Bajo’s Adventure: An effort to develop students computational thinking skills through mobile application

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Abstract. The thought of the need for ownership and developing computational thinking skills emerged in the last few decades. This raises a number of other interesting derivative ideas, including how to teach and train computational thinking skills in students. This study aims to develop a game-based mobile application that can be used as a means to train computational thinking skills. In addition, this study also aims to identify the relationship between learning experiences that students get through the mobile application with some basic abilities in computational thinking, especially in terms of generalizing and algorithmic abilities. The data shows that the ability to think student computing can be formed and even improved in a relatively short period of time through media that is discerning to teach and train computational thinking skills. Nevertheless, the teacher's role is still needed that is pedagogically able to facilitate the students deadlock in connecting what students have gained through the media with the concepts they want to teach.

1. Introduction
The thought of the need for ownership and developing computational thinking skills emerged in the last few decades. This is inseparable from the development of the computing world which is increasingly penetrating into various segments of society and professions [1]. This condition raises a number of other interesting derivative ideas, including how to teach and train computational thinking skills in students. An assumption emerged that by teaching computer science from an early age, it would help prepare today's generation to enter many career fields, both inside and outside the computer [1].

Computational Thinking can be understood as a basic skill that is more directed at how humans think and act in solving a problem [2]. Computational Thinking is not synonymous with thinking like a computer, but thinking about the computational process in which a person is required to be able to formulate problems and compile a good solution in a computational approach or explain why no suitable solution is found [3]. This forms a new perception that these basic skills are different and cannot be represented by other basic skills such as reading, writing and arithmetic [4].

In general, Computational Thinking is divided into four mutually continuous parts, namely Decomposition, Abstraction, Algorithm, and Pattern Recognition. Decomposition in the scope of computer science means solving complex systems or problems into small parts that are easier to manage and understand [5]. The part of the problem that has been split into small parts will be easier to solve or design solutions individually. Problems will tend to be more difficult to solve if the problem is not decomposed or described first. By outlining the problem, we may be able to find the same pattern from
each small part of the problem, and can find a more effective solution to solving these problems [6]. If in decomposition the problem is divided into several small parts to get details of the problem, then in the process of abstraction the problem will be looked at in general, and the details are ignored [5]. The purpose of the abstraction itself is actually to find a problem solver that can be used to solve other problems. Algorithm is a series of instructions or plans that are carried out in stages to solve a problem. In its use, each instruction is usually identified and sorted in such a way as to produce a more structured and planned solution. Algorithms are a bridge to understanding the performance of a computer so that it can work according to what we want. Although the term algorithm is more often used in computer science, the use of algorithms in solving problems can also be used in various other problem areas outside the field of computer science [7]. Pattern recognition is a process of finding similarities or patterns between problems that are being faced simultaneously [6]. The aim is that more complex problems can be solved more efficiently. Finding patterns in every problem that is being faced is important. This facilitates the task at hand.

The rapid progress of information and communication technology (ICT), as well as the widespread development of global information infrastructure, has changed the pattern and manner of human activities. Our students grow in a world filled with various technological conveniences. As a result, they not only become proficient as users of technological devices, but technology and technology-based learning environments also have the opportunity to expand students’ knowledge outside of conventional classrooms.

Digital media and technology are revolutionizing the way, place and when our children learn. By developing transformative innovations in the field of education and learning, digital media has improved learning service standards and forced many educators to completely rearrange the learning scenarios they use [8]. Mobile application-based learning technology can make students more confident and focused in a longer time [9]. In addition, mobile application-based learning can also be used to encourage learning experiences independently and collaboratively [10].

This study aims to develop a game-based mobile application (called Bajo’s Adventure) which can be used as a means to train computational thinking skills. In addition, this study also aims to identify the relationship between learning experiences that students get through the mobile application with some basic abilities in computational thinking, especially in terms of generalizing and algorithmic abilities.

2. Methods
This research is a development research. This is related to the purpose of the research in the form of the development of learning media products that can improve students’ skills, especially those related to the ability of Computational Thinking. Achievement of Computational Thinking skills is captured through pretest-posttest, questionnaire and interview. The study was conducted on students of one of the junior high schools in the city of Bandung, especially those at level 8.

Figure 1. Bajo’s Adventure Interface.
Bajo’s Adventure is developed using a fixed pattern at each level. In general, the application interface is presented by Figure 1. The interface in Figure 1 (a) will appear when the software is first run. In this interface, there are three menu options. Namely Play, About, and Settings. The Play menu will direct the user to the world selection menu. The About menu will pop-up info about the application. Figure 1 (b) is a display if the player chooses the Play menu on the start page of the game. This display will provide 4 menu options, namely Algorithm, Decomposition, Abstraction, and Pattern Recognition. Each menu will have 5 different game levels and game variations. The interface displays as shown in Figure 1 (c) is the display when the player has selected one of the four menus provided on the World Selection Page. The completed level will be marked with an asterisk, the level that is open and can be played will be marked with an open padlock image blue bajo, while the level that is still locked and cannot be played will have a locked padlock symbol with a bajo gray accent as background. Figure 1 (d) presents the game board where the board is an area that players can explore. The board consists of a collection of plots with a shape of 5x5. A gray plot is a path or path that can be traversed by a player, while a plot with a stone or an empty plot indicates that the plot cannot be passed by the player. Red plots indicate the final goal of the game. The player must move the ship using the command button presented by Figure 2.

![Game Board](image)

**Figure 2.** Bajo’s Adventure Guide.

Testing the reliability of Bajo’s Adventure is done using AppCrawler by Bitbar. The details of the virtual device that runs the learning software that has been created are presented in Table 1.

Figure 3 presents the results of Bajo’s reliability testing using a virtual device. The development of mobile applications must pay attention to efficiency in terms of resource use, this is because mobile applications are very sensitive to delay. One factor that can cause delay is the process of executing commands carried out in the programming language used in the application. Programming languages
can affect the use of the CPU (Central Processing Unit) and memory on the server. Therefore, it is necessary to analyze service performance to determine the differences in CPU usage (Central Processing Unit), memory, and execution speed of the programming language used. Based on Figure 3, it can be seen that CPU usage of software has an average usage of 33.9% with an average memory usage of 150MB. This shows that there is no error or warning message caused by the software. In general, learning software that is made can run stably and function without any error messages or warning messages.

Table 1. Virtual Hardware Specifications.

| Unit Name   | Google Nexus 5          |
|-------------|-------------------------|
| Manufacture | LG                      |
| Android Version | 6.0.1 (Marshmallow)   |
| Chipset     | Qualcomm MSM8974 Snapdragon 800 |
| CPU         | Quad-core 2.3 GHz Krait 400 |
| RAM         | 2 GB                    |
| GPU         | Adreno 330              |

![Performance](image)

Figure 3. CPU and memory usage performance on virtual hardware.

3. Results and Discussion

Bajo’s Adventure is tested for students who have not studied Basic Programming material. The implementation of the media and testing its effectiveness are carried out by using the scenario of division of 3 groups, namely the upper middle and lower groups. The upper group is a group of students whose initial value (taken from the raw value for the previous material) is more than the mean value + the standard deviation. While the lower group is a student whose value is less than the mean value - the standard deviation. Which do not belong to the upper and lower groups, fall into the middle group category.
In Table 2, it can be seen that the gain obtained by the top group gets the highest value of 0.75 (high), comparable to the magnitude of the response given by upper class students to all aspects of Bajo’s Adventure's multimedia assessment, with an average percentage of each the aspect is 96%. This proves that Bajo’s Adventure is very effective in increasing students' understanding of the upper group. Not much different from the upper group, students in the middle group got a gain of 0.67 (medium) with an average percentage of each aspect of Bajo’s Adventure of 94.8%. The biggest difference is shown by students in the lower class, which is equal to 0.52 (medium). However, the responses given by students to Bajo’s Adventure are high, even the highest among other groups of students. This shows that the lower group students are quite easy to adapt to Bajo’s Adventure. It's just that it may take longer to be more adaptable to the learning media.

| Group  | Gain Score | Mechanical | Multimedia Element | Information Structure | Documentation | Quality of Content |
|--------|------------|------------|--------------------|----------------------|--------------|--------------------|
| Upper  | 0.75       | 0.8        | 1                  | 1                    | 1            | 1                  |
| Middle | 0.67       | 0.87       | 0.9                | 1                    | 0.97         | 1                  |
| Lower  | 0.52       | 0.92       | 1                  | 1                    | 1            | 1                  |

The researcher interviewed 20 people to find out the constraints, as well as criticisms and suggestions for the application developed. Based on the results of the interview, it was found that there were technical obstacles in the form of installations which were mostly caused by mobile devices owned by students that did not support the minimum specifications required by the application, around 35%. The rest is more limited to the memory capacity of mobile devices.

In the upper group, 5 out of 6 students who had very good gains were above 0.7 for their understanding of basic programming materials. One student who has a gain value of 0, which means that the student has not experienced an increase. After reviewing, it turns out that the student already has a pretty good score on the test questions both the pre-test and the post-test given is 88.89. In the middle group, there is an increase and decrease in the gain value which is more diverse. One of the students who did not experience increased ability, gave a value of 50 on multimedia elements. When interviewed, the respondent stated that he only tried learning multimedia twice, and only about 10 minutes in his session. Students assume that the multimedia provided is less attractive. Other students who did not experience improvement gave perfect value to the multimedia created by researchers. After the interview, the student only played the game to level 10. Because the material on Pattern Recognition was at level 16 to level 20, the researcher suspected that the student did not experience an increase because he had not played the game to the level needed to learn about Pattern Recognition. In the lower group, students have a pretty good gain value. Some students having technical problems related to multimedia, mostly because of a bug during the installation process due to the adjustment application with the operating system used on mobile devices. However, that does not prevent students from gaining learning experiences using Bajo’s Adventure.

The response given by students to Bajo’s Adventure is very good, the enthusiasm of students in playing this educational game is quite high, this can be proven from the results of the questionnaire responses of students regarding the use of Bajo’s Adventure as a learning aid. In general, students provide feedback about the application of Bajo’s Adventure for learning logic and this interesting computer algorithm, the content is easy to understand, fun and teaches in the pattern of game-based learning. In terms of the effect of applying Bajo’s Adventure on increasing understanding, 72% of students think that Bajo’s Adventure is very helpful in increasing understanding. The things that according to students provide a significant influence in improving student understanding is the presentation of material in an easy-to-understand educational game, illustrations that are displayed at each level, plot, mission, and display of Bajo’s Adventure. Some of the other influences that students
get after the implementation of Bajo’s Adventure are that they can better understand computer learning algorithms.

4. Conclusion
In general, learning multimedia can improve the ability of Computational Thinking well. As for students who do not experience improvement in Computational Thinking skills, they still assume that the learning multimedia made by researchers is good enough. Computational Thinking ability enhancement is influenced by the use of language in multimedia, and the intensity of players in using multimedia learning. There needs to be supervision or control from the teacher as a teacher when using this multimedia learning, considering that multimedia learning made by researchers only supports the main learning activities, not replacing them. Further development is needed so that multimedia learning can function in various devices to improve accessibility of users who do not use the Android platform.

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