Abstract Thinking Skills of High School Students in STEM Learning: Literature Review

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Abstract. Computational Thinking is a skill that must be possessed in STEM learning. The abstraction process is at the core of CT. Abstract thinking is built on ideas and ideas based on experience. From the literature studies that have been read, many have adopted robotics media in education but researchers have not found the use of robotics media in the field of biology at the high school education level. Therefore, a systematic literature review was conducted to find out the latest developments regarding the topics in this literature. Therefore, this study highlights 3 points of the application of robotics in high school education to hone students' abstract thinking skills. First, STEM can facilitate abstract thinking. Second, the role of robotics in education which is proven to increase student motivation. The third is the implementation of STEM learning in high school education. The search was limited to literature data-based publication outlets such as DOAJ, ERIC, Science Direct, and Google Scholar to maintain credibility. While previous research shows that students' abstract thinking skills tend to be lower when using conventional learning. So that we need an approach such as STEM which is useful for solving a problem by utilizing symbols and is more effective in exploring concepts.

1. Introduction

According to Henderson, et al. (2007) Computational Thinking is viewed as the core of all STEM science disciplines [1]. Computational Thinking skill levels can be evaluated using five constructs, namely abstraction, generalization, algorithms, modularity, and decomposition [2]. Romero, Lepage, & Lille (2017) are aligned with the Wing (2008) statement that considers the process of abstraction as the core of Computational Thinking. Abstract thoughts are built on ideas based on more experience and do not have to be based on physical experience itself [4]. In this case, Zehetmeier, et al. (2019) conducted a literature study on abstract thinking and found an indicator that can be used to evaluate abstract thinking or to be called as Abstract Thinking Framework. Therefore, the most important skill for every student regarding STEM or other learning is logical thinking and is now better known as computational thinking or CT [6].

Meanwhile, STEM learning can be implemented by utilizing robotics media [7]. Robotics itself has a role as a means of shaping students' understanding of engineering, developing interest in creativity, and focusing on choosing professional techniques and work specializations [8]. According to Laboy-Rush (2010) STEM integrated learning is learning that combines fields of science, namely science, technology, engineering or engineering, mathematics, or STEM with a minimum of two or more [9]. In this case, robotics can be put to good use in education. This is because robotics is used as problem-solving learning which can hone the scientific thinking skills of students [10]. Relevant to the research of Arlegui, et al. (2008) which states that programmable robot construction is an effective way to
improve student learning in science and technology [11]. This condition is supported by robotics design that requires creative ideas that facilitate the development of students [12]. But on the other hand, integrated STEM or science learning, more precisely biology subjects, is considered difficult [13]. In this case, high school students experience difficulty in learning concepts and topics in biology subjects; this has an impact on the acquisition of biology learning outcomes [14]. Therefore, through hands-on activities, we will gain direct experience that correlates with the lesson [15] along with understanding the material so that it is not easily forgotten. In this case, it is expected that biology subjects can be easily understood and understood by students so that they can change the mindset of students regarding biology subjects at the high school level.

In this research, a further literature review will be carried out regarding students' abstract thinking skills in STEM learning at the high school level using robotics, to be integrated into biology learning material and various other subject matter such as technology, engineering, and mathematics, besides that it can develop Abstract Thinking skills using Abstract Thinking Framework.

2. Methods
According to C. Okoli, K.S. (2010) research on this topic is based on the framework of review of Systematics [16]. The literature review was done on articles related to the topic, especially the articles containing the keywords that are abstract thinking, robotics, and high school. Article searching was done using these keywords and generates a total of 36 articles. The search was limited to literature data-based publication outlets such as DOAJ, ERIC, Science Direct, and Google Scholar to maintain credibility. The journal publication year is from 2001 to 2020.

In this case, a concept matrix is created which is useful for highlighting the insights extracted from a paper. There are three main points highlighted from the literature review: STEM learning facilitates abstract thinking, the robotics role in education, and the implementation of STEM learning in high school. These points will be discussed in more depth in the next section.

3. Discussion
3.1. STEM Learning facilitates abstract thinking
One of the key approaches to supporting STEM learning is to incorporate Computational Thinking elements into the topic of STEM [17]. STEM learning is not only an integrated science, technology, engineering, and mathematics but an interdisciplinary and application approach that combines the real world with problem-based learning [18]. The level of Computational Thinking skills can be evaluated using five contracts, namely abstraction, generalization, algorithm, modularity, and decomposition [2].

Abstract thinking has long been regarded as a core skill for many scientists [19]. Abstract thinking and abstraction is a fundamental concept in the field of computers as well as being the primary key when studying it [20]. Abstract thinking processes are included in 2 types of creative thinking, namely convergent thinking where individuals try to conclude and understand a relationship according to available information to get new results and divergent thinking, namely individuals produce something new but for which previous information is not available [21].

There is a relationship between the process of abstract thinking skills and scientific skills [22]. Not long ago, robot enthusiasts through STEM-based learning conducted assembly, programming, and test activities, as well as skills regarding CT [23]. In the study of Aristawati et al. (2018) also explained that the participants demonstrated the capability of CT abstraction and modularity by describing how the robot was compiled. STEM Integrated Learning is, therefore, able to facilitate one of the CT skills of abstract thinking. Thus, the combination of STEM with abstraction can solve a problem with the use of symbols and be more effective in exploring the concept [24]. In addition, students’ ability in abstract thinking tends to be low when using conventional learning [25]. Students who have high abstract thinking skills can quickly solve the understanding of programs that are considered difficult [26].
3.2. The role of robotics in education
In the educational world, robotics is usually limited only to the introduction of technology used by the robot [27]. Whereas robotics can be used to the maximum possible in education. Robotics education can make learners develop skills, creativity, and can increase student motivation [28]. With robotics, students are expected to create a technological product in the future and can understand the concept of theory in learning.

Robotics equipment that can be used for learning is a robot kit. The education robot kits usually contain sensors, LED, PIN, module, cable, switch, remote, Bluetooth [29]. The robot kit used in the research of Kim et al.(2011) is Lego Mindstorm NXT. For students, Lego Mindstorm allows them to design, program, and apply the level of robotics [31]. Lego robots adapt to the skills of the program for beginners and can increase the learning motivation of students [32].

3.3. Implementation of STEM Learning in high school
STEM has been widely applied in learning, this is demonstrated after the application of STEM can improve knowledge understanding, apply the knowledge that is useful to solve problems, and allow students to create products or something new [33]. STEM learning in high school with the Natural Science Program (IPA) must be prepared using various literature, it will be a benefit for the students who will take the next education that is university level, especially in the field of STEM [34].

During this time according to El-Deghaidy, Mansour, Alzaghibi & Alhammad (2017), some studies showed that usually teachers have the only experience in the subject matter but still lacking in STEM educational skills [35]. This resulted in the graduates being produced are less able to compete with foreign workers. A study suggests that science is not only about skill and knowledge but how learners are in appreciation and knowledge-excommunication [36]. With this, robotics is necessary, STEM learning using robotics in high school, especially natural science programs for teachers to use the latest curriculum is the teacher only as a facilitator so that the students will have a career in the STEM field.

4. Conclusion
The most important skill for any student regarding STEM or other learning is computational thinking or CT. Of the five CT skills, abstraction is at the core of CT because it is built on ideas or ideas based on experience. Various approaches have been made to determine the impact of CT learning. In this case, we use robotics media because it makes students develop skills, creativity, and can increase student motivation so that it can influence student development and feel more capable and confident in STEM skills. The application of STEM can increase the understanding of knowledge that is useful for solving problems. Therefore, robotics will be combined with STEM to be integrated into various other subject matters such as science, technology, engineering, and mathematics, besides being able to develop Abstract Thinking abilities using the Abstract Thinking Framework. So in this article, it describes the abstraction thinking ability of students using abstract thinking framework in STEM learning at the high school level using robotics modules. Future research is expected to address this topic in more detail.

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