Exploration of computational thinking skills: A case study of islamic senior high school students

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Abstract: This study aims to identify madrasah students' Computational Thinking (CT) skills on temperature and heat material. This research was conducted using a qualitative descriptive method using 5 CT-test essay questions to 53 grade XI IPA one of the Islamic Senior High School in Probolinggo. Data analysis techniques in research consist of 3 stages: data reduction, data presentation, and conclusions. Data analysis showed indicators of students' CT skills on a scale of 5 consisting of decomposition 3.90, recognition pattern 3.63, abstraction 2.83, and algorithm 2.37. Based on the study's results, it can be concluded that the CT skills of the Islamic Senior High School in Probolinggo at temperature and heat are included in the medium category. Several indicators of CT skills are still challenging for students, especially in developing algorithms and abstractions. Some students need help identifying the steps to solve complex problems in understanding abstraction concepts and algorithms. In this case, practice, intensive tutoring, and student collaboration can help improve students' skills to overcome these difficulties.

Keywords: exploration; Computational Thinking Skills; Islamic Senior High School Students

Introduction

Indonesia is entering the industrial era 4.0, where almost all aspects of life are connected to technology (Annisa et al., 2023). The connectivity includes aspects of transportation, economy, society, and politics, and one of the important is education. Education shapes students' superior thinking skills (Parno et al., 2020; Sukarelawan et al., 2021; Taggart et al., 2002; Wegerif, 2017). Thinking skills are an activity that leads to achieving specific goals (Critten et al., 2022; Etikamurni et al., 2020; Taggart et al., 2002). Therefore, thinking skills are needed to equip students to compete globally. So the skill to think plays a vital role in problem-solving and understanding information (Weintrop et al., 2016; Wing, 2006). Some are the skills to think logically, analytically, critically, creatively, synthetically, systematically, mathematically, reflectively, socially, and ethically.

One of the essential thinking skills at this time is Computational thinking (CT). CT skills are a thinking process that can be done in mathematical and other disciplines (Del Olmo-Muñoz et al., 2023; Weintrop et al., 2016; Wing, 2006). CT trains students in problem-solving in the digital age (George-Reyes, 2023; Palts & Pedaste, 2020). The changing times bring humans a vast amount of data (Chevalier et al., 2020; Yang et al., 2021). Therefore, CT skills are fundamental and increasingly needed today (Palts & Pedaste, 2020; Saidin et al., 2021; Weintrop et al., 2016). The rapid development of technology has made many countries realize the importance of CT in education (Delal & Oner, 2020; Lee & Malyn-Smith, 2020; Piedade et al., 2020; Saidin et al., 2021; Weintrop et al., 2016).

The CT process can aid students' understanding of many academic domains, such as math, science, and languages (Chevalier et al., 2020). CT is widely recognized as important, not only for those interested in computer science and mathematics but also for any student in the 21st century (Delal & Oner, 2020). According to Wing (2006), CT is a process that involves students in solving problems, designing systems, and understanding human behavior, by drawing on basic concepts of computer science. Meanwhile, according to Saidin et al. (2021), CT is one of the essential skills to solve problems posed in a technology-driven and complex society successfully. The CT skills of madrasah students to change problem patterns into simpler parts to make it easier to find solutions. Therefore, CT skills are essential for students. Supporting this statement, it is necessary to develop learning tools to support students' CT abilities (Aminah et al., 2022; Atqiya et al., 2021; Sulman et al., 2023).

There are several problems of madrasah students commonly encountered in the classroom, such as lack of experience in computing (Del Olmo-Muñoz et al., 2023; Saidin et al., 2021; Wegerif, 2017) and knowledge in mathematics and logic (Aminah et al., 2022; Fanchamps et al., 2021; Lee & Malyn-Smith, 2020). In addition, the CT skills possessed by students still need to be improved (Chevalier et al., 2020; Fanchamps et al., 2021; Gong et al., 2020). Some students have yet to be able to meet the abstraction indicators and algorithms on CT. One of the factors that affect the low CT skills of students is caused by essential competencies that have yet to be achieved. Of the many learning indicators, only a few are met. Therefore, it takes student-centred, collaborative learning, emphasizing problem-solving and integration with technology. In line with these characteristics, one of the physical materials that needs attention is temperature and heat. Temperature and heat materials are found in physics lessons for grade XI students. The material significantly contributes to solving problems across branches of science (Batlolona & Souisa, 2020; Mayub et al., 2020; Sukarelawan et al., 2021; Yeo et al., 2021).

This research aims to explore the CT skills of madrasah students. Several studies have revealed students' difficulties in mastering the topic of temperature and heat (Etikamurni et al., 2020; Parno et al., 2020; Priyadi et al., 2019; Sujito et al., 2018; Sukarelawan et al., 2021; Yeo et al., 2021). These difficulties are caused by several factors, including that students must activate concepts related to temperature and heat (Yang et al., 2021). In addition, students are also less skilled in operating mathematical equations and have difficulty analyzing physical quantities (Batlolona & Souisa, 2020; Mayub et al., 2020; Nurul Fazita et al., 2016; Ulus & Oner, 2020; Yang et al., 2021; Yeo et al., 2021). This causes students to have difficulty mastering concepts and solving temperature and heat problems, so students' interest in learning becomes stronger (Nurul Fazita et al., 2016). Given the importance of CT skills for students at this time, researchers conducted preliminary research to explore the CT skills of madrasah students. This is the initial stage of further research to ensure the proper intervention in using learning models or approaches in the classroom, where the intervention is adjusted to the study's material characteristics and support needs.

Method

This type of research is descriptive qualitative. The respondents involved in the study were 53 students of class XI IPA one of the Islamic Senior High School in Probolinggo. Subject selection using a purposive sampling technique. The data collection technique used in this study was a test. The instrument used is 5 CT test questions developed based on CT indicators, according to Weintrop. This test is an essay with four indicators of CT skills: decomposition, recognition patterns, abstraction, and algorithms (Weintrop et al., 2016).

This study aimed to see the CT skills of madrasah students in solving the essay test questions on temperature and heat material. CT skills data is obtained from the stages carried out by students in solving problems seen from CT skills indicators. From these data, they are grouped into several categories that represent the CT skills of the student. After collecting data, the study will continue with data analysis.

Data analysis techniques in research consist of 3 stages, namely 1) data reduction, 2) data presentation, and 3) conclusion drawing (Sugioyono, 2013). In data reduction, there is a process of sharpening, classifying information, sorting data, and coordinating data into meaningful. In addition,

this study presented data description of student skills results in the form of indicators related to the CT process owned by students. Furthermore, a concluding stage was completed by completing essay test questions in the form of CT skills categories of madrasah students. The research flow can be seen in Figure 1 below.
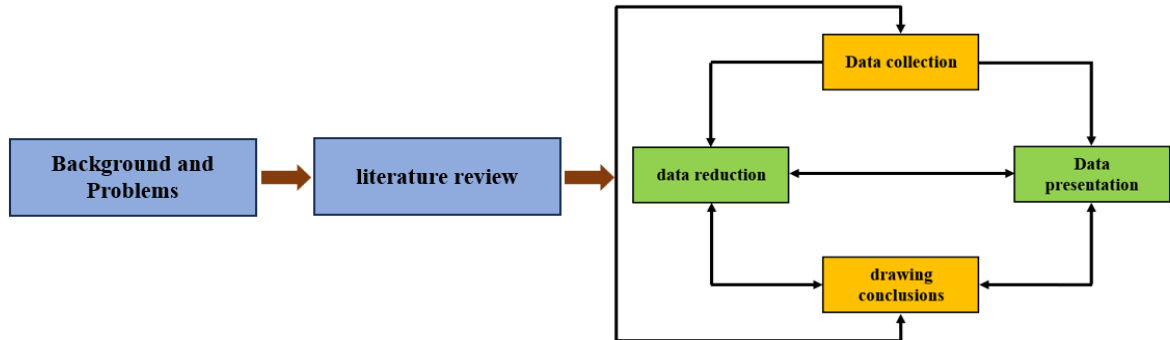

Figure 1. Descriptive qualitative research flow

Results and Discussion

Based on data from solving five essay questions on temperature and heat physics material. The average results of CT skills of madrasah students are obtained, which arise naturally as seen from the fullness of CT skills indicators. Madrasah students' CT skills data on the achieved CT skills indicators can be seen in Figure 2 below.
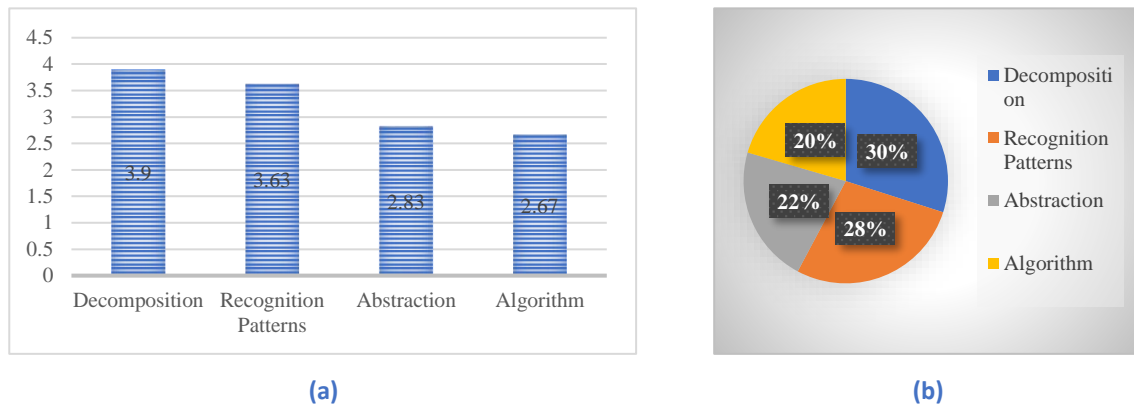

(a)   **(b)**

Figure 2. (a) Average CT Skills Results (b) Averages Percentage CT Skills of Madrasah Students

Figure 2 (a) and (b) show that the algorithm, with an average of 2.67 out of a scale of 5 or 20% of the total assessment, became a problematic problem-solving for all XI IPA one of the Islamic Senior High School in Probolinggo. Some need help explaining the types, properties, and heat transfer processes. In addition, this indicator also gives students the same difficulty in explaining the difference in conduction coefficients with symbols (heat counts) with solving steps. But the opposite is true in Figures 2. (a) and (b). It can be seen that decomposition is the most superior CT indicator among other types, with an average of 3.90 out of a scale of 5 or 30% of the total value. This is very likely to happen because students from the beginning have learned the first steps of how to classify the material of everyday life based on temperature and heat material.

The CT skills of temperature and heat material in Figure 2. (a) and (b) show the algorithm as the lowest indicator compared to other indicators. In the context of temperature and heat material, students apply algorithms to guide problem-solving steps such as calculating heat, explaining how and with what heat transfer occurs, and following the process. The low valuation is almost the same as obtained on the abstraction indicator. Studies conducted Kong & Lai (2022) and Weintrop et al. (2016)

emphasize the importance of applying decomposition, recognition patterns, abstractions, and algorithms in learning that benefit students in solving problems effectively just as abstraction assists students in identifying and focusing on critical elements in complex problems (Docktor & Heller, 2009). Thus increasing their understanding of the concept being studied. It also enhances students' skills in formulating systematic and structured solutions. However, this study found that algorithms and abstractions are weak indicators that cause many difficulties for students in testing applications to the physics of matter, temperature, and heat.

Students' skills in categorizing physics problems come from students' experiences and beliefs about solving physics problems. This is motivated by initial understanding, background knowledge, and study habits that affect students' skills to adopt and apply CT skills. The difficulties experienced by madrasah students align with the studies conducted Saxena et al. (2020) that in similar levels of problem-solving, K1 students show a similar pattern of skills to devise correct algorithms.

Thus, the difficulties experienced by some other students in carrying out algorithmic processes on temperature and heat matter can be considered as influenced by the factors mentioned above. In addition to problem-solving with computational methods, this study supports studies conducted by Su & Yang (2023). To overcome computational problems such as algorithm indicators and abstractions, students can develop their non-cognitive abilities, such as collaborating between students, structured discussions, conducting guidance, and multiplying practical experimental exercises independently or in groups.

The objective conditions of the students above show that some students find it easy to apply decomposition in understanding temperature and heat material. They can break down the problem into smaller steps and identify different aspects that need to be studied separately. This aligns with previous studies, such as those conducted by Zhang & Savard (2023), which show that the stages of decomposition in learning can increase students' understanding of physics concepts. However, some students need help at first in terms of recognition patterns. This suggests that pattern recognition in the context of temperature and heat requires more practice and experience.

This finding aligns with studies conducted by Weese & Feldhausen (2017), which emphasize the importance of intensive practice and guidance in recognizing patterns in learning. This means that learning approaches must offer active, interactive learning that allows students to actively break down problems into smaller steps (decomposition) and recognize patterns in various contexts. These findings support cognitive ideas by allowing students to process information, and discover and apply their ideas (Markandan et al., 2022).

Therefore, this study underscores that student on the importance of CT skills. CT skills allow students to learn to solve complex problems in smaller, organized steps. However, it is essential to note that not all students are maximally able to apply CT skills in learning. Students with difficulties need more intensive guidance and practice to solve problems with the CT process. Students must be allowed to see and identify patterns in experimental data or given situations in the context of temperature and heat material.

Conclusion

Based on the test results and data processing, it can be concluded that the average CT skills of 53 grade XI science students at MAN 2 Probolinggo on temperature and heat material are in the medium category. Several indicators of CT skills are still challenging for students, especially in developing algorithms and abstractions. Some students need help identifying the steps to solve complex problems in understanding abstraction concepts and algorithms. In this case, practice, intensive tutoring, and student collaboration can help improve students' skills to overcome these difficulties. Student assessment results show that it has yet to make students think creatively and critically. Most students get moderate grades, which show good comprehension but still minor flaws in reasoning or calculation. However, there are some limitations to this study. This study was conducted only on grade XI Science 3 and 4 students in the same school, so the generalization of the results is limited to that context. In addition, although many students have good CT skills, some still need higher

scores. Researchers suggest expanding the scope of the study to involve more schools and different grade levels.

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