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Abstract. Increasingly human interaction with technology and the increasingly complex development of digital technology world make the theme of computer science education interesting to study. Previous studies on Computer Literacy and Competency reveal that Indonesian teachers in general have fairly high computational skill, but their skill utilization are limited to some applications. This engenders limited and minimum computer-related learning for the students. On the other hand, computer science education is considered unrelated to real-world solutions. This paper attempts to address the utilization of NCLab-Karel in shaping the computational thinking in students. This computational thinking is believed to be able to making learn students about technology. Implementation of Karel utilization provides information that Karel is able to increase student interest in studying computational material, especially algorithm. Observations made during the learning process also indicate the growth and development of computing mindset in students.

1. Introduction

Nowadays life highly depends on technology. Technology has brought a sense of comfort as well as safety in every aspect of life. Michael Cox, chief economic analyst at the Federal Reserve Bank, predicts that one day the students will at least experience five types of jobs, and four of them have not discovered yet. In the context of education, prediction is interpreted as: "What should students learn in school so that they will be prepared to live an unpredictable future?". So far, the relevant answer is that the school should have ability to transform students as lifelong learners thus they are capable to adapt to changes in the environment. Students are not only capable to perform literacy but also to utilize the information obtained and to implement it in their personal environment to achieve success [1].

A decade ago, Wing popularizes the term of Computational Thinking (CT) as thinking ability emerging from computing field [2]. CT cannot be represented by other literacy abilities: reading, arithmetic, and writing [3]. It is no wonder to state that computational thinking potentially develops as the new literacy, which by mastering it significantly affects the success [4]. CT is an ability that is required by everyone due to its role in various disciplines as well as daily life [2].

Since the beginning, computer science education for K12 in Indonesia obstructed by its growing perception – Computer science exclusively focuses on programming, method to use internet properly and digital presentation [5]. The prior studies related to Computer Literacy and Competency denote that generally Indonesia teacher possess fairly high basic computational skill, however the utilization is confined merely to selected application [6]. This engenders limited and minimum computer-related learning for the students. Additionally, the computer science learning is considered as solitaire in which it is disconnected with its connection and relevance with daily problems solving [7].

The contrary situation between escalation of students' interaction with technology and digital technology development complexity; with limited quantity and quality of Information and Communication Technology (ICT) infrastructure along with society knowledge of ICT [8], causes Indonesian society eroded by the 'wave' of international community in welcoming MEA, particularly for the areas which require computational approach in its management. Responding to the issue, ideally the students should be taught the basic knowledge of computer science. In consequence, students will not merely play part as technology user but also take part in innovative computer utilization to improve the quality of life [9].

By eliminating ICT subject on the structure of the Indonesia's education curriculum, the activities of technology and computing learning are within the scope of ICT services and guidance. Its role emphasizes more on the activities for student preparation to be adequately competent to anticipate the rapid development of technology, thus students are capable to maximumly utilize ICT properly and correctly in accordance with their expertise. Furthermore, to actualize active learning atmosphere and process, the teachers are expected to apply various learning materials to develop students' potency to achieve education purposes. To manifest supported learning situation for students' potency in curriculum implementation, the learning process need to be accompanied by ICT utilization. This will assist in learning materials exploration, effectively and efficiently, by maximizing the role of ICT teachers and KKPI (Computer and Information Management Skill) teachers in school [10]. This condition brings advantages for school that are capable to manage its ICT resources optimally, because it provides very large discretion in teaching materials management system. On contrary, it also turns out as weakness due to the absence of national achievement target in cognitive, affective and psychomotor aspects among students, especially that are related technology mastery and utilization.

Computational thinking does not mean thinking as a computer does, instead of thinking about computation, in which the students are required to (a) formulate the problems in computation form and (b) arrange right computational solutions (in form of algorithm) or explain the absence of suitable solutions. Computational thinking is purposed for problem solving, which is not confined to specific computer science problems but also for variety of problems. From the perspective of present science context, for instance machine learning, it has transformed on how statistic science should be utilized - as well as its utilization in data mining (in the context of computation), which is usually performed to search the data in order to discover particular pattern.

There are abundant literatures discussing about how to develop CT skill for students, and some of them focus on modelling and simulation, robotics, and game design and development [11]. In modelling and simulation context, CT is associated with a particular simulation involving agent (as in scratch) to attract students interests toward learning objects [12]. From the perspective of constructivism theory, learning activities, which involves robotic (or known as educational robotic), is considered to help students develop their mental skills, to form more active students in constructing an assumption or hypothesis-testing and drawing conclusions [13]. In some studies, it frequently mentions that learning activities involving Educational Robotics provides a good impact on the development of high-level thinking skills (such as critical thinking skill, creative skill and problem-solving skill) and metacognitive [14]. Games involvement in intervening learning process is proved to improve students' enjoyment in learning [15]. Creation of a contextual learning experience with a problem-based learning approach is also considered as one of the things that can develop CT skills [16].

Actually, Karel is a simulated robot that developed by R. Pattis and used for learning basic programming for beginner [17]. Students only need to give instructions, in five basic commands: *move, turnLeft, turnOff, pickBeeper* and *putBeeper*, on Karel in order to complete each given mission [18]. As a learning tool, Karel succeeded in simplifying the programming material into a more easily understood set of logical entities [19], even Karel can be used in development of higher-order thinking skills [20].

Based on the problem description, this study conducts two research questions are as follows:
a. How does Karel utilization improve students' CT skills?
b. How does to evaluate the CT development of the students?

2. Methods

For the purposes of the study, Karel is applied as a medium to teach CT skills in the context of basic algorithm learning at the Junior High School level. Karel is a programming language developed by Richard E. Pattis to help students in understanding programming [21]. The Karel application can be downloaded at the url https://nclab.com/. This study was conducted in one of junior high schools in Bandung. The study involves 22 students (12 boys and 10 girls). Students worked in a small group of 3 people, each of whom will act as analyst, algorithm designer and programmer or debugger. This study was conducted in a duration of 2 lessons with each lesson contained about 90 minutes.

This study confines the measurement of CT Parameter, which involves:

- Pattern Recognition that is comprehended as the ability to see the similarities or even differences in patterns, trends and regularities in the data that further is used for predictions and data presentation.
- Abstraction that is defined as generalization and common principle identification process that generate such patterns, trends and regularities.
- Suggestions for abstraction skill development process are by: 1) Identifying the objects characteristics that are manipulated or imagined; 2) Identifying the characteristics of the object through direct observation; 3) Generalizing; And 4) Making connections between processes or concepts to form a new understanding.
- Algorithm Design which is an effort to develop the step-by-step troubleshooting instructions, thus others enable to implement the step / information to solve the similar problem.

Algorithm learning scenario, which uses Karel, is divided into several stages: firstly, the students are teamed up into groups of 3 people. Each member of the group possesses the role of analyst, algorithm designer and programmer or debugger alternately in several class activities. Secondly, the teachers provide a student activity sheet that serves as an investigative guide to solve the problem. In this sheet, the CT-related components are emphasized therefore the students can possess the skills in managing and utilizing CT to solve their daily problems. Thirdly, the teachers request the students to discuss and collaborate in solving cases given in the student activity sheet. During the discussion process, the teachers take part as facilitator who direct the students through the referring questions so that the students can meet their need for CT attainment.

In its learning class implementation, Karel is presented in two scenarios, namely unplugged scenario and learn code. Unplugged scenario is a scenario designed to purposely develop students' reasoning skill for solving the given problem. Figure 1 is one exhibit of the case provided in the unplugged scenario. Meanwhile, the learning code scenario is a learning scenario in which students are asked to test their analysis and reasoning in solving problems by using Karel.

In the beginning of learning process, Karel's ways of workings and environmental activities are introduced to the students. Subsequently, the pretest is performed to map the students' basic skills within the scope of the algorithm. In the first session, the worksheet is shared to the students for the introduction of Karel and the concept of the algorithm. The essence of each worksheet is to construct the basic understanding and assimilation of CT skills that are part of achieving students' CT skills. The next session, the higher level of case complexity is presented in the student activity sheet. In this learning, each student undertakes five student activity sheets.

This study employs quantitative approach for data collection. Some of the instruments used to support the success of the learning design are as follows:

- Student activity observation sheets, which is used to record student activities throughout the learning process. The instrument is a form filled with some notes of student activities\
- Individual pretest (url https://nclab.com/pretest/), which is given before the learning is started and used to determine the basic skill of students especially the ability of computational thinking
- Individual post-test (url https://nclab.com/posttest/), which is enclosed after the learning process is completed and used to determine changes in students' skills related to computational thinking
- Structured interview form, which is used to delve the impact of learning algorithms using Karel on the overall learning process

Those instruments are utilized to measure students' concept mastery and interest towards CT materials and skill.

Figure 1. Karel Unplugged Case

3. Result and Discussion

The Descriptive statistics are given in Tabel 1. Table 1 shows a change in the student's CT skill level of 0.61 based on a normalized gain calculation referring to the calculations recommended by Hake [22]. This result is categorized as medium category, which means the impact of Karel involvement in the material Algorithm to the improved mastery of material content is quite good. Table 2 presents information about changes in mastery of algorithm material based on student activity sheets for each CT component. In general, most students discover the difficulties in adapting to changing teaching patterns so that it is plausible that the beginning results of the student activity sheet are in an unsatisfactory level. However, the increase shown by students from their learning activities from one to another produces optimistic perception that Karel has an opportunity to support students in achieving goals of CT mastery.

Table 1. Normalized Gain

	Pretest	Post-test	Normalized Gain
Mean ($\bar{X}$)	48.94	81.06	0.61
Standard Deviation (SD)	15.34	8.32	0.18

Note: Maximum value = 100

Table 2. Data Summary

Computational Thinking Skill	Activity Sheet 1	Activity Sheet 2	Activity Sheet 3	Activity Sheet 4	Activity Sheet 5
Design Algorithm	$\bar{X} = 52.41$; $SD = 7.27$	$\bar{X} = 60,95$; $SD = 6.51$	$\bar{X} = 64.73$; $SD = 6.25$	$\bar{X} = 69.91$; $SD = 5.82$	$\bar{X} = 83.91$; $SD = 6.28$
Abstraction	$\bar{X} = 54.95$; $SD = 7.12$	$\bar{X} = 60.05$; $SD = 6.49$	$\bar{X} = 65.59$; $SD = 6.17$	$\bar{X} = 69.23$; $SD = 6.16$	$\bar{X} = 84.05$; $SD = 5.62$
Pattern Recognition	$\bar{X} = 53.27$; $SD = 5.73$	$\bar{X} = 58,32$; $SD = 5.92$	$\bar{X} = 66.64$; $SD = 5.44$	$\bar{X} = 72.27$; $SD = 6.27$	$\bar{X} = 85.18$; $SD = 6.62$

Table 3. Two-Way Anova Without Replication

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	2296.364	65	35.32867	0.88402	0.021916	1.358318
Columns	36224.65	4	9056.164	226.6101	1.83E-83	2.406362
Error	10390.55	260	30.96364			
Total	48911.56	329				

Referring to Table 3, it can be explained that P value of rows (Activity Sheet) is 0.0219 <0.05. It indicates significant difference in the students' CT skill based on the student activity sheet. Meanwhile, the P value of column (CT skill) is 0.00 <0,05 which signifies that the development of CT skill based on its relative component has significant difference. A relatively smaller MS Error score when compared to MS Row or MS Column indicates the absence of interaction between the results of the student activity sheet assessment with the CT forming component

The interview, which is conducted on several students, explain that changes in the value acquisition from the activity sheet are the result of learning habituation which further affects the students' mindset in solving the problem. In the process of interviewing about Karel's role in learning, some students state: 'Karel helps me in simplifying the problem'; 'Karel makes learning algorithms easier to understand'. Even, some students claim that learning is not perceived as much as learning in general, but rather like playing and it is very exciting.

4. Conclusion
The study shows that teachers' role and creativity are required to formulate the proper materials into variety teaching materials to ease the learning process for students. Karel involvement encourages the increase in students' interest to learn algorithm. The observation during the learning process indicates the improvement and development of students' CT skill, especially related to pattern recognition components. Some students assume that similar learning pattern is applicable to be used in other subjects to certainly create good impact. So, it can be said that the implementation of Karel utilization provides information that Karel is able to increase student interest in studying computational material, especially algorithm.

The further study focusing on CT theme will be directed more on discussing independent computational teaching materials and learning media development in accordance with the Indonesia curriculum structure. TPACK framework involvement is also interesting aspect to be involved in the future study, especially within the analysis process and learning design.

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