand and remember lessons. There are three different learning styles and result in different ways of learning. Visual students take advantage of the eyes in learning, namely remembering things more easily done by sight. Auditory students use the ear in learning, namely remembering something is easier to do by hearing. kinesthetic student utilizing body movements in learning, namely remembering something is easier to do by moving and doing hands-on practice.

The relationship between computational thinking and learning styles is related to how individuals process information and learn. Computational thinking involves the ability to organize, analyze, and solve problems using principles similar to the way computers process information (Ansori, 2020). Learning style, on the other hand, refers to individual preferences in obtaining and processing information. There are several models of learning styles that try to describe individual differences in this regard, the three learning styles namely visual, auditory, and kinesthetic, each individual has a dominant different learning style, some are dominant in one or two learning styles, some are dominant in the three learning styles. Learning styles include how one learns, how one's technique balances learning and learning success, studying one's technique of receiving, absorbing, and processing information.

The characteristics of the three learning styles mentioned by Ahmad, (2020) are as follows: (a) The visual learning style is the dominant learning style in observation, the five senses that are relied on are the eye senses. Visual students have the following characteristics: tidy, preferring to read alone rather than being read to, good at spelling, not easily distracted by noise, maximizing the use of their eyes in learning, and being thorough and detailed; (b) Auditory learning style is a learning style that prioritizes sensitivity to sound and hearing. The five senses that are relied on are the senses of the ear. Auditory students have characteristics: fluent speakers, like to read aloud, remember what was discussed, easily distracted by noise, and like to talk to themselves; (c) Kinesthetic learning style, namely learning by maximizing the limbs to understand something. Kinesthetic students have characteristics including: speaking slowly and slowly, liking learning through hands-on practice, using the finger as a pointing device when reading, not being able to stand still for long periods of time.

The importance of computational mathematical thinking has been examined by (Cahdriyana & Richardo, 2020; Kamil et al., 2021). While learning style is a determining factor in achieving mathematical thinking abilities, it has been studied by (Dilla et al., 2018; Wassahua, 2016). This study itself aims to look at learning style factors in achieving computational mathematical thinking abilities of mathematics education students who take algebraic structure courses.

METHOD

This research was conducted in the Department of Mathematics Education, for students taking the Algebraic Structures course in the academic year 2023/2024. The subjects of this study amounted to 34 students. This research method is a correlational method, this method is carried out to see the relationship between one variable (computational mathematical thinking ability) and another variable (learning style). The research data was collected through tests, questionnaires about learning styles and documentation. Which test given in the form of questions about computational thinking mathematical ability. The learning style questionnaire used uses a Likert scale. The tests and questionnaires were first validated by experts (mathematics education lecturers). Then the data was analyzed using the *Product Moment* correlation test. The following are indicators used to measure students' mathematical computational thinking skills.

Table 1. Stages of Mathematical Computational Thinking Ability

Stages of Computational Thinking	Computational Thinking Ability	Description
Defining the Problem	Problem formulation	Formulate the problem
	Abstraction	Identify the right information to solve the problem
	Problem Reformulation	Reformulate or model the problem into a solvable problem
	Decomposition	Breaking the problem into smaller parts so that complex problems are easier to understand
Solve the problem	Data collection and analysis	Evaluating data sets to ensure that the data obtained can facilitate the discovery of patterns and relationships

	Parallelization Algorithm Design and Literacy Automation	Makes a series of sequential steps to solve a problem or achieve a goal
Analyze the Solution	Generalization testing and evaluation	Re-examine the solution, and formulate it into a general form that can be applied to other problems

The indicators used to measure student learning styles are as follows:

Table 2. Visual Learning Style Indicators

Indicator	Description
Neat and regular	Make notes with a neat and regular study on the environment which neat notice neatness in dress
More like read from on read out	More like read book than listening explanation from the lecturer.
A planner long-term which Good	Prepare study for exam long before finish task a number of day before assignments collected
Thorough to details	Thorough in do question research answer from questions before the collected
Remember what is seen than what which be heard	Easy to remember the material given by the lecturer in writing than the material described by the lecturer. Take note of the material provided by a lecturer in the form of a written note easy to accept material in a kind picture

Table 3. Auditory Learning Style Indicators

Indicator	Description
Easy disturbed with commotion	Study in circumstances quiet
Learn by listening and remember what which discussed rather than what seen	Study with listening explanation from the lecturer
Glad to read with hard	Read books with hard
Like discuss and like explain long wide	Study with method discussion explain something with length and width
Find it difficult to write but great at telling a story	More like telling a story than writing

Table 4. Kinesthetic Learning Style Indicators

Indicator	Description

Learn in a way that practice	Study with do exercise question
Always oriented physique And Lots of move	Respond to something with motion physique like activity which relates physically
Speak with slowly	Explain something to others and slowly land
Want to do something	Do more than one activity in every time
For games which busy	Like lesson through the game

Furthermore, one example of a test instrument on computational thinking skills used in this study is as follows: 1) Show that G= {0,1}, (G, x) is not a group.

RESULTS

Based on trials conducted on class A majoring in Mathematics Education as many as 34 students with 25 item statements about learning styles consisting of positive statements and negative statements, the learning styles of mathematics education students in algebraic structure courses vary, this can be seen from the different learning style questionnaire scores obtained. Next, a histogram of the learning styles of mathematics education students will be seen.

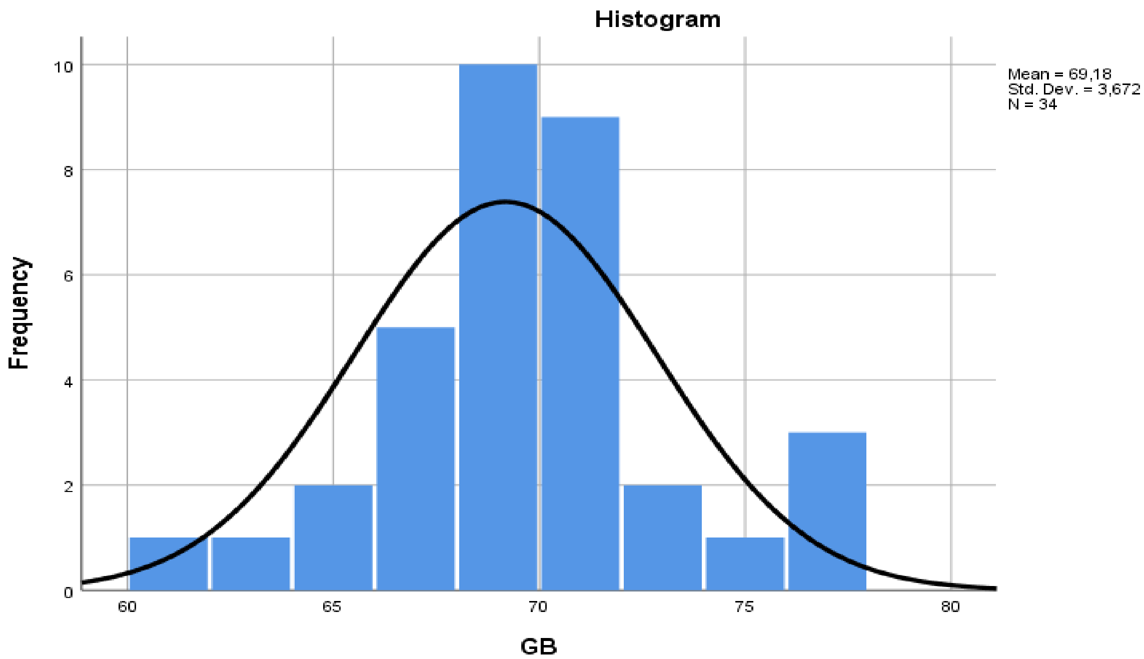


Figure 1. Histogram of Student Learning Styles

Figure 1 above shows that the average learning style of mathematics education students in the algebraic structure course is 69.18. From the questionnaire data, the highest score was 77, the lowest score was 6 1 with a standard deviation of 3.672, the median (middle value) was 69, the mode (the value that often appears) was 68.

The computational mathematical thinking abilities of mathematics education students in the algebraic structure course vary, this can be seen from the test scores on the mathematical computational thinking skills obtained are different. Next, we will look at the histogram of the mathematical computational thinking ability of mathematics education students.

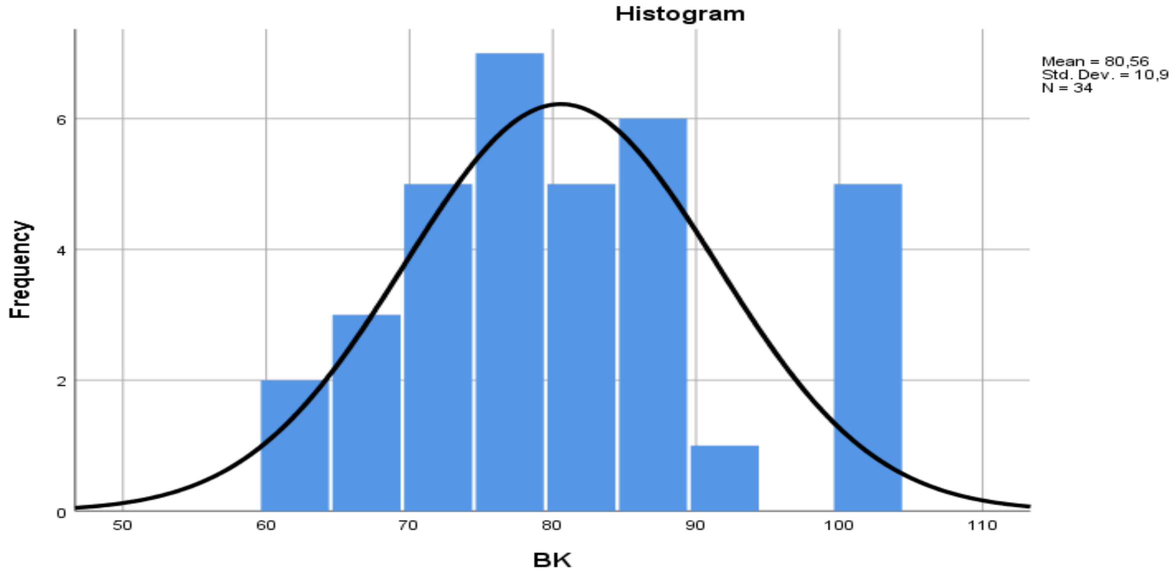


Figure 2. Histogram of Students ' Mathematical Computational Thinking Ability

Figure 2 above shows that the average computational mathematical thinking ability of mathematics education students in the algebraic structure course is quite good, namely 80.56. From the results of the mathematical computational thinking ability test, the highest score was 100, the lowest score was 6 2 with a standard deviation of 10.9, the median (middle value) was 79.5, the mode (the value that often appears) was 100. the range of learning styles is 16 while the range of mathematical computational thinking abilities of mathematics education students in the algebraic structure course is 38. The variance of learning styles is 13.483 with a standard error of 0.63, while the variance of mathematical computational thinking skills of mathematics education students in the algebraic structure course is 118.799 with a standard error of 1.869.

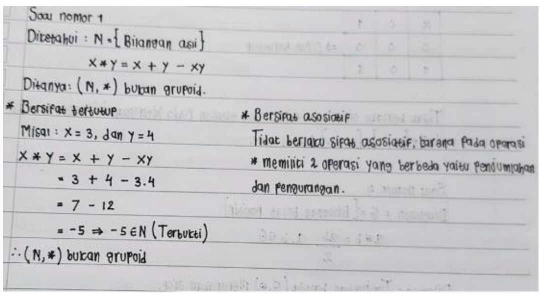
The correlation of learning styles and mathematical computational thinking skills of mathematics education students in the algebraic structure course has a positive correlation with the correlation value of 0.44. That is, the higher a student's learning style, the higher his mathematical computational thinking ability. Correlation is a statistical method used to measure the extent to which two variables are related to each other. In this context, the observed variables are learning styles and computational mathematical thinking abilities. Learning style refers to the way a person processes information and learns effectively. Each individual has a preference in learning methods, such as visual (learning through pictures or diagrams), auditory (learning through hearing), or kinesthetic (learning through physical movement). Mathematical computational thinking ability refers to students' ability to apply mathematical concepts in problem solving and computational calculations. Some points that can be interpreted from table 6 above are:

1. The positive correlation indicates that there is a positive relationship between learning styles and computational thinking in the population studied. This means

that, overall, individuals who have more effective or intensive learning styles also tend to have better computational thinking skills, and vice versa.

2. Moderately strong relationship: A correlation value of 0.44 indicates that the relationship is not simply coincidental or weak, but has a clear trend. This correlation indicates that there is a fairly consistent pattern in the relationship between learning styles and computational thinking.
3. Further interpretation: For example, individuals who have a more adaptive learning style, are motivated to learn, and are active in seeking new knowledge, tend to also have better computational thinking skills. On the other hand, individuals who have a less effective or less enthusiastic learning style may tend to have lower computational thinking skills.
4. The importance of the learning approach : This finding shows that the way students learn can affect their ability to think computationally mathematically. Therefore, a learning approach that pays attention to individual learning styles can help improve their ability to understand and apply mathematical concepts in computational situations.
5. Course relevance: The results of this correlation also show that the algebraic structure course plays a role in developing the mathematical computational thinking skills of students of mathematics education. By understanding this correlation, educators can consider more effective and relevant learning strategies to better help students achieve their learning goals.
6. Potential for further research : The correlation value of 0.44 provides initial insight into the relationship between learning styles and mathematical computational thinking abilities. However, to understand the more in-depth factors that influence this correlation, further research is needed with more detailed methods and involving a larger sample of students.

The following are the results of student answers on the computational thinking ability test in the algebraic structure course: The following are the results of student answers on the computational thinking ability test in the algebraic structure course:



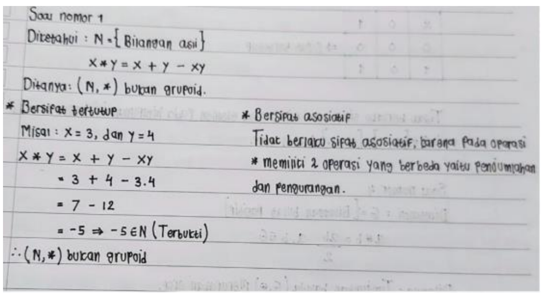


Figure 3. Student Mathematical Thinking Ability Test Answers

Based on the answers to the results of the students' mathematical computational thinking skills test above, information was obtained that these students were able to analyze mathematical problems or computational situations well. The student can break down the problem into clear steps or algorithms to find a solution. Student Such individuals may have a tendency to think creatively in finding efficient and innovative solutions. These students can utilize existing knowledge and skills to face new challenges. In computing problem solving, small errors can lead to different results. Good test results indicate an individual's ability to think carefully and accurately in executing algorithms and computational processes. Good computational thinking skills also reflect a strong understanding of the mathematical concepts that underlie computational processes. These students are able to handle complex mathematical or computational problems and solve them with strong thinking skills. Good test results can show that the student can execute computational processes quickly and efficiently. Computational thinking skills can be continuously developed and improved through practice, learning, and experience and adapted to each student's learning style. A good test result is a positive step, but that doesn't mean the individual doesn't need to keep learning and practicing to keep improving their abilities in computational thinking. The answers to the students ' mathematical thinking ability tests obtained in this study are in line with the opinion (Dilla et al., 2018; Wassahua, 2016) that learning style is a determining factor in the achievement of mathematical thinking abilities.

CONCLUSION

Based on data processing, a positive correlation value of 0.44 was obtained which indicated that there was a positive relationship between learning styles and computational thinking in the observed students. This means that, overall, individuals who have more effective or intensive learning styles also tend to have better computational thinking skills, and vice versa. Keep in mind that correlation indicates a statistical relationship between two variables, but does not imply a causal relationship. Therefore, even though there is a positive correlation, it cannot be concluded that learning style causes an increase in mathematical computational thinking skills or vice versa. Interpretation must be made with caution and not to conclude causality without further evidence.

REFERENCES

Ahmad. (2020). *Gaya Belajar Matematika Siswa SMP.* Bandung: Penerbit Cakra.

Anderson, N. D. (2016). A Call for Computational Thinking in Undergraduate Psychology. *Psychology Learning & Teaching*, *15*(3), 226–234. https://doi.org/10.1177/1475725716659252

Angeli, C., Voogt, J., Fluck, A., Webb, M., Cox, M., Malyn-Smith, J., & Zagami, J. (2016). A K-6 computational thinking curriculum framework: Implications for teacher knowledge. *Educational Technology and Society*, *19*(3), 47–57.

Ansori, M. (2020). Penilaian Kemampuan Computational Thinking. *Salamiya: Jurnal Studi Ilmu Keagamaan Islam*, *1*(2), 176–193.

Araujo, C., Lima, L. V. O., & Henriques, P. R. (2019). An Ontology based approach to teach Computational Thinking. *International Symposium on Computers in Education (SIIE)*, 1–6. https://doi.org/10.1109/SIIE48397.2019.8970131

Astuti, E. A., Nurimani, & Wulandari, A. (2021). Hubungan Gaya Belajar Siswa dengan Kemampuan Penalaran Matematika. *Prosiding Seminar Nasional Pendidikan STKIP Kusuma Negara III*, 73–79.

Barr, D., Harrison, J., & Conery, L. (2011). Computational Thinking: A Digital Age Skill for Everyone. *Learning and Leading with Technology*, *38*(6), 20–23.

Bocconi, S., Chioccariello, A., Dettori, G., Ferrari, A., Engelhardt, K., Kampylis, P., & Punie, Y. (2016). Developing Computational Thinking in Compulsory Education - Implications for policy and practice. In *Joint Research Centre (JRC)* (Issue June). https://doi.org/10.2791/792158

Cahdriyana, R. A., & Richardo, R. (2020). Berpikir Komputasi Dalam Pembelajaran Matematika. *Literasi (Jurnal Ilmu Pendidikan)*, *11*(1), 50. https://doi.org/10.21927/literasi.2020.11(1).50-56

Csizmadia, A., Curzon, P., Dorling, M., Humphreys, S., Ng, T., Selby, C., & Woollard, J. (2015). Computational Thinking: A Guide for Teachers. *Computing At School*, *October 2018*, 18.

Dagienė, V., Stupurienė, G., & Vinikienė, L. (2017). Implementation of Dynamic Tasks on Informatics and Computational Thinking. *Baltic Journal of Modern Computing*, *5*(3). https://doi.org/10.22364/bjmc.2017.5.3.05

Deng, W., Pi, Z., Lei, W., Zhou, Q., & Zhang, W. (2020). Pencil Code improves learners' computational thinking and computer learning attitude. *Computer Applications in Engineering Education*, *28*(1), 90–104. https://doi.org/10.1002/cae.22177

Dilla, S. C., Hidayat, W., & Rohaeti, E. E. (2018). Faktor Gender dan Resiliensi dalam Pencapaian Kemampuan Berpikir Kreatif Matematis Siswa SMA. *Journal of Medives : Journal of Mathematics Education IKIP Veteran Semarang*, *2*(1), 129. https://doi.org/10.31331/medives.v2i1.553

Hinterplattner, S., Skogø, J. S., Kröhn, C., & Sabitzer, B. (2020). The Children's Congress: A Benefit to All Levels of Schooling by Strengthening Computational Thinking. *International Journal of Learning and Teaching*, 241–246. https://doi.org/10.18178/ijlt.6.4.241-246

Israel, M., Wherfel, Q. M., Pearson, J., Shehab, S., & Tapia, T. (2015). Empowering K–12 Students With Disabilities to Learn Computational Thinking and Computer Programming. *Teaching Exceptional Children*, *48*(1), 45–53. https://doi.org/10.1177/0040059915594790

Kale, U., Akcaoglu, M., Cullen, T., Goh, D., Devine, L., Calvert, N., & Grise, K. (2018). Computational What? Relating Computational Thinking to Teaching. *TechTrends*, *62*(6), 574–584. https://doi.org/10.1007/s11528-018-0290-9

Kallia, M., Borkulo, S. P. V., Drijvers, P., Barendsen, E., & Tolboom, J. (2021). Characterising computational thinking in mathematics education: a literature-informed Delphi study. *Research in Mathematics Education*, *23*(2), 159–187. https://doi.org/10.1080/14794802.2020.1852104

Lee, J., Joswick, C., & Pole, K. (2023). Classroom Play and Activities to Support Computational Thinking Development in Early Childhood. *Early Childhood Education Journal*, *51*(3), 457–468. https://doi.org/10.1007/s10643-022-01319-0

Li, Y., Schoenfeld, A. H., DiSessa, A. A., Graesser, A. C., Benson, L. C., English, L. D., & Duschl, R. A. (2020). Computational Thinking Is More about Thinking than Computing. *Journal for STEM Education Research*, *3*(1), 1–18. https://doi.org/10.1007/s41979-020-00030-2

Liu, Y.-C., Huang, T.-H., & Sung, C.-L. (2021). The determinants of impact of personal traits on computational thinking with programming instruction. *Interactive Learning Environments*, 1–15. https://doi.org/10.1080/10494820.2021.1983610

Maharani, S., Kholid, M. N., Pradana, L. N., & Nusantara, T. (2019). Problem Solving in the Context of ComputationaL Thinking. *Infinity Journal*, *8*(2), 109. https://doi.org/10.22460/infinity.v8i2.p109-116

Mohaghegh, M., & Mccauley, M. (2016). Computational Thinking: The Skill Set of the 21st Century. *International Journal of Computer Science and Information Technologies*, *7*(3), 1524–1539. www.ijcsit.com

Nordby, S. K., Bjerke, A. H., & Mifsud, L. (2022). Computational Thinking in the Primary Mathematics Classroom: a Systematic Review. *Digital Experiences in Mathematics Education*, *8*(1), 27–49. https://doi.org/10.1007/s40751-022-00102-5

Park, Y.-S., & Green, J. (2019). Bringing Computational Thinking into Science Education. *Journal of the Korean Earth Science Society*, *40*(4), 340–352. https://doi.org/10.5467/JKESS.2019.40.4.340

Repenning, A., Basawapatna, A., & Escherle, N. (2016). Computational thinking tools. *IEEE Symposium on Visual Languages and Human-Centric Computing (VL/HCC)*, 218–222. https://doi.org/10.1109/VLHCC.2016.7739688

Ribeiro Silva, L., Pedro da Silva, A., Toda, A., & Isotani, S. (2018). Impact of Teaching Approaches to Computational Thinking on High School Students: A Systematic Mapping. *IEEE 18th International Conference on Advanced Learning Technologies (ICALT)*, 285–289. https://doi.org/10.1109/ICALT.2018.00072

Rich, K. M., Spaepen, E., Strickland, C., & Moran, C. (2020). Synergies and differences in mathematical and computational thinking: implications for integrated instruction. *Interactive Learning Environments*, *28*(3), 272–283. https://doi.org/10.1080/10494820.2019.1612445

Kamil, M. R., Imami, A. I., Abadi, A. P., Matematika, P., & Singaperbangsa Karawang, U. (2021). Analisis kemampuan berpikir komputasional matematis Siswa Kelas IX SMP Negeri 1 Cikampek pada materi pola bilangan. *Aksioma*,*12*(2), 259–270.

Roussou, E., & Rangoussi, M. (2020). On the Use of Robotics for the Development of Computational Thinking in Kindergarten. *Educational Intervention and Evaluation* (pp. 31–44). https://doi.org/10.1007/978-3-030-26945-6_3

Shute, V. J., Sun, C., & Asbell-Clarke, J. (2017). Demystifying computational thinking. *Educational Research Review*, *22*, 142–158. https://doi.org/10.1016/j.edurev.2017.09.003

Taslibeyaz, E., Kursun, E., & Karaman, S. (2020). How to Develop Computational Thinking: A Systematic Review of Empirical Studies. *Informatics in Education*, *19*(4), 701–719. https://doi.org/10.15388/infedu.2020.30

Tofel-grehl, C., & Richardson, D. (2018).Teaching Computational Thinking to English Learners University of California at Irvine. *Nys Tesol Journal*, *5*(July), 12–24. https://par.nsf.gov/servlets/purl/10073683

Urhan, S. (2022). Using Habermas' construct of rationality to analyze students' computational thinking: The case of series and vector. *Education and Information Technologies*, *27*(8), 10869–10948. https://doi.org/10.1007/s10639-022-11002-x

Valovičová, Ľ., Ondruška, J., Zelenický, Ľ., Chytrý, V., & Medová, J. (2020). Enhancing Computational Thinking through Interdisciplinary STEAM Activities Using Tablets. *Mathematics*, *8*(12), 2128. https://doi.org/10.3390/math8122128

Vinayakumar, R., Soman, K., & Menon, P. (2018). Fractal Geometry: Enhancing Computational Thinking with MIT Scratch. *9th International Conference on Computing, Communication and Networking Technologies (ICCCNT)*, 1–6. https://doi.org/10.1109/ICCCNT.2018.8494172

Voogt, J., Fisser, P., Good, J., Mishra, P., & Yadav, A. (2015). Computational thinking in compulsory education: Towards an agenda for research and practice. *Education and Information Technologies*, *20*(4), 715–728. https://doi.org/10.1007/s10639-015-9412-6

Wassahua, S. (2016). Jurnal matematika dan pembelajarannya 2013. *Jurnal Matematika Dan Pembelajarannya*, *2*(1), 84–104.

Yang, K., Liu, X., & Chen, G. (2020). The Influence of Robots on Students' Computational Thinking: A Literature Review. *International Journal of Information and Education Technology*, *10*(8), 627–631. https://doi.org/10.18178/ijiet.2020.10.8.1435

Zahilah Mohamed Zaki, F., Wong, S. L., & Ridzwan Yaakub, M. (2019). A Review of Common Features inComputational Thinking Frameworks in K-12 Education. *IOP Conference Series: Materials Science and Engineering*, *551*(1), 012063. https://doi.org/10.1088/1757-899X/551/1/012063