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Improving Children's *Computational Thinking* Through a Combination of *Unplugged* and *Plugged-in CT Techniques Tangible* with Robot Games

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Abstract
In today's digital era, introducing the concept of computational thinking (*CT*) from an early age is very important. Binekas School, as an educational partner at the Playgroup, Kindergarten (TK), and Elementary School (SD) levels, is committed to introducing CT to children starting at the age of 4. Currently, Binekas School only offers optional extracurricular coding activities at the elementary school level and uses a hard coding approach, which may be too challenging for most students. This school wants to prepare students with an introduction to the basics of coding from kindergarten using a more child-friendly approach, namely plugged-in with tangible robotics. The proposed solution includes an introduction to CT knowledge with a focus on algorithm development and CT training through *tangible plugged-in techniques* using robots for children aged 4 years and above. This training will not only improve children's understanding of the CT concept in an interactive and fun way, but will also prepare them for future educational challenges. The tools that will be used in this training are the Robotic Gigo Smart Brick, a robotic system designed for children so that they can learn basic programming concepts and computational thinking through interactive games. This outreach activity uses a combination of *unplugged CT* through card media and physical maps to train problem-solving mindsets accompanied by the opportunity to test proposed solutions with *plugged-in CT* using the Robotic Gigo Smart Brick. From the results of the activity evaluation through a questionnaire, it was found that 92% of students agreed that the application of the combination of *unplugged CT and plugged-in* CT was fun, the material was easy to understand and they were interested in getting further material.

Keywords: Computational Thinking , Robot, CT unplugged , CT plugged-in tangible

INTRODUCTION

In today's digital era, computational thinking *(* CT) has become one of the important skills that need to be introduced from an early age. Computational thinking involves a series of cognitive abilities that enable children to understand, analyze, and solve problems through a structured and logical approach. By developing these skills in children, especially those aged 4 years and above, we prepare future generations to be better prepared to face the challenges of an increasingly complex and technology-based world. Research shows that introducing CT in early childhood can improve problem-solving abilities, creativity, and critical thinking skills that can be applied in various contexts of everyday life (Fagerlund et al., 2020; Li et al., 2021).

In teaching CT concepts to children, there are two main approaches, namely *plugged-in* and *unplugged* . The plugged-in approach involves the use of digital or screen-based devices, such as computers, tablets, or special software applications designed to teach CT. In contrast, the unplugged approach does not require the use of digital technology, but rather relies on concrete tools and physical activities that help children understand CT concepts through direct experience. Several studies have shown that children may benefit more when they are first introduced to CT concepts through the *unplugged approach* , as this approach allows them to develop a deeper and more intuitive understanding before moving on to digital applications as their CT skills develop (Bers, 2019; Hsu et al., 2022). Thus, the combination of these two approaches is believed to provide a more significant positive impact on the development of CT abilities in early childhood.

The plugged-in approach to teaching CT to children also offers a number of significant benefits. By using digital tools, such as interactive applications, educational games, and programming software specifically designed for children, this approach can increase children's

engagement in the learning process. The use of technology in the plugged-in approach allows children to explore abstract concepts in a more engaging and interactive way. For example, through programming-based games, children can visualize the logical thinking process and problem-solving steps, which in turn can strengthen their understanding of the basic principles of CT. In addition, studies have also shown that the plugged-in approach can increase children's learning motivation and encourage them to learn independently, as technology offers immediate feedback and personalized learning experiences (Papadakis et al., 2021; Kazakoff & Bers, 2020). Thus, the plugged-in approach not only enriches children's learning experiences but also prepares them to be more familiar with the digital tools they will encounter in the future.

The community service activities carried out aim to improve *Computational Thinking* in elementary school students who are in line with the Tri-Dharma of Higher Education and efforts in the SDGs 4 program - Quality Education . This counseling aims to improve the concept of computational thinking (*Computational Thinking* - CT) and spark the interest of elementary school students to explore CT-based activities. Counseling is carried out with a group learning mechanism to shape the character of Pancasila students, especially in working together, thinking critically and creatively.

METHOD

This community service activity is carried out with a school partner, namely Binekas Bandung School. The profile of Binekas School is as follows:

Address : G7 Complex, Jl.
Opening hours : Open 8.00 - 16.00 WIB
Contact : 0813-9522-1590
Website : https://sekolahbinekas.com/

Binekas School is an educational partner committed to supporting families in providing quality education for children at the Playgroup, Kindergarten (TK), and Elementary School (SD) levels. Currently, Binekas School only offers extracurricular coding activities at the elementary school level, which are optional and paid. This limitation means that only a small number of students can participate in these activities. Furthermore, coding taught at the elementary school level uses a hard coding approach with computers, which is an advanced skill and may be quite challenging for most students at that age.

Binekas School has a vision to introduce the basics of coding from kindergarten level, with the aim of preparing all students to be better prepared for learning at the elementary school level. However, in line with the cognitive development of children at kindergarten age, the school wants to use a more appropriate approach, namely without involving the use of computers as applied at the elementary school level. Therefore, it is recommended to adopt a more child-friendly and interactive plugged-in approach, in order to bridge the transition from kindergarten to elementary school more effectively and inclusively for all students.

The method that will be given during the implementation of community service is a counseling method in a class lasting 2-3 hours. Activities are carried out in groups. The following are the stages of implementing community service:

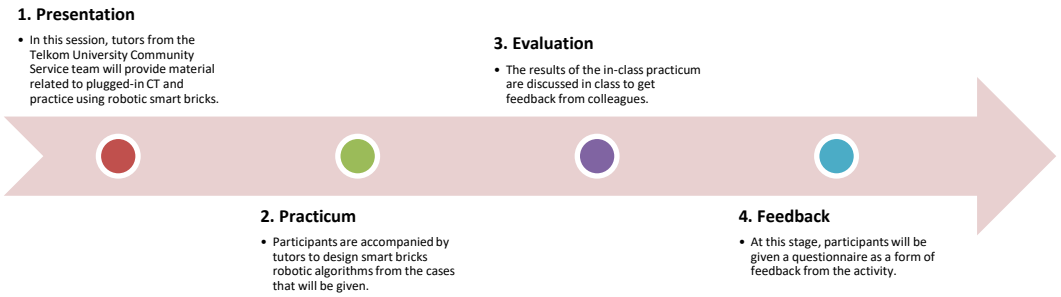

Figure 1. Stages of PKM implementation.

In this PKM activity, students will be given problems related to the map of the Gigo Smart Brick robot. Furthermore , students are asked to form or arrange robot instructions with cards that have arrows. The following is a description of the robotic smart bricks tools that will be used in the PKM activity session:

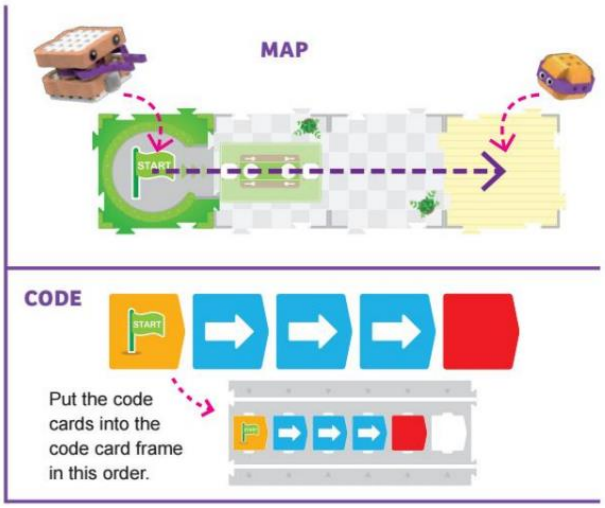

Figure 2. Illustration of how to play the Gigo Smart Brick robotic.

The Robotic Gigo Smart Brick is a robotics system designed for children to learn the basic concepts of programming and computational thinking through interactive play. It involves the use of bricks or building blocks that can be assembled into various robot models. Once the robot model is built, children can program the robot using a simple controller or app.

The main components of the Gigo Smart Brick include motors, sensors, and controllers that allow the robot to move and react to its environment. Children can program the robot to perform various actions, such as walking, avoiding obstacles, or following a line, by constructing logical instructions that control the motors and sensors. Through this activity, children learn about algorithms, logical sequences, and decision-making while playing and experimenting with their own robots.

RESULTS AND DISCUSSION

The training activity to improve *Computational Thinking* of elementary school students was held on November 20, 2024 at SD Binekas Bandung which was attended by 50 6th grade students. The counseling was conducted in two sessions by dividing the participants in each session into 6 groups of 4-5 students. The counseling activity scenario implemented a combination of *unplugged* and *plugged-in CT* using the Robotic Gigo Smart Brick, with 3 types of problems including: 1) introduction to basic instructions 1, 2) introduction to basic instructions and 3) introduction to repetition instructions 1. For each type of problem, each group was given an A1-sized physical map and an instruction card to carry out the *unplugged CT activity* . Each group discussed, collaborated and simulated the solution to the problem given. After the solution was found, the group could try the solution using plugged-in CT on the Robotic Gigo Smart Brick. The problem maps given to students can be seen in Figures 3, 4 and 5 below:

Figure 3. Problem Map 1.

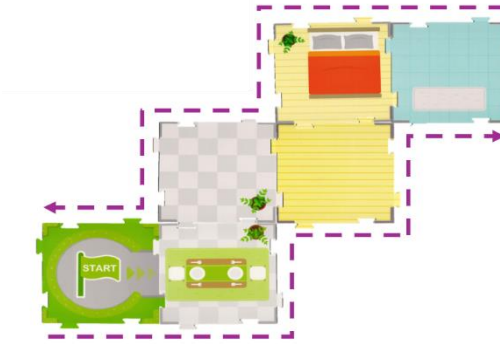

Figure 4. Problem Map 2.

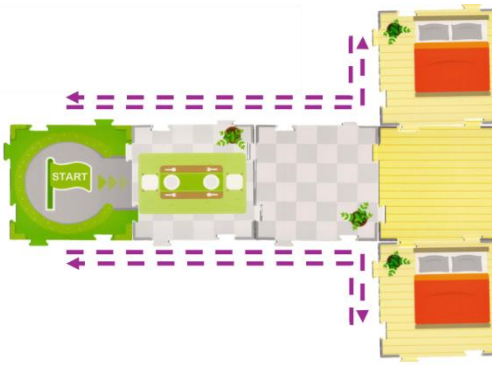

Figure 5. Problem Map 3.

In Figure 3, a map for simple robot motion is given. The problem begins with moving the robot forward, backward, and turning around. In Figure 4, a more complex problem is given by increasing the turning directions for the robot. In Figure 5, the students' ability to analyze how the robot can turn and move across various maps is given.

The atmosphere of the training activities at Binekas school can be seen in Figure 6 (a) and Figure 6 (b) below:

(a)

(b)

Figure 6. (a) Group photo with children before the training began. (b) Children's activities when trying to compile instructions/algorithms to solve the given problems.

Before conducting the training session, students and teachers along with the PKM team took a group photo followed by an introductory presentation of the Gigo Smart Bricks robot, as seen in Figure 6 (a). Furthermore, to test students' ability to compile algorithms, students were asked to directly use the Gigo Smart Bricks robot and try to run it, as seen in Figure 6 (b).

In the final session of the counseling activity, a questionnaire was distributed to evaluate the activity. The questions in the questionnaire were adjusted to the respondents, namely elementary school students, and were intended to see the achievement of the activity's objectives, namely to spark the interest of elementary school students to explore CT-based activities. For each questionnaire question, respondents could choose five options, namely: Strongly Disagree (STS), Disagree (TS), Neutral (N), Agree (S), and Strongly Agree (SS), as shown in Table I.

Table I. List of activity result survey questions.

No	Question	Information
1	The activity material is very enjoyable	Seeing the consistency of elementary school students' responses regarding CT activities
2	The activities are not boring	Seeing the consistency of elementary school students' responses regarding CT activities
3	The activities are easy to understand	Seeing the effectiveness of the combination method of unplugged and plugged-in CT
4	The committee provided good service during the activity	Assessment of preparation and implementation of activities
5	Very happy to continue in the future	The main assessment item for the activity is to spark the interest of elementary school students to explore CT-based activities.

The results of the questionnaire processing, Table II, show that the responses from respondents can be stated as consistent. This can be seen from the results of questions 1 and 2 which have very small

deviation values. For the effectiveness aspect of the combination of *unplugged* and *plugged-in CT* , question 3, in general, participants stated that with the combination method, the material presented was easy to understand. In question 3, the distribution of responses between S and SS had quite a deviation, as well as for question 4 related to the preparation and implementation of activities, there were 4% of respondents who stated TS. This is estimated from the limited time where each problem session was given 20 minutes and the limited *plugged-in CT device* , only using 1 unit of Robotic Gigo Smart Brick. Following up on the results for questions 3 and 4, for the next activity, consider adding time or the number of plugged-in CT devices used. In general, the purpose of the activity to spark the interest of elementary school students in exploring CT-based activities was stated to have been achieved with 92% of respondents agreeing/strongly agreeing if there were further activities to be carried out.

Table II . Survey results related to PKM activities.

No	Question	STS (%)	TS (%)	N (%)	S (%)	SS (%)
1	The activity material is very enjoyable	**0**	**0**	**2**	**24**	**74**
2	The activities are not boring	**0**	**0**	**2**	**26**	**72**
3	The activities are easy to understand	**0**	**2**	**4**	**42**	**52**
4	The committee provided good service during the activity	**0**	**4**	**2**	**26**	**68**
5	Very happy to continue in the future	**0**	**0**	**8**	**16**	**76**

CONCLUSION

Based on the results of community service activities to improve children's *Computational Thinking* through a combination of *unplugged* and *plugged-in CT techniques* followed by 50 6th grade elementary school students, it can be concluded that: 1) CT-based activities are fun activities for elementary school students, 2) Elementary school students show interest in participating in advanced CT activities, and 3) The effectiveness of the combination of unplugged and plugged-in CT is influenced by the allocation of time and available plugged-in CT devices.

The evaluation results related to the main objective of the activity, namely to spark the interest of elementary school students in CT-based activities, showed positive results where 92% of respondents agreed/strongly agreed if there were further activities to be carried out. Therefore, the creation of a CT-based coding learning syllabus is one of the follow-ups in the implementation of further activities. In addition, the evaluation results showed that to increase the effectiveness of the combination of *unplugged* and *plugged-in CT* , more time management and supporting facilities, especially *plugged-in CT, are needed* which are more adequate in terms of quantity.

ACKNOWLEDGEMENT

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REFERENCES

Bers, M.U. (2019). Coding as a Playground: Programming and Computational Thinking in the Early Childhood Classroom. Routledge.

Fagerlund, J., Häkkinen, P., Vesisenaho, M., & Viiri, J. (2020). Computational Thinking in the Context of Learning Programming in K–12 Education: A Systematic Literature Review. Computers & Education, 147, 103778.

Hsu, TY, Chang, YS, & Chiu, H.L. (2022). Unplugged and Plugged-In: The Impact of Different Programming Approaches on Preschool Children's Computational Thinking. Journal of Educational Technology & Society, 25(1), 53-64.

Li, Y., Swanson, M. C., & Benenson, F. (2021). Computational Thinking in Early Childhood Education: A Systematic Review. Computers & Education, 165, 104148.

Kazakoff, E.R., & Bers, M.U. (2020). Promoting Positive Technological Development in Early Childhood with the ScratchJr Coding App. Computers in the Schools, 37(4), 285-303.

Papadakis, S., Kalogiannakis, M., & Zaranis, N. (2021). Digital Game-Based Learning in Preschool Education: Analyzing Teachers' and Parents' Attitudes, Beliefs, and Perceptions. Journal of Educational Technology & Society, 24(1), 1-15.