Research Article

Implementation of an Online Programming Software to Explore the Computational Thinking Ability of Biological Education Students

Sri Maryanti[1]*, Ade Yeti Nuryantini[2], Pina Pitriana[2], and Dede Trie Kurniawan[3]

[1]Biology Education, Faculty of Tarbiyah and Teacher Training, Bandung State Islamic University, Indonesia
[2]Physics Education, Faculty of Tarbiyah and Teacher Training, Bandung State Islamic University, Indonesia
[3]PGSD, Indonesian Education University Campus in Cibiru, Indonesia

ORCID
Sri Maryanti: https://orcid.org/0000-0003-2577-1189
Ade Yeti Nuryantini: https://orcid.org/0000-0001-6382-7249
Pina Pitriana: https://orcid.org/0000-0001-6436-6309
Dede Trie Kurniawan: https://orcid.org/0000-0001-9628-0673

Corresponding Author: Sri Maryanti; email: sri.maryanti@uinsgd.ac.id

Published: 3 April 2024

Publishing services provided by Knowledge E

Selection and Peer-review under the responsibility of the ICMScE Conference Committee.

Abstract.

This study aimed to explore the Computational Thinking (CT) ability of biology education students in artificial intelligence courses through code.org programming, an online programming software. Students were required to solve problems systematically and design systems with coding for beginners. The research method used a qualitative approach because it was based on observational data from computational media produced in accordance with artificial intelligence learning for education and based on CT indicators. The subjects of this study were 73 students of the Biology Education Study Program in 2021. How students responded to using the code.org platform was captured through a questionnaire distributed via a Google form. The results showed that students could follow each stage of educational game projects through the code.org platform to practice computational thinking skills in accordance with the success of the stages of doing simple projects through good, systematic and problem-solving coding. Student responses to the code.org platform as an online program tool that can hone computational thinking can provide creativity and enthusiasm for student learning. As evidenced by the questionnaire results, 63.3% of students strongly agree that this increases creativity.

Keywords: online programming, computational thinking, biological education, students

1. INTRODUCTION

Entering the 4.0 revolution era, one of the efforts in the development of education is to use ICT as a learning tool (ICT for learning). ICT is no longer a taboo or hard-to-reach thing that must be learned. The challenge of the 21st century is that it is no longer learning to use ICT but is already in the phase of using ICT for the learning process.

Computational Thinking (CT) abilities of biology education students need to be honed in accordance with the challenges of 21st century learning, requiring both teachers and prospective teacher students to be able to present ICT in learning [1]. This is clearly implied in the 2013 curriculum utilizing ICT for the learning process by integrating it with all subjects. Presenting cyber-physical. artificial intelligence courses biology education students are equipped with skills related to programming, although not as skilled as computer engineering students, with the proximity of the real world and the digital world.

The Indonesian education system also needs to form the readiness of the Indonesian people from an early age. To prepare for it, students must have a correct understanding of the principles and applications of Informatics. Informatics here focuses on Computational Thinking (CT), with this CT ability students can utilize/design computer systems well and are able to formulate problems to understand issues rationally so that they can provide problem solutions (problem solving) and can combine when they are going to jump. to the field as a solutive and innovative teacher. . In this course, there is study material on computational thinking (CT). Digital technology plays an important role in the digital era, and has become an integrated part of the world of education, thus changing the way students learn [2]. From this it strengthens teachers and/or prospective biology teachers must have competence in the field of CT. CT education needs to be provided in an attractive, fun and enjoyable form so that making teaching materials or integrating them into learning is not difficult. Learn CT through code.org programming as an online programming software.

Artificial Intelligence for biology education courses contains various artificial intelligence-based learning problems. Computational thinking is a way of thinking to solve problems (problem solving) by breaking it down into several stages that are effective, efficient, and comprehensive, including: decomposition, pattern recognition, abstraction, algorithms which are some of the basic concepts of computer science. Wing [3] argues that computational thinking involves problem solving, system design, understanding human behavior by reflecting on basic computer science concepts. In applying CT through programming, media designed by biology education students are needed through code.org assisted programming. where during the process of making media students are required to solve problems systematically and design systems. This process will be carried out when a biology education student becomes a biology teacher. Online coding 'code.org' which helps beginners have an easy programming experience based on the characteristics of the website, and proposes suitable teaching methods [4]. Students learn coding early for beginners because the

survey results show almost 75% of prospective biology teacher students from the class of 2021 have not learned about coding. In this context, it becomes necessary to mention an essential competence for the 21st century: computational thinking [5]. Through code.org students are trained to hone their coding skills. Coding is a way of developing creative activities with children. Still, it also allows them to gain a broader view of computer uses, creatively solving real-world problems, by focusing primarily on design, planning, and implementation of a particular project [6]. The platform code.org maintains a very broad set of educative resources and tools that can be executed in almost all platforms, including smartphones and tablets which makes it very flexible and easy to use. Its vision is that every student in every school should have the opportunity to learn computer science, just like biology, chemistry or algebra [7]. In this paper, we will reveal how to achieve computational thinking for prospective biology teacher students to achieve abstraction, generalization, decomposition, algorithms and debugging skills from products produced by prospective biology teacher students in the code.org application.

2. RESEARCH METHOD

The research method used in this study is descriptive with a qualitative approach because it is based on observational data from computational media produced in accordance with artificial intelligence learning for education and based on CT indicators. Descriptive research focuses on solving actual problems as they were at the time the research was carried out [8]. The subject of this research involves students of the Biology Education Study Program semester 2 in 2021 with descriptive data analysis techniques. In this case the researcher tries to describe or describe all the events and events that are the center of his attention so that there is no need for a hypothesis in it. Does not require treatment or manipulation of variables, because the symptoms and events already exist and the researchers just need to describe them according to the reports of direct and indirect observations with conclusions that are not detailed, in line with Sugiyono's statement 2005 Descriptive method is a research method used to describe or analyze a research result, but it is not used to make broader conclusions [9]. The variables studied can be single, or more than one variable, and can even describe the relationship between several variables. Figure 1 briefly describes the method steps carried out.

The formulation of the problem in this study reveals how the process of using the code.org platform by students to train computational thinking and how students respond

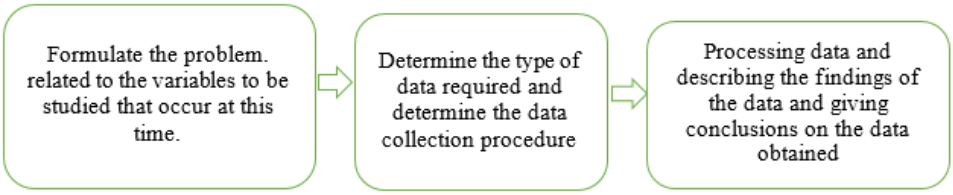

Figure 1: The research flow process carried out.

to the use of the code.org. Platform that has been collected through questionnaires distributed using Google form.

The ability of CT is revealed with a product assessment rubric from a biology learning application development project using code.org. The data collection techniques used was questionnaires and tests as primary data, while secondary data were obtained through observation and documentation. This questionnaire contains indicators of computational thinking, while the test concerns test questions and how the sample can solve the available problems. The following is a table of data collection techniques:

TABLE 1: Data collection technique.

No	Collection Techniques	Instrument	Results
1	Questionnaire	Questionnaire Grid	Questionnaire Result Data
2	Code.org Product Ratings	Code.org Product Rubric	Score And Grade
3	Observation	Observations on the Game made	Observation data
4	Documentation	Documentation List	Photo Documents

3. RESULTS AND DISCUSSION

The Process of Using the Code.org Platform as an Implementation of Online Programming Software to Explore the Computational Thinking Ability of Biological Education Students

The first step is to enter the code.org platform which will then proceed to the next step to enter the platform. Access to the platform has been built to respond to almost any existing combination today. Students can start testing the platform without creating an account. More traditionally, students can use an account created on the platform. Additionally, they can also use a pre-existing account from other platforms, such as Google, Facebook, and Microsoft, as can be seen in Figure 2.

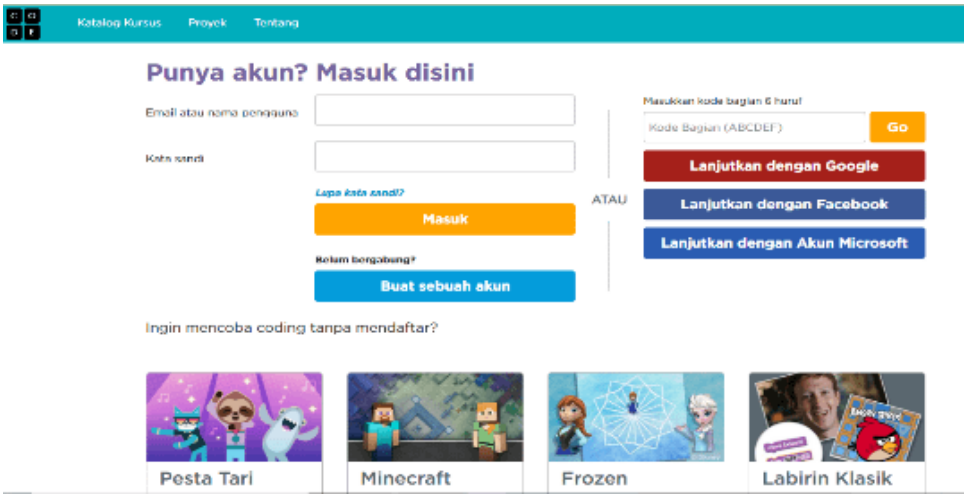

Figure 2: The various login possibilities on the code.org platform.

The following is the result of one of the biology education students which can be seen in detail on the link page : https://www.youtube.com/watch?v=XRRlq9ISZ2Q&t=2s

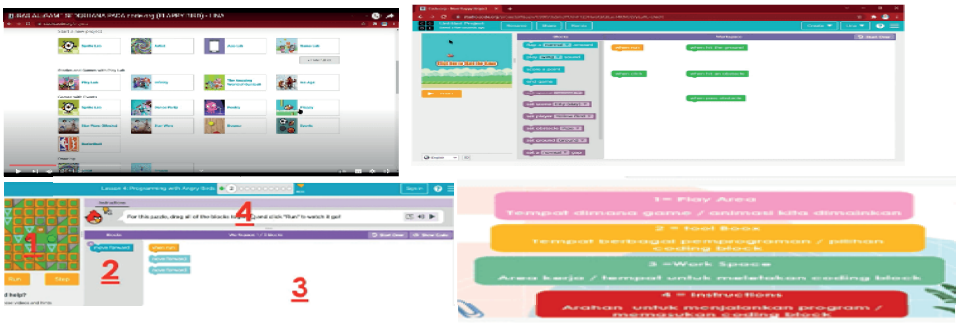

Figure 3: The first step of coding through code.org.

Figure 4 is the coding section which is the activity of assembling, compiling and communicating the code line of a programming language that will be used from language understood by humans to machine language understood by computers. This line of code will be executed by the computer to run something according to the purpose for which it was created. Additionally, the fact that the platform is built as a web application that runs entirely in a browser environment means there is no need to pre-install or configure the devices where the students will work. The whole process of learning and development of computational thinking is done through a graphical environment in which students build their algorithms Developing Computational Thinking in Early Ages: A Review of the code.org. Platform by dragging and dropping instruction blocks to solve each of the challenges (Figure 4). While performing a coding task, students are given the maximum number of blocks that should be used to find the optimal solution in each of the problems. If a student can solve a particular problem using the optimal

solution, the problem number will be filled in green, on their progress overview. If they do solve it but not with the optimal solution, the problem number is filled with a light green color, as seen in Figure 4, so that the student can return to that program at a later time and find the optimal solution. Not at once coding has to be completed.

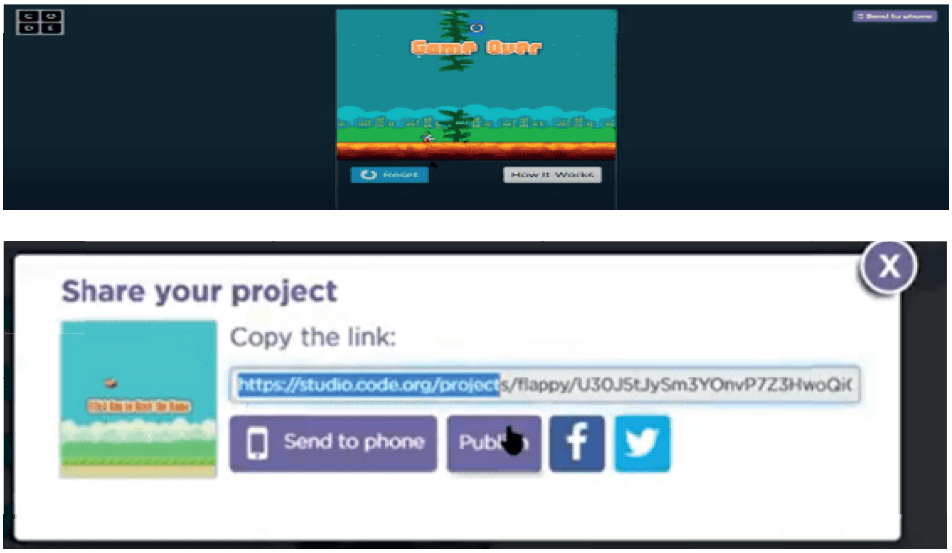

Figure 4: The final display of an example of making an educational game through code.org.

The project that has been successfully created can be shared with friends or other people who may be students to play it as shown in Figure 4. The selected character may not be angry bird but after several times of practice and the choice can choose a character that corresponds to the student material to be studied. After students familiar with coding blocks, the use of Code.org can be expanded to create educational games, especially in of biology [6]. The Fight Virus game is a simple game made not only to provide entertainment for users but also contains education and knowledge, especially about vaccines and viruses. The game describes that giving any kind of vaccine or immunization to increase the body's immunity highly recommended as an effort to maintain a healthy body, especially for disease caused by viruses. The appearance of the Fight Virus game is shown in Figure 5.

In the game there are five kinds of objects including one boy, three viruses, and another solution object which is considered a vaccine. The main role of the object is the boy. This object can be moved by pressing the up, down, right and left keys or arrows. If the main object hits the virus then the main object will disappear at the same time the game must be repeated. If the main object can directly hit the object vaccine then the game was won. This educational game can be accessed by anyone at the following link:

https://studio.code.org/projects/spritelab/h5o9gk1kNqZxXhUSG0Hn2wkNd2N4%20dlC34Uj

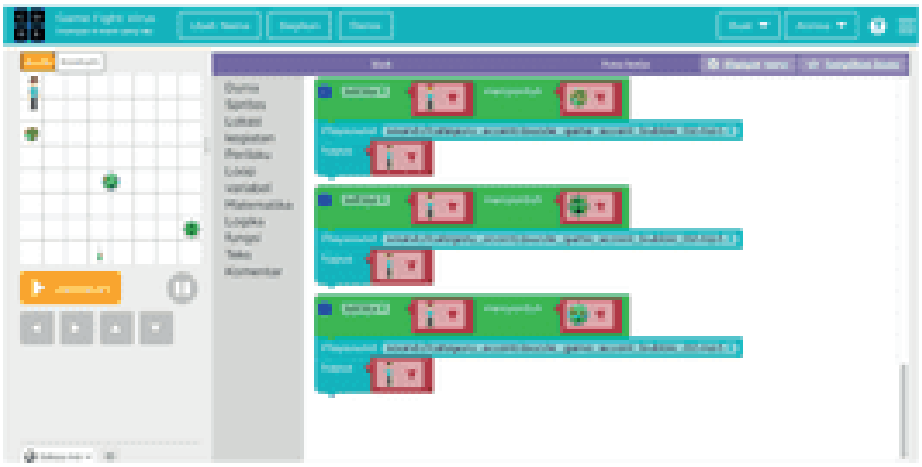

Figure 5: The Fight Virus Game.

Achievement of Computational Thinking from Code.org Project Products

The achievement of Computational thinking was obtained from the assessment of the product process for preparing teaching materials for biology lessons developed by prospective biology teacher students at UIN SGD Bandung using the code.org application, while the results of achieving Computational thinking were carried out by 3 experts in the fields of biology content, learning media and Literacy ICT in learning, the results obtained are as in the following Table 2.

Student Responses to Online Programs to Practice Computational Thinking Skills

The data that is netted apart from the online program introduction process through code.org is student responses about things that have been experienced in the form of training activities in the form of projects being worked on. The student subjects who captured the data were 76 respondents who were students of biology education class 2019/2020. Data collected through implied statements in Table 1. From the data, 56.2% stated that they strongly agreed that AI for education learning (especially the code.org project material) was able to attract students' interest in learning related to computational thinking.

Computational thinking is an innovative thinking ability in identifying life phenomena to provide various practical solutions to the problems studied arrange a better computational solution in the form of an algorithm [10]. Of the 73 respondents, 46.6% agreed that users could easily interact or operate the code.org program. However, 23.3% disagreed, 1.4% disagreed and 1.4% strongly disagreed. This shows that not all students find it easy to operate the code.org platform. This study used the lessons provided by the code.org platform to analyze the development of computational thinking at an early age. As all the tasks proposed to the students included the search for the solution

Table 2: Recapitulation of the results from experts regarding the achievement of computational thinking for prospective biology teacher students at the FTK UIN SGD Bandung in the code.org project.

Assessment Aspects	Assessment Indicators	Assessment Results
Abstraction	Ability to decide what information about an entity/object is known for stored and what information should be ignored	Three experts stated that students' abstraction was good in this code.org project, but it is necessary to adapt the biology content to the program language that can be run in this code.org
Generalizatior	Ability to formulate solutions in general terms so they can be applied to different problems	The three experts said that students' generalization abilities were good in this code.org project, because in different content students can use general patterns and can solve them.
Decompositio	The ability to break complex problems down into smaller or simpler parts that are easier to understand and resolved	The three experts stated that this decomposition ability was still insufficient, because there would be error processes encountered in the creation at code.org but could not be solved properly because they did not really understand computer programming language.
Algorithms	Algorithms The ability to design a series of operations/actions in stages (step by step) on how to solve a problem	The three experts stated that students had good algorithmic abilities because they were able to make games with specific and correct sequence systematic for biology content in the code.org application.
Debugging	Ability to identify, remove and correct errors	The two experts stated that the debugging ability was quite good, because it was found that students were still confused about completing the project if it did not match the demands of the examples given in making teaching materials with code.org

of a problem, concepts, practices and computational perspectives it is possible to say that computational thinking was promoted. Students achieved very positive results, at the same time they trained problem-solving skills, building and retaining knowledge better [11]. Table 1 presents the results of the questionnaire responses to the use of the code.org platform, interest and motivation to learn in learning coding for the sake of learning or making educational games. The code.org platform supports learning to hone computational thinking. In line with Rim H's 2017 statement, that Learning computational thinking is very important in programming education.

Computational thinking refers to the problem-solving ability based on the theories of computer science, indicating the importance of algorithm thinking. That is the reason for focusing on promoting creativity and improving the problem-solving ability of the students in programming education.

Overall, if seen from Table 3. The recapitulation of the calculation of student responses to the implementation of online programs through the code.org platform gave a positive response with the results included in the table in the form of a percentage.

Table 3: Recapitulation of the questionnaire responses of 73 biology education students to the code.org platform.

No.	Statement	Response (%)				
		STS (1)	TS (2)	KS (3)	S (4)	SS (5)
1	The material presented by the lecturer in the learning AI for education (especially the code.org project material) is able to attract students' interest in learning related to computational thinking	0	0	6.8	37	56.2
2	User can easily interact or operate the code.org program	1.4	1.4	23.3	46.6	27.4
3	I have difficulty when learning AI for education using the program on code.org	9.6	20.5	34.2	27.4	8.2
4	I'm having a hard time working on an educational based game project using a program on code.org	9.6	16.4	37	27.4	9.6
5	The stages in making educational games as a basic part of learning coding are easy to understand on code.org	0	5.5	30.1	43.8	20.5
6	I enjoy using code.org as a coding base to create educational based games	0	5.5	24.7	38.4	31.5
7	Learning to use code.org makes me excited to learn coding	0	1.4	23.3	42.5	32.9
8	The code.org platform is not effectively used to help the AI for education learning process in learning coding	52.1	35.6	9.6	1.4	1.4
9	The code.org platform is less efficient to use to help the learning process of coding to create educational games	45.2	41.1	9.6	2.7	1.4
10	Using the code.org platform in AI for education courses can increase my creativity in learning	0	0	5.5	34.2	60.3

Description: STS = Strongly Disagree, TS = Disagree, KS = Disagree, S = Agree, SS = Strongly Agree

4. CONCLUSION

From this study it can be concluded that the computational thinking skills of prospective biology teacher students at FTK UIN SGD Bandung when completing teaching material development projects and gamification of biology learning have been mastered, this can be seen from the assessment of code.org products and processes observed by experts. However, students need to improve their decomposition and debugging skills on CT because students are still not used to the work patterns of a programmer. For abstraction, algorithms and generalization students have done well for computational thinking

Students were able to follow each stage of making educational game projects through the code.org platform to practice computational thinking skills in accordance with the success of the stages of making simple projects through good, systematic and problem solving coding. Student responses to the code.org platform as an online program tool

that can hone computational thinking can provide creativity and enthusiasm for student learning as evidenced by the results of a questionnaire, 63.3% of students strongly agree that this increases creativity. This research needs to be continued to measure CT according to indicators so that the expected results are obtained for sharpening CT in students.

Acknowledgments

The author would like to thank the Biology and physics education study program, FTK UIN SGD and the UPI campus in Cibiru, which have helped in writing this paper. This paper is funded by LPPM UIN Sunan Gunung Djati Bandung in 2022.

References

[1] Maryanti S, Hartati S, Kurniawan DT, Mukhtar SN. Development of Assessment For Learning (AFL) through the educandy application for middle school Biology learning. Journal of Natural Science and Integration. 2017;5(1):12–22.

[2] Sa'adah S, Maryanti S, Maspupah M, Mas'ud A. "Literasi digital mahasiswa calon guru biologi dalam menyusun bahan ajar berbasis audio visual.," p. 2020.

[3] Wing JM. Computational thinking. Commun ACM. 2006;49(3):33–5.

[4] Rim H. A study on teaching using website'code.org'in programming education based on computational thinking. Journal of Korea Multimedia Society. 2017;20(2):382–95.

[5] Wing J. Computational thinking's influence on research and education for all. Italian Journal of Educational Technology. 2017;25(2):7–14.

[6] Barradas R, Lencastre JA, Soares S, Valente A. "Developing computational thinking in early ages: A review of the Code. org platform.," p. 2020.

[7] Code.org. About | code.org [Internet]. 2021.

[8] Soendari T. Metode penelitian deskriptif. Bandung: UPI. Stuss, Magdalena & Herdan, Agnieszka; 2012

[9] Sugiyono AG. Memahami penelitian kualitatif. Bandung: CV Alfabeta; 2005.

[10] Malik S, Prabawa HW, Rusnayati H. Peningkatan kemampuan berpikir komputasi siswa melalui multimedia interaktif berbasis model quantum teaching and learning [Dissertation]. Bandung: Universitas Pendidikan Indonesia; 2017.

[11] Jonassen DH. Learning to solve problems: A handbook for designing problem-solving learning environments. Routledge; 2010. https://doi.org/10.4324/9780203847527.