

The Effectiveness Analysis of Computational Thinking Patterns and Levels of Students' Meta-Cognitive Awareness in Solving Learning Problems

¹Sudadi, ²Enos Lolang, ³Joko Ariawan, ⁴Iwan Henri Kusnadi, ⁵Misbahul Munir

¹Universitas Islam Negeri Sultan Aji Muhammad Idris Samarinda, Jl. H. A. M. Rifaddin, Harapan Baru, Kec. Loa Janan Ilir, Kota Samarinda, Kalimantan Timur

²Universitas Kristen Indonesia Toraja, Jl. Jenderal Sudirman No.9, Bombongan, Kec. Makale, Kabupaten Tana Toraja, Sulawesi Selatan

³Universitas Bina Sarana Informatika, Jl. Kamal Raya No.18, RT.6/RW.3, Cengkareng Tim., Kecamatan Cengkareng, Kota Jakarta Barat, Daerah Khusus Ibukota Jakarta

⁴Universitas Subang, Jl. Raden Ajeng Kartini No.KM. 3, desa nyimplung, Pasirkareumbi, Kec. Subang, Kabupaten Subang, Jawa Barat

⁵STAI Ma'had Aly Al-Hikam Malang, Jl. Cengger Ayam No.24, Tulusrejo, Kec. Lowokwaru, Kota Malang, Jawa Timur
upm.gkm_pasca@uinsi.ac.id

Abstract

The goal of this study is to characterize students' computational thinking skills in problem-solving in terms of their degree of metacognition awareness. The study is descriptive and qualitative in nature. The participants were selected using purposive sampling, comprising of two students with reflective metacognitive awareness, two students with strategic metacognitive awareness, two students with aware metacognitive awareness, and two students with tacit metacognitive awareness. The data was collected through written tests and interviews and analyzed based on the computational thinking indicators. The findings reveal that the computational thinking abilities of students who use metacognitive awareness in problem-solving are abstraction, pattern recognition, and decomposition. Furthermore, students with strategic metacognitive awareness exhibit proficiency in abstraction and pattern recognition. Additionally, students who use metacognition awareness through abstraction or decomposition exhibit computational thinking abilities when solving problems. However, students with tacit metacognitive awareness do not meet the computational thinking indicators while solving problems.

Keywords: Computational Thinking, Awareness, Students, Computational

Abstrak

Tujuan dari penelitian ini adalah untuk mengkarakterisasi keterampilan berpikir komputasi siswa dalam pemecahan masalah dalam kaitannya dengan tingkat kesadaran metakognisi mereka. Penelitian ini bersifat deskriptif dan kualitatif. Partisipan dipilih dengan menggunakan purposive sampling, terdiri dari dua siswa dengan kesadaran metakognitif reflektif, dua siswa dengan kesadaran metakognitif strategis, dua siswa dengan kesadaran metakognitif aware, dan dua siswa dengan kesadaran metakognitif tacit. Pengumpulan data dilakukan melalui tes tertulis dan wawancara serta dianalisis berdasarkan indikator berpikir komputasional. Temuan menunjukkan bahwa kemampuan berpikir komputasi siswa yang menggunakan kesadaran metakognitif dalam pemecahan masalah adalah abstraksi, pengenalan pola, dan dekomposisi. Selain itu, siswa dengan kesadaran metakognitif strategis menunjukkan kemahiran dalam abstraksi dan pengenalan pola. Selain itu, siswa yang menggunakan kesadaran metakognisi melalui abstraksi atau dekomposisi menunjukkan kemampuan berpikir komputasi saat memecahkan masalah. Namun, siswa dengan tacit metacognitive awareness tidak memenuhi indikator berpikir komputasi saat menyelesaikan masalah.

Kata Kunci: Berpikir Komputasi, Kesadaran, Siswa, Komputasi

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Corresponding author: Sudadi

Email Address: upm.gkm_pasca@uinsi.ac.id (Jl. H. A. M. Rifaddin, Harapan Baru, Kec. Loa Janan Ilir)

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INTRODUCTION

The fourth industrial revolution has largely dominated all spheres of human life, so skills are needed in using and making the most of technology. In response to this, the Indonesian government has taken strategic steps by compiling a roadmap for Making Indonesia 4.0, which is an effort to accelerate the national vision for Indonesia to be included in the list of the top 10 countries with the

strongest economies in the world in 2030. In order to meet the needs of 21st-century competences, the objective of Making Indonesia is to increase the quality of human resources through an overhaul of the educational curriculum that stresses STEAM (Science, Technology, Engineering, the Arts, and Mathematics) (Cahdriyana & Richardo, 2020). Computational thinking is one of the skills that students need to develop in order to be prepared to respond to the globalization of the twenty-first century. By outlining the fundamental ideas of computer science, computational thinking is defined as a set of procedures that encompass problem-solving, system design, and understanding human behavior. Consider computing as a problem-solving method that started in computer science and may be used to solve problems in all other academic fields. Therefore, computational thinking is also very appropriate to be developed in the field of mathematics to train students to think logically, efficiently, and effectively (Chairani, 2016). This is also supported by previous research, which shows that computational thinking skills also support students in solving math problems (Ramli et al., 2023).

According to the findings of the observations, some materials still pose challenges for children when it comes to solving math problems (Wing, 2006). It cannot be said that every piece of material presented provides understanding for all students. Usually, students tend to master certain materials but are weak in others, as well as other students. Furthermore, the significance of acquiring computational thinking abilities can provide solutions to the challenges of modern-day learning and can also serve as an incentive for research (Danoebroto & Listiani 2020). This investigation's findings can act as a guide for educators and other researchers in creating further studies, such as determining learning approaches or developing relevant learning materials. Computational thinking is undeniably intertwined with divergent thinking, innovativeness, resolving problems, conceptual thinking, repetition, collaboration, patterns, synthesis, and self-reflection (Hartarto, 2018). The students' capability for self-reflection is a crucial emotional factor that contributes to the process of resolving mathematical issues. The process of resolving problems is the cognitive process of a person in devising a plan or focused attempt to discover the correct solution to a predicament. Of course, a person needs to control and manage his thoughts well, utilize the knowledge he has, and reflect on his own thought process so that it can help him solve problems (Dianto et al., 2023).

Metacognition as awareness and the ability to regulate and control one's thinking processes. Students must think about their knowledge, realize their abilities, and have confidence in solving problems (Ningrum, 2021). With this awareness, students can assess and determine strategic steps in making decisions when solving problems (Kuzle, 2013). This is also in accordance with the statement of previous researchers that the more students know their thinking processes, the greater their awareness of their knowledge, and the better the learning process and achievements that might be achieved (Madaling et al., 2023). The teacher said that most students would answer that they understood when asked about their understanding of the material conveyed by the teacher (Maharani et al., 2019). However, when given questions, students experienced difficulty solving problems, as seen from the number of questions that were not answered without scribbles on the answer sheet.

Many factors influence this, but students' awareness of their knowledge also plays a very important role in solving problems.

METHOD

The research methodology employed in this investigation is qualitative research utilizing a descriptive methodology. The primary focus of this inquiry is computational thinking and its application in the resolution of mathematical problems, taking into account the degree of metacognitive consciousness demonstrated by students. The findings of this analysis consist of a written portrayal of the aptitude to apply computational thinking principles to the solution of mathematical problems, based on the students' level of metacognitive awareness. While the source of data or research subjects in this study were class students. This study used the triangulation method in obtaining data, namely combining data sourced from written test results in the form of descriptions, questionnaire data, and interviews. The utilization of computational reasoning in resolving numerical issues was derived from assessments and interviews, which were subsequently scrutinized based on the students' level of metacognitive consciousness. To authenticate the credibility of the data utilized, technical triangulation was employed, which involved checking the data's reliability from the same source utilizing different approaches, transferability, dependability, and confirmability testing. This research employs the Miles and Huberman data analysis technique, which encompasses data reduction, data presentation, and validation.

RESULT AND DISCUSSION

After analyzing the data, it is apparent that there exist variations in computational thinking skills that involve metacognitive levels such as reflective, strategic, aware, and tacit use while resolving issues. Individuals who possess a reflective level of metacognitive awareness satisfy three out of four criteria of computational thinking. Learners possess the capability to tackle problems that incorporate indicators of abstraction, pattern recognition, and decomposition. However, they are less able to solve problems that contain indicators of algorithmic thinking. Students with a level of metacognitive awareness of reflective use have the highest computational thinking ability among students with a level of metacognitive awareness of strategic use, aware use, and tacit use. The proficiency of students in computational thinking skills is evident from several indications. The data analysis results indicate that students who possess a level of metacognitive awareness characterized by reflective usage are capable of resolving problems that feature computational thinking markers. Furthermore, they can accurately and fully articulate the reasoning that underpins their thought process, albeit some may provide incomplete justifications. Students who possess a level of metacognitive awareness characterized by reflective usage are capable of extracting meaning or drawing conclusions from the information presented in the problem. Able to identify, recognize, and

develop patterns, relationships, or equations to understand the strategies used in solving problems. Able to break down information into smaller parts to make it easier to understand complex problems. Capable of recognizing the required information from the given problems. Proficient in providing justifications that bolster his opinions, displays self-motivation, consistently verifies and assesses his work outcomes, and exhibits confidence in his responses. This is in accordance with indicators of the level of metacognitive awareness of reflective use in previous research.

Pupils who possess a metacognitive standard of strategic implementation satisfy two out of the four computational thinking benchmarks. Students are able to solve problems that contain indicators of abstraction and pattern recognition. However, they are less able to solve problems that contain indicators of algorithmic thinking and decomposition. Students who possess a degree of metacognitive awareness regarding the strategic utilization of skills exhibit superior computational thinking abilities compared to those who possess a degree of metacognitive awareness regarding tacit utilization. This is evident from the various indicators of computational thinking skills that such students have mastered. According to the aforementioned data analysis, students who have a metacognitive level of strategic use awareness are capable of resolving problems that contain computational thinking indicators and can provide sound and comprehensive reasoning to support their thought process, albeit some may provide incomplete reasons. Additionally, students who possess a level of metacognitive awareness regarding strategic use can extract meaning or draw conclusions from the information presented in the problem. Able to identify, recognize, and develop patterns, relationships, or equations to understand the strategies used in solving problems. Capable of recognizing the information that is required and requested from the given problems. Capable of providing justifications that substantiate his ideas, possesses self-initiative, and consistently verifies and assesses his responses even when uncertain of their accuracy.

Students who possess a heightened level of metacognitive awareness satisfy one of the four criteria for computational thinking. These students are capable of resolving problems that comprise indications of abstraction, while some can tackle problems that feature indications of decomposition. Students who exhibit an awareness of their metacognitive processes possess superior computational thinking abilities compared to students who display a tacit level of metacognitive awareness, but inferior to those who possess reflective and strategic levels of metacognitive awareness. This is evidenced by the numerous computational thinking indicators that students master. The data analysis results indicate that students with a heightened level of metacognitive awareness can address problems that contain computational thinking indicators, and can accurately and comprehensively express the reasoning behind their thought processes, although some may present incomplete reasoning. Students with a heightened level of metacognitive awareness can derive meaning or conclusions from the information presented in the problem, and some can break down the information into smaller components to simplify complex problems. They can identify the information that is known and required from the problems presented. He is less able to give reasons that support his

thoughts, can motivate himself, experience confusion in understanding and solving problems, and does not always check and evaluate.

Students lacking a reflective level of metacognitive awareness do not exhibit the four key indicators of computational thinking. These students struggle with solving problems that involve abstraction, pattern recognition, algorithmic thinking, and decomposition. Compared to students who possess reflective, strategic, or aware levels of metacognitive awareness, those with only a tacit understanding of metacognition have the weakest computational thinking skills. This is apparent from the various computational thinking indicators that students have mastered. The data analysis results confirm that students with a tacit level of metacognitive awareness are unable to solve problems that require computational thinking skills and are unable to provide sound and thorough reasoning to support their thought processes. Additionally, these students struggle to derive meaning or draw conclusions from the information presented in the problem. Not able to identify, recognize, and develop patterns, relationships, or similarities to understand the strategies used in solving problems. Inability to understand and analyze problems in developing sequences for finding solutions and alternatives. Not being able to break down information into smaller parts to make it easier to understand complex problems. Identify information that is known and ask about problems that are given unclearly, are unable to give reasons to support their thoughts, or tend to solve problems at random. can motivate himself, experience confusion in understanding and solving problems, not be aware of the mistakes and concepts used, and not always check and evaluate.

CONCLUSION

The level of metacognitive awareness required for reflective use in solving problems is the best for students with other levels of metacognitive awareness because it fulfills three of the four indicators of computational thinking: being able to find meaning, identify, recognize, and develop patterns, relationships, or equations to understand the strategies used in solving problems. Metacognition of strategic use in solving problems fulfills two of the four indicators of computational thinking: being able to find meaning, identify, recognize, and develop patterns, relationships, or equations to understand strategy. Aware use of metacognition in solving mathematical problems fulfills one of the four indicators of computational thinking: being able to find meaning or conclusions from information and data. The extent of comprehension regarding the implicit utilization of metacognition in resolving mathematical quandaries is the least amongst pupils possessing different degrees of metacognitive awareness due to their inability to satisfy the four criteria of computational thinking.

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