

IMPLEMENTING COMPUTATIONAL THINKING IN ELEMENTARY SCHOOL ICT EDUCATION AND EVALUATION USING THE KIRKPATRICK METHOD

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ABSTRACT

The lack of understanding of computational concepts and problem-solving among students who still consider computers merely as tools for gaming and entertainment, along with their limited exposure to computational Thinking, constrains their ability to address problems systematically. Although the 2013 Curriculum emphasizes critical Thinking, basic data analysis, problem-solving, creativity, and innovation, aligned with the computational thinking method, it remains a distinct challenge for students and teachers to integrate it into their teaching. The objective of computational thinking education is to shift the paradigm and introduce students to computational thinking skills, particularly in ICT Education. Testing this method employs the Kirkpatrick method, which demonstrates a significant improvement in students' ability to solve problems with a more systematic and computational approach. Students can comprehend the concepts of decomposition, pattern recognition, abstraction, and algorithm development. This improvement is reflected in their performance on various computer-based problem-solving tasks. The benefits of implementing computational Thinking include students applying computational thinking principles not only in computer-based learning but also in their daily lives, gaining more confidence in facing technology-based challenges.

Keywords: Computational Thinking, Kirkpatrick, ICT Education, Elementary School

1. INTRODUCTION

Computational Thinking (CT) is a term that refers to the ideas and core concepts in the field of Informatics and Computer Science (Bocconi et al., 2016). Computational Thinking is one of the key components of digital literacy, where an individual possesses skills that enable them to solve problems systematically, similar to how computers operate (Ribeiro, 2013), even though computers originally mimicked human behavior.

Computational Thinking is an effort to understand and solve complex problems using computer science techniques and concepts such as decomposition, pattern recognition, abstraction, and algorithms, which many experts consider a crucial skill supporting the dimensions of 21st-century education (Maharani et al., 2020). In computational Thinking, students are directed to develop critical, creative, and communicative skills and the ability to collaborate in problem-solving. Furthermore, computational Thinking sharpens logical, mathematical, and mechanical knowledge combined with modern knowledge of technology, digitization, and computerization, and even shapes confident, open-minded, tolerant, and environmentally aware individuals (Ansori, 2020). Computational Thinking is a component of the Information and Communication Technology (ICT) curriculum, now referred to as Informatics, which is a government initiative emphasized in ministerial regulations to enhance national education.

Computational Thinking has been introduced previously and can be applied not only in the ICT environment. This critical analytical ability can be applied to various other fields. ICT education as a form of digital literacy enrichment for society still needs to be carried out partially on hardware and its use, often hindered by inadequate infrastructure. However, computational Thinking can be taught even without relying on infrastructure availability.

The socialization of computational Thinking in educational institutions is considered far from expectations. This is evident from the low participation and suboptimal results of all participants from elementary schools (SD) to high schools throughout Indonesia, leading to a need for more basic skills for analytical abilities that form the basis of reading, writing, and arithmetic skills. This is demonstrated by an article titled "Indonesian Kids Do not Know How Stupid They Are" (Pisani, 2013), which states that the mathematical and scientific abilities of Indonesians are very weak. Pisani provides this insight based on data from the Programme for International Student Assessment (PISA) study. Based on the results of the 2018 PISA study, it can be seen that out of 79 countries studied, Indonesian students' reading abilities rank 74th. Similarly, in mathematics, Indonesian students rank 73rd, while in science performance, Indonesia ranks 71st (Schleicher, 2019).

Based on these facts, it is only fitting to introduce a breakthrough in addressing the longstanding educational issues in Indonesia. One is by teaching students how to possess computational thinking skills, as already applied in advanced countries today. Computational Thinking is closely related to computational logic, mathematics, algorithms, and rationality, which are the main weaknesses in students' abilities, as previously discussed.

2. METHOD

An illustration of the community involvement initiatives undertaken is provided in the chart below:

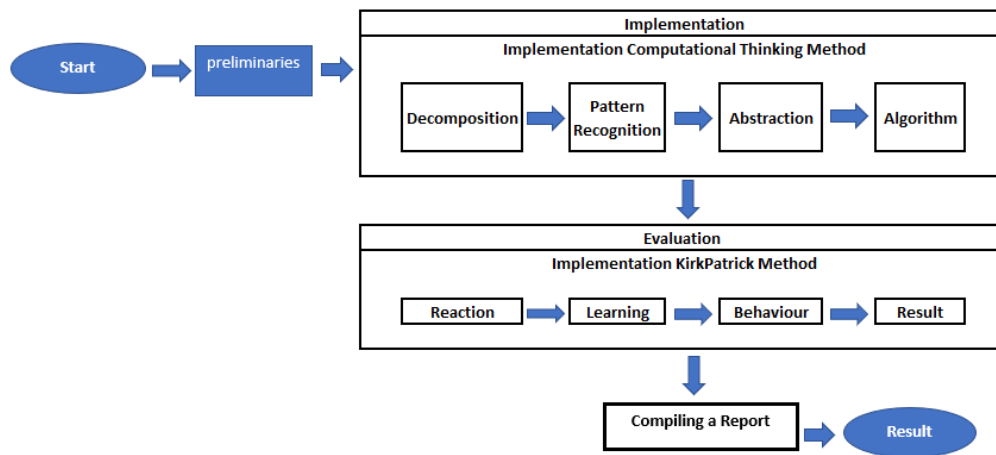


Figure 1. The stages of Community Engagement Activities

- a. Preliminaries: In this phase, the team representatives visited the Partner's location, and the School, represented by Mrs. Mardha Tresnowaty Putri, S.Psi, M.Pd, facilitated a meeting with the Informatics teacher and the 4th-grade teacher. During the meeting, interviews were conducted to identify issues and determine appropriate solutions since a significant portion of the students at SD Islam Al-Azhar Syuhada lack adequate problem-solving skills using Computational Thinking techniques, especially in systematically solving complex problems using computer science concepts and techniques.
- b. Implementation: In this stage, Computational Thinking is applied. Computational Thinking is the process of problem-solving and finding solutions, allowing these solutions to be represented (Alfina, 2017)
In this training, the Computational Thinking method is applied with the following steps (Supiarmono et al., 2022):
 - c. Decomposition: Breaking down large/complex problems into smaller, manageable problems. This stage involves identifying the information known from the presented problem and identifying the information required from the presented problem.
 - d. Pattern Recognition: Providing challenging tasks to be solved autonomously or with assistance and finding patterns, as there are often specific patterns in a problem that need to be recognized to solve it.
 - e. Abstraction: Focusing on important information and disregarding irrelevant details.
 - f. Algorithm: Developing a step-by-step solution or a set of rules to follow to solve the problem.

Table 1. Activity Stage

No	Activity	Method	Duration
1.	Computational thinking Introduction	Lecture	10 Minute
2.	Computational Thinking Stage Introduction (Dekomposisi et al.)	Practical	20 Minute
3	Computational Thinking Implementation	Practical	2 x 30-minute
4	Examples of Computational Thinking Exercises in Mathematics and Informatics.	Practical	2 x 45-minute
5	Training Evaluation (Feedback).	Discussion dan Q&A	30 Minute

- g. Evaluation: Evaluation Needs to Measure whether the training using the Computational Thinking method is successful or not; this activity employs measurement using the Kirkpatrick Evaluation Model, which consists of 4 stages in its Implementation (Nurhayati, 2018), namely:

- 1) Reaction: Evaluation related to the participant's reaction to the training/program is to measure participant satisfaction (customer satisfaction). The training is effective if participants find it enjoyable and satisfying, leading to their interest and motivation to learn and practice. Reaction Evaluation utilizes a reaction sheet in the form of a questionnaire, making it easier and more effective.
- 2) Learning: Evaluation related to learning involves knowledge, attitude, and skills. In this Evaluation, participants are considered to have learned if there is a change in attitude, improved knowledge, and enhanced skills.
- 3) Behavior: Evaluation at this stage is related to the assessment of behavior that focuses on behavior improvement after participants return to the workplace. The success indicators at this stage include changes in attitude that occur after training and are applied by participants after attending the training, making the assessment external.
- 4) Impact: Evaluation focused on the final results experienced by participants who have completed the training. In training activities, this Evaluation refers to the final results obtained by training participants (Badu, 2013).

3. RESULTS AND DISCUSSION

a. Result

1. Evaluation of Activity Results

Based on the activities conducted, the following findings were obtained:

- a) Due to the COVID-19 pandemic conditions starting in March and continuing through April 2022, large-scale social restrictions (PSBB) are still in effect in Jakarta. As a result, the Implementation of the Computational Thinking introduction training to enhance students' learning skills at SD Islam Al-Azhar Syuhada South Jakarta, which was originally planned as in-person, had to be adapted to an online format through Zoom meetings.
- b) Since the training was scheduled to take place after students' regular school hours and the students were joining via Zoom from their homes, all students could directly participate and practice under the guidance of tutors during this training.
- c) Training on introducing Computational Thinking to enhance students' learning skills at SD Islam Al-Azhar Syuhada South Jakarta."

b. Discussion

1. Training Evaluation

a) Reaction Level

This stage involves evaluating the satisfaction of training participants with various activities they have participated in. The level of success of the training program's objectives can be assessed through the participants' reactions. There are two types of reaction instruments to evaluate at the reaction level:

- 1) Participant reactions to the Training Implementation. The aim is to determine the level of participant satisfaction with the success of learning, which is inseparable from interest, attention, and motivation related to (a) participation, (b) the organizing committee, (c) accommodation, (d) curriculum; (e) consumption; and (f) training facilities (Nurhayati, 2018).

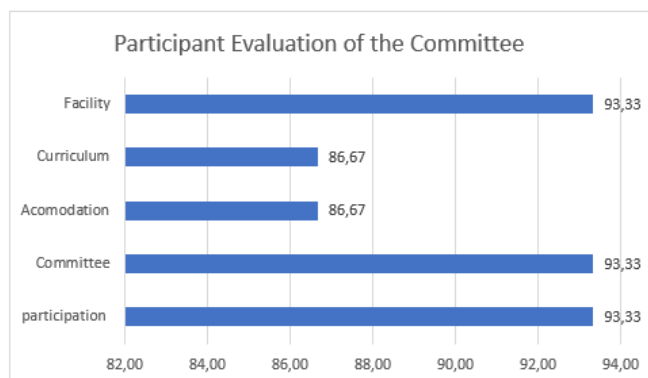


Figure 2. Participant Evaluation of the Committee

Based on the above graphic, the overall average value of participant evaluation of the committee's reactions is 90,66. The numerical value of 90,66 falls into the "Very Good" category.

- 2) Participant reactions to the speakers. The aim is to determine the satisfaction of training participants with the conduct of the learning process by examining two aspects, such as Tutor's Knowledge and Tutor's Attitude.

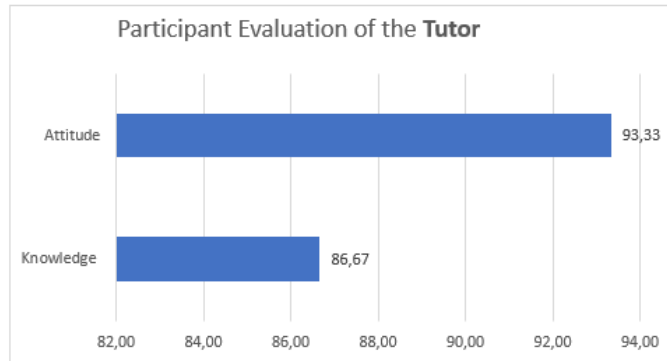


Figure 3. Participant Evaluation of the Tutor

In every training session, participants consistently attended and actively engaged in the material presentation sessions. Based on the questionnaire results, it is evident that participants, in general, displayed enthusiasm in participating in the training. The evaluation results of participants regarding the Tutor are rated as "Very Good," as indicated by an average score of 90. The Tutor is one person, Reva Ragam Santika, MM., M.Kom.

- b) Learning Level

At this level, for measuring the effectiveness of the training program, three aspects need to be measured: attitude, knowledge, and skills (Nurhayati, 2018). At this level, changes in participants are expected in these three aspects, in line with the objectives of the training program. Therefore, in measuring learning evaluation, criteria assessment will be conducted as follows: (1) changes in attitude, (2) knowledge acquired, and (3) skills developed or improved. The assessment of changes in attitude consists of several sub-indicators, including behavior, discipline, attendance, cooperation, participation, and responsibility, with an overall average score of 86.67, falling into the "Good" category.

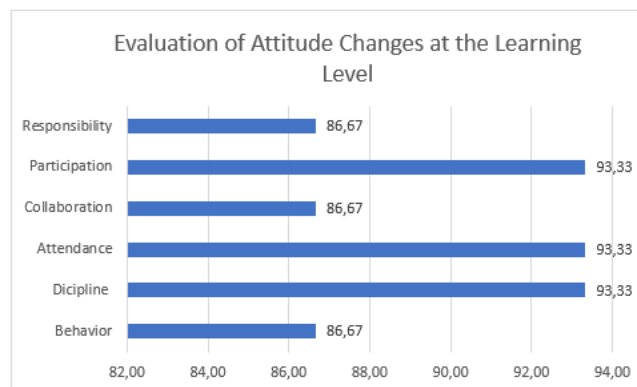


Figure 4. Evaluation of Attitude Changes at the Learning Level

The second criterion involves the aspect of knowledge acquired. Evaluation is done through a written test (multiple choice) to measure the initial knowledge of the participants, followed by a final multiple-choice test. Based on the results, the initial test had an average score of 54.70, while the final test had an average score of 90. There is a noticeable increase in participants' knowledge competence, and the final test results fall into the "Good" category.

The third criterion pertains to skills evaluated through practical application in utilizing Computational Thinking Introduction Techniques to enhance learning skills, with practical

examples from Bebras Indonesia. Based on this Evaluation, the overall average score for participants' skills is 85.30, which also falls into the "Good" category.

c) Behavioral Level

Behavioral Evaluation measures the knowledge, skills, or attitudes learned to be applied or transferred to the job (Tan et al., 2013). This Evaluation aims to assess changes in existing work behaviors after employees participate in a training program. 4 (four) conditions are measured, namely (1) an individual must have the desire to change; (2) an individual must know what needs to be done and how to do it; (3) an individual must work in the right work environment; (4) and an individual must receive recognition for the changes (Kirkpatrick, 2006).

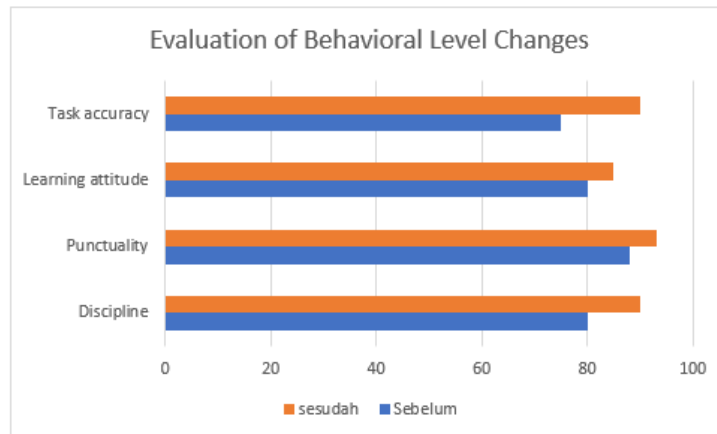


Figure 5: Behavioral Level Change Evaluation

At this stage, an assessment of the training participants is carried out to determine the extent of behavioral changes after participating in the training or upon their return to their respective jobs. Information about the changes in training participants is obtained from the accompanying teachers of the training participants. The assessment is conducted by randomly selecting a sample of 25 (twenty-five) participants from SD Islam Al-Azhar Syuhada in South Jakarta. Based on the results of observations and questionnaires filled out by the accompanying teachers, it is depicted in the graph as follows:

From the interviews and questionnaires, it is evident that the training participants were enthusiastic when they joined their respective work units. According to the responses of the accompanying teachers, all participants experienced a relative improvement in their behavior, indicating that the training activities for the training participants at SD Islam Al-Azhar Syuhada in South Jakarta were executed effectively. Based on this assessment, it is known that the overall average score for the improvement in the participants' behavior reaches 91.40, which falls into the category of "Excellent."

d) Impact Level

At the impact level, an assessment is conducted on the participants of SD Islam Al-Azhar Syuhada in South Jakarta to determine the changes in students' competencies after attending the training or when participants are working on their respective school assignments. The information is obtained from both the accompanying teachers and subject teachers. At this level, the assessment is conducted through interviews with the accompanying teachers and subject teachers.

Based on the interview results, it is evident that the training has had a clear impact on the participants of SD Islam Al-Azhar Syuhada in South Jakarta. The training has enhanced the competencies and skills of the participants in solving every problem given, with the average score increasing from 80 to 88 after implementing the Computational Thinking method. Therefore, all training participants have completed and implemented the knowledge they acquired during the training.



Figure 6: Evaluation of training using The Kirkpatrick Method

4. CONCLUSION

Implementing the training for improving technical writing skills in academic papers through applying computational thinking methods to enhance learning skills at SD Islam al-azhar Syuhada in south Jakarta has proceeded successfully. This is evident from the questionnaire results prepared using the Kirkpatrick method and distributed to the training participants, guiding, and subject teachers. It was found that at the reaction level, which consists of two types - the participants' reaction to the training scored 90.66, and the Tutor's reaction scored 90, falling into the 'good' category. At the learning level, there was a significant increase in participants' knowledge competencies, with a score of 90. At the behavioral level, there was a notable change in behavior, reaching 91.40, which falls into the 'excellent' category. At the impact level, there was an observable enhancement in participants' competencies and skills in completing each assigned task, scoring 88. The training module has been created to meet user needs by applying the computational thinking method, allowing students to continue self-directed learning without the guidance of a teacher. The competencies and abilities of students in problem-solving techniques or lesson-related issues using the computational thinking method have significantly improved.

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5. REFERENCES

- Alfina, A. (2017). Berpikir Komputasional Siswa dalam Menyelesaikan Masalah yang Berkaitan dengan Aritmetika Sosial Ditinjau dari Gender. *SimkiTechsain*, 01(04).
- Ansari, M. (2020). Pemikiran Komputasi (Computational Thinking) dalam Pemecahan Masalah. *Dirasah*, 3(1), 111–126.
- Badu, S. Q. (2013). Implementasi Evaluasi Model Kirkpatrick Pada Perkuliahan Masalah Nilai Awal Dan Syarat Batas. *Jurnal Penelitian Dan Evaluasi Pendidikan*, Universitas Negeri Yogyakarta, 102–109.
- Bocconi, S., Chiocciariello, A., Dettori, G., Ferrari, A., & Engelhardt, K. (2016). *Developing Computational Thinking in Compulsory Education*.
- Maharani, S., Nusantara, T., As'ari, A. R., & Qohar, A. (2020). *Computational Thinking Pemecahan Masalah di Abad Ke-21* (Issue December).
- Nurhayati, Y. (2018). Penerapan Model Kirkpatrick Untuk Evaluasi Program Diklat Teknis Substantif Materi Perencanaan Pembelajaran Di Wilayah Kerja Provinsi Kepulauan Riau. *Andragogi Jurnal Diklat Teknis*, IV(2), 170–187. <https://media.neliti.com/media/publications/275133-penerapan-model-kirkpatrick-untuk-evaluaced0cdda.pdf>
- Pisani, E. (2013). *Indonesian Kids Do not Know How Stupid They Are*. ETC: Exploring the Improbable Nation. <http://indonesiaetc.com/indonesian-kids-dont-knowhow-stupid-they-are/>.
- Ribeiro, L.;dkk. (2013). Computational Thinking: Possibilities and Challenges. *IEEE*, 978–1–4799. <https://doi.org/10.1109/WEIT.2013.32>.
- Schleicher, A. (2019). *PISA 2018 Insights and Interpretations*.
- Supiarmono, M. G., Hadi, H. S., & Tarmuzi, T. (2022). Student's Computational Thinking Process in Solving PISA Questions in Terms of Problem-Solving Abilities. (*Jiml*) *Journal of Innovative Mathematics Learning*, 5(1), 01–11. <https://doi.org/10.22460/jiml.v5i1.p01-11>