The Influence of Educational Robotics to Abstraction Skill in High School

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Abstract. The skills that individuals need to face the 21st century is computational thinking or CT. Abstraction ability is an essential ability for students to have, but there is still little research on this ability, especially in Indonesia. If in a programming language, abstraction is the programmers action to focus on essential aspects to simplify and beautify the use of code. This article aims to determine the effect of robotics on the abstraction ability of students in secondary schools. The research results from the literature review show that robotics can improve student’s abstraction abilities. Besides, learning with robotics makes students more interested in the learning process. Educators have started to develop robotics to incorporate it into a variety of subjects. Integration of science, technology, engineering and mathematics disciplines or so-called STEM. It takes teachers who can pursue careers in the STEM field. Besides, STEM learning with robotics requires teachers to be able to explore various abilities, one of which is the abstraction ability of students. With this ability, students are expected to be able to simplify complex problems so that they are easier to solve. Future research is expected to discuss more on this topic.

1. Introduction

The skills that individuals need to face the 21st century is computational thinking or CT [1]. According to [2], CT is an approach to understanding human behavior, designing systems and solving problems by referring to the basic concepts of programming. If it is related to STEM education, then CT is a skill possessed by educators to identify, solve problems, and determine steps to get solutions in learning [3]. Research by [4] reveals that a recent focus on developing CT is as a key 21st century skill. [5] also argued the same thing, that the key skill of the 21st century is CT. [6] explained that CT has five components, namely: (1) problem decomposition, (2) pattern recognition, (3) abstraction (4) algorithm design for solutions, and (5) evaluation. Abstraction is a major element in CT [2]. According to [7], abstraction is a simplification of a complex problem by removing something that is not important to make it easier to solve the problem. If in a programming language, abstraction is the programmer’s action to focus on important aspects in order to simplify and beautify the use of code [8].

Abstraction is one of the abilities that is needed by individuals in science [9]. According to the concept of [10] abstraction ability will make someone able to decide something appropriately, think rationally, and have self-criticism. The ability to think abstractly is inseparable from knowledge of concepts because it requires the ability to describe or imagine something that is not always there physically. Someone will find it easier to understand abstract concepts if they have good abstract thinking skills [11].

STEM education has progressed in various countries [12]. In Indonesia, STEM education has been carried out, namely in 2013. The activity is in the form of teacher training to develop teacher perceptions about STEM education which is applied in science learning in secondary schools in the 2013 curriculum [13]. However, in Indonesia, STEM education has not received special attention, because in fact, many teachers in Indonesia do not know about STEM-based media [14]. STEM has been developed in science
learning which includes chemistry, physics, and biology in several schools and universities in Indonesia and abroad [15]. Learning with STEM will be better understood if students are active and do hands-on activity, especially if it is supported by a medium that attracts students attention, one of which is through robotics [16].

In recent decades, robotics in education has attracted teacher interest as a medium for developing cognitive and social skills for students from preschool to secondary school and for supporting learning in science, mathematics, technology, informatics and other school subjects [17]. Robotics can be used as a tool capable of providing opportunities for students to develop computational thinking skills [2]. Robotics in education helps create a fun and engaging learning environment, which attracts students and is actively involved in learning [18]. This is a project-based learning media, whereby students are required to complete the making of robots in groups, it is hoped that students will gain more knowledge about the subjects being studied [19].

2. Methods
The research that the authors conducted on this topic by reviewing the literature based on the systematic literature review framework [20]. This research explores the question; What is the role of abstraction in learning OOP, Why is abstraction associated with STEM, Why does STEM use robotics, by reviewing the literature based on systematic procedures. This study searches for answers to research questions by systematically reviewing the articles concerned by the keywords, namely Abstraction Skills, STEM Learning, Robotics in Education. The searches that the author did with these keywords resulted in a total of 34 articles, search especially articles indexed on ScienceDirect, Researchgate and Scopus were published between 2006 and 2020 to maintain the credibility of the articles. There are three main focuses of the literature review, namely the role of abstraction in object-oriented programming (OOP) learning, abstraction ability in STEM learning and the application of robotics in STEM learning. These three main focuses will be discussed in depth in the next section.

3. Discussion
3.1. The Role of Abstraction in Object-Oriented Programming (OOP) Learning
CT has five components, namely: (a) problem decomposition, (b) pattern recognition, (c) abstraction (d) algorithm design for solutions, and (e) evaluation [6]. Abstraction is a major element in CT [2]. Abstraction ability is an essential ability for students. However, there is still little research on this capability, especially in Indonesia [21]. According to [7] abstraction is a simplification of a complex problem by removing something that is not important to make it easier to solve the problem. If in a programming language, abstraction is the programmer's action to focus on essential aspects to simplify and beautify the use of code [8].

Abstraction is a basic concept in programming in general and object-oriented programming in particular [22]. While object-oriented programming (OOP) is a method of programming that is oriented towards separate objects [23]. Many students find it difficult to learn abstraction, even though abstraction is an essential component for studying computer science in general and programming in particular [24]. There are many advantages of using abstraction in programming, among others, it helps increase the security of a program because it only displays the interface, avoids code duplication, makes it easier for further application development, because the programmer can change the code without causing an error to the user [25]. Based on research conducted by [24] the students hone abstraction skills while creating complex and unprecedented programs. The students demonstrate software they have made well and programs that have an attractive interface. This is supported by research from [26] showing that there are indeed differences in applications when made using abstractions, it is also stated that the more complex the application is made, the longer it will be finished.
3.2. Abstraction Ability in STEM Learning

STEM stands for integration of science (S), technology (T), engineering (E) and math (M) [27], [28]. This approach can combine disciplinary empathy through integrated and active learning to solve problems. According to [29] STEM is an effort and approach to integrating four disciplines into one learning based on the relationship between subjects to solve a problem. Meanwhile, according to [30] STEM is defined as an approach to integrated learning between two or more subjects in schools. Based on several descriptions from previous researchers, it can be concluded that STEM is an approach to integrate interdisciplinary science, technology, engineering, and mathematics into one integrated learning to solve a problem. One of the keys to supporting STEM education is to incorporate CT [3]. Abstraction is a major element in CT [2]. If linked with STEM, then abstraction is a skill to solve problems with an emphasis on the use of concepts and symbols [10]. According to [31], unstructured problems make students associate abstract mathematical knowledge with their daily lives. Thus, they can abstract, generalize, and structural issues in everyday life. They learn to reread information, focus their thinking that leads to new understandings, and they think of alternatives to find the most appropriate solutions. Unstructured problems with these situations can be used to develop higher-order mathematical thinking skills of abstraction and reasoning. Abstraction is implemented as a process from concrete to abstract with a level of development [32].

3.3. Application of Robotics in STEM Learning

Robotics is very popular and has continued to increase staggeringly in recent years [33]. According to [33], Robotics is seen by many as offering new benefits in education at all levels. The robotics market in education is also growing. Research by the Japan Robotics Association (JPA), United Nations Economic Commission (UNEC), and the International Federation of Robotics (IFR) shows that the growing market for robots used for both entertainment and educational purposes has seen a tremendous increase and this trend can continue over the next few decades [33]. According to [18] robotics in education appears as a unique learning tool because it offers hands-on activities, learning becomes more fun, thereby attracting students' interest and curiosity in learning. A literature review has revealed that robotics in education is a growing field that significantly impacts science and technology education at all levels, from kindergarten to university [17]. According to [34], there are reports of improved STEM learning resulting from robotics projects in education, although most of the evidence is based on reports of teachers achieving positive results through individual student initiatives.

As stated by [18] robotics in education is a useful tool for project-based learning in which STEM, coding, computational thinking and engineering skills are all integrated into one project. Educators have started to develop robotics to include it in various subjects, such as mathematics, science, and engineering [35]. Robotics in education has opportunities not only in STEM but also many other disciplines. This allows students to find new ways to work together to foster collaboration skills, problem-solving and critical and innovative thinking [18]. In a study conducted by [36], conducting experiments using robotics, examining the effect of learning robotics on learning motivation and scientific skills of students in science and technology learning, it was found that robotics was able to significantly improve students' abstraction skills in science and technology learning.

4. Conclusion

This article aims to determine the effect of robotics on the abstraction ability of students in secondary schools. The research results from the literature review show that robotics can improve students' abstraction abilities. Also, learning with robotics makes students more interested in the learning process. Educators have started to develop robotics to incorporate it into a variety of subjects. Integration of science, technology, engineering and mathematics subjects or commonly referred to as STEM requires teachers who can pursue careers in that field. Also, STEM learning with robotics requires teachers to be able to explore various abilities, one of which is the abstraction ability of students. With this ability, students are expected to be able to simplify complex problems so that they are easier to solve. Future
research is expected to discuss further the effect of robotics on students' abstraction abilities in secondary schools.

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