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DEVELOPMENT OF MATHEMATICS LEARNING BASED ON COMPUTATIONAL THINKING FOR PRIMARY SCHOOL TEACHERS

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Abstrak: Keterampilan Computational Thinking (Berpikir Komputasi) merupakan salah satu keterampilan abad 21 yang perlu dimiliki oleh siswa sekolah dasar. Mengingat pentingnya CT dan masih banyak guru-guru yang belum mengetahui dan menguasai keterampilan ini, maka diperlukan kegiatan workshop yang dapat mendukung keterampilan CT guru dan juga mampu merancang pembelajaran matematika berbasis CT. Oleh karena itu, tim PkM FKIP UNRI berkolaborasi dengan UPM Malaysia melaksanakan workshop pengembangan pembelajaran matematika berbasis CT bagi guru-guru sekolah dasar di Kecamatan Tambang, Kabupaten Kampar, Provinsi Riau. Metode pelaksanaan PkM menggunakan Participatory Action Research (PAR) dengan pendekatan blended learning. Kegiatan workshop diikuti oleh 33 orang guru dari 3 sekolah dasar di Kecamatan Tambang. Kegiatan workshop ini mampu meningkatkan keterampilan CT guru-guru, namun perlu tindak lanjut kegiatan sehingga keterampilan CT guru bisa lebih optimal dan mampu menerapkannya dalam pembelajaran matematika di kelas masing-masing.

Kata Kunci: keterampilan computational thinking, pembelajaran matematika, workshop

Abstract: Computational Thinking (CT) skills are crucial for elementary school students in the 21st century. Recognizing the significance of CT and the prevalent lack of knowledge and mastery among teachers, there is a need for workshop activities that can support teachers in developing CT skills and enable them to design CT-based mathematics learning. To address this gap, the FKIP UNRI community service team collaborated with UPM Malaysia to conduct a workshop on CT-based mathematics learning development for elementary school teachers in the Tambang Sub-district, Kampar Regency, Riau Province. The implementation method of this community service utilized Participatory Action Research (PAR) with a blended learning approach. Thirty-three teachers from three elementary schools in the district participated in the workshop. While the workshop successfully enhanced teachers' CT skills, subsequent activities are essential to optimize these skills further and facilitate their application in mathematics learning within their respective classrooms.

Keywords: computational thinking skills, mathematics learning, workshops

Introduction

Industrial Revolution 4.0 has brought many changes to the world of education. These changes are felt directly from primary to tertiary education levels. The global COVID-19 outbreak has further accelerated these transformations since early 2020. Consequently, it is undeniable that both teachers and students must be equipped with technological knowledge, including digital literacy and computational thinking (Chen, 2017).

Computational thinking (CT) is a crucial skill in the 21st century (Yadav et al., 2016). It serves as the key to transitioning students from mere technological literacy to utilizing computational tools for problem-solving (Yadav et al., 2016). Initially rooted in computer

science, CT has become essential for students to address problems across various scientific fields, particularly mathematics (Tang et al., 2020). Hence, it is imperative to prepare students from an early age in CT to enable them to tackle complex challenges in the future.

Wing (2006) defines computational thinking as attitudes and skills applicable universally. There are at least four fundamental CT skills that students need to master and that teachers can impart: decomposition, algorithms, pattern recognition, and abstraction and generalization (Ansori, 2020; Korkmaz, 2017; Tang, 2021). Decomposition involves breaking down complex artifacts, processes, or systems into component parts for easier problem-solving. For instance, the number 10 can be expressed as the sum of two numbers, such as 5 + 5 or 8 + 2. Algorithms pertain to the ability to identify processes and sequences of events, akin to the steps in cooking food. Pattern recognition involves identifying patterns and similarities, such as numerical patterns. Lastly, abstraction and generalization are essential for dealing with complexity by distilling unnecessary details, crucial for finding solutions to intricate mathematical problems. These four basic CT skills require teacher support, especially in elementary schools.

Despite the importance of CT as a science to be taught from an early age, it has not yet become an integral part of the education curriculum in Indonesia (Gunawan et al., 2023; Putra, Ramiati, et al., 2022; Safitri et al., 2023). This contrasts starkly with other countries worldwide. For example, CT has been a mandatory component of the primary school curriculum in England since 2014 (Sentance, 2017). This delay in implementing CT in the Indonesian curriculum places the country significantly behind its global counterparts.

Based on discussions with elementary school teachers in Tambang Sub-district, Kampar Regency, Pekanbaru, during prior service activities, it was revealed that these teachers lacked knowledge about CT and how to integrate it into mathematics learning at the elementary level. Consequently, the community service team selected these teachers as the target audience for implementing CT workshop activities. Moreover, these teachers had previously participated in community service activities and demonstrated strong motivation for ongoing learning and development. This aligns with research by Putra et al. (2022), which indicated low CT abilities among elementary school students in Pekanbaru. Hence, there is a pressing need for a Computational Thinking-based Mathematics Learning Development Workshop for Primary School Teachers. This workshop serves as an initial step in introducing teachers to CT and supporting them in designing CT-based learning. The activity aims to enhance teachers' knowledge about CT and develop their skills in designing mathematics learning that integrates CT in elementary schools. Thus, the primary goal of this community service activity is to increase CT knowledge among elementary school teachers in the Tambang Sub-district, Kampar Regency, Riau.

Method

A workshop focused on developing CT-based mathematics learning for elementary school teachers in Tambang Sub-district, Kampar Regency, was held from August 4 to August

12, 2023. The workshop utilized the Participatory Action Research (PAR) method, which prioritized experiential knowledge to address social issues and drive social change (Stoudt, 2007). PAR emphasized relationship-building and a shared understanding of challenges in schools. Implementing community Service using the PAR approach involved collaborative observation, problem analysis, planning, and implementing learning in the classroom (Cornish et al., 2023).

The workshop employed a blended learning approach, starting with a pre-test, material presentation, and discussion by the community Service team of FKIP Riau University at SDN 042 Kualu on August 4, 2023. Subsequently, from August 5 to 11, 2023, teachers worked in groups to design CT-based mathematics learning and tested it with students in their respective classes. On August 12, 2023, an online workshop was conducted via a Zoom meeting. Community service guest experts from Universiti Putra Malaysia reinforced CT in mathematics learning in elementary schools. Additionally, reflection on the workshop and pre-test of elementary school teachers' CT abilities was carried out. The steps for implementing community service are illustrated in Figure 1.

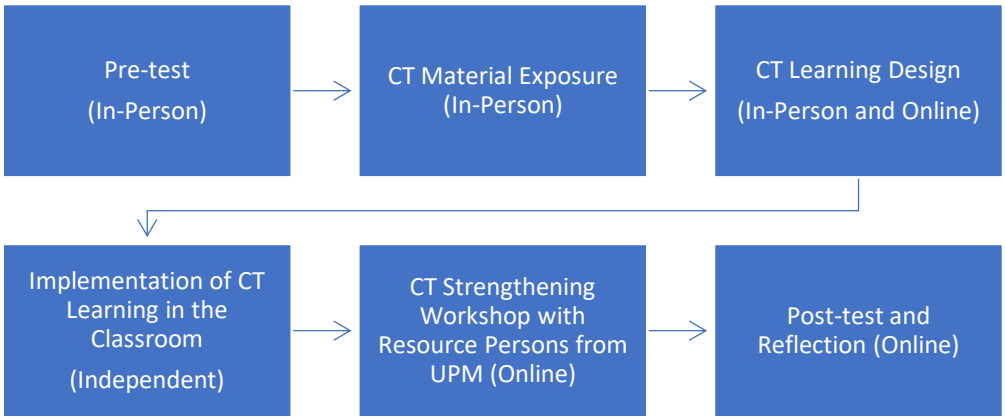

Figure 1. Flowchart of PkM Implementation

Participants in the CT-based mathematics learning workshop comprised 33 elementary school teachers from three partner elementary schools: SDN 008 Kualu, SDN 032 Kualu, and SDN 042 Kualu. The activity was conducted offline at SDN 042 Kualu. Participant information is presented in Table 1. The majority of participants taught in grade 1, with varying lengths of teaching experience ranging from 0 to over 25 years. The educational background of participants included S1 PGSD, Bachelor of Mathematics/ Mathematics Education, S1 Other Education, and Other S1. Most participants held the role of classroom teacher.

The instrument for measuring teachers' CT abilities used an instrument developed by Putra et al. (2022), previously employed in studies by Gunawan et al. (2023) and Safitri et al. (2023). The CT skills measurement instrument comprised 22 questions covering four CT skills: decomposition (5 questions), algorithms (5 questions), pattern recognition (6 questions), and abstraction and generalization (6 questions). Figure 2 provided an example of a question related to pattern recognition, grounded in the Malay cultural context. The questions were administered to workshop participants using Google Forms.

Table 1. Participant Information

Variable	Category	Amount	Percentage
Current Teaching	Grade 1	8	24.24%
	Grade 2	4	12.12%
	Grade 3	4	12.12%
	Grade 4	6	18.18%
	Grade 5	6	18.18%
	Grade 6	5	15.15%
Teaching Tenure	0 - 5 Years	12	36.36%
	6 - 10 Years	3	9.09%
	11 - 15 Years	10	30.30%
	16 - 20 Years	6	18.18%
	21 - 25 Years	1	3.03%
	Over 25 Years	1	3.03%
Educational Background	Bachelor of Elementary Education	15	45.45%
	Bachelor of Mathematics/Mathematics Education	4	12.12%
	Other Bachelors of Education	12	36.36%
	Other Bachelor Programs	2	6.06%
Role in School	Classroom Teacher	28	84.85%
	Islamic Education Teacher	5	15.15%

Figure 2 . CT questions related to Pattern Recognition

Results and Discussion

Workshop Activity Planning

The planning phase for the workshop activities focused on developing CT-based mathematics learning for elementary school teachers in Tambang Sub-district, Riau Province commenced with the preparation of a detailed activity plan by the community service team. The team meticulously crafted a program outlining various activities and materials provided to workshop participants. The implementation of this community service initiative was structured around a total of 32 lesson hours, encompassing diverse learning activities detailed in Table 2.

Table 2. CT Workshop Program for Elementary School Teachers

No	Activity	Time Allocation
1	Computational Thinking Skills	4 Academic Hours
2	Development of Mathematics Learning Based on Computational Thinking Skills	8 Academic Hours
3	Preparing Teaching Modules Based on Computational Thinking Skills	8 Academic Hours
4	Simulation of Mathematics Teaching Practices Based on Computational Skills	8 Academic Hours
5	Reflection	4 Academic Hours
Total Implementation Hours		32 Academic Hours

The community service Team then meticulously crafted the CT Module for the workshop participants. This comprehensive module consists of four chapters covering Introduction, Independent Curriculum and its Relationship to CT, CT Skills, and Preparation of CT-based Mathematics Teaching Modules. The module cover is illustrated in Figure 3, and Figure 4 displays a barcode accessible to teachers for all modules used in CT learning.

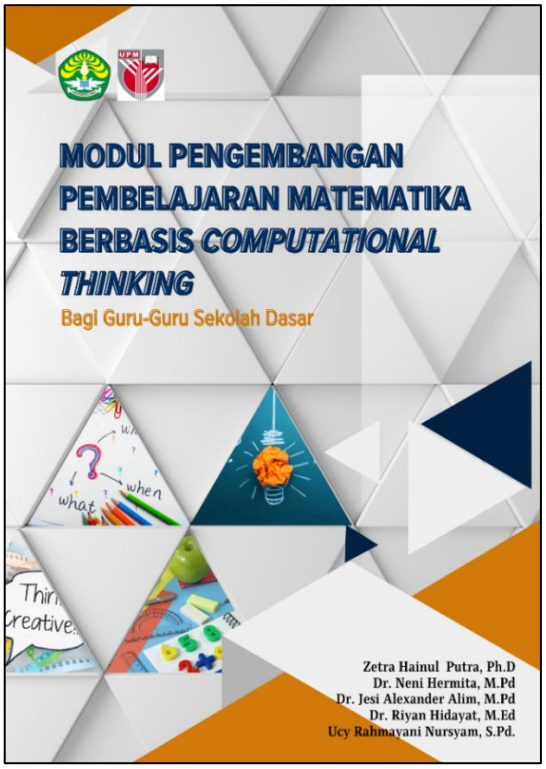

Figure 3. CT Module Cover

Figure 4. CT Module Barcode

Additionally, the community service team prepared CT questions adapted from previous research (Putra, Ramiati, et al., 2022), encompassing the four CT skills. These questions were presented through a Google Form to facilitate data collection. An illustrative example of the questions used is provided in Figure 2.

Implementation of Offline Workshop at SDN 042 Kualu

Workshop activities aimed at developing CT-based mathematics learning for elementary school teachers in Tambang Sub-district, Kampar Regency, Riau Province were conducted offline on August 4, 2023, at SDN 042 Kualu. The event was attended by 33 teachers from three elementary schools, with the participation of three school principals. The workshop commenced with an opening and welcoming remarks from the head of SDN 042 Kualu, expressing gratitude for the continuation of the community service activity, building upon previous successful workshops involving the school (Putra, et al., 2022a; Putra et al., 2022b).

The community service activity proceeded with administering a pre-test to assess the initial CT skills of the participants. Teachers exhibited great enthusiasm in tackling these questions as they necessitated analysis to formulate responses. Following the pre-test, the first resource person from the community service team delivered material on CT, elucidating the importance of instilling CT in elementary school students (Figure 5). The teachers displayed keen interest in the speaker's explanation, given that knowledge about CT was a novel concept for them.

The material presentation unfolded interactively, with participants providing additional examples of each CT skill presented. In Figure 6, participants were tasked with creating a CT question related to decomposition. One participant raised the inquiry of how to encourage students to think at a higher level, given the close relationship between CT and higher-order thinking. The resource person illustrated this by offering open-ended questions to students and representing the questions visually, as shown in Figure 4. For instance, when presenting a frame to first-grade elementary school students containing 10 objects, of which 6 are colored, the students need to be prompted with questions such as how many objects are colored and how the children identify them. Developing questions that stimulate higher-level thinking is

crucial to cultivating students' cognitive skills.

Figure 5. Resource person explained ct to workshop participants

Figure 6. Resource person discussion with participants who asked questions

The second speaker delved into the preparation of teaching modules aligned with the Indonesia's Emancipated Curriculum. Teachers were provided insights into constructing effective teaching modules, including the essential components. Additionally, examples of teaching modules for mathematics learning, integrating CT, were shared with the teachers. Subsequently, teachers engaged in small group discussions to share their opinions and collaboratively develop CT-based mathematics teaching modules for implementation in their respective classes.

Implementation of CT-based Mathematics Learning

For one week, teachers were tasked with designing CT-based mathematics learning and implementing the designs with students in their respective classes. Teachers were required to create video recordings of their learning implementation. The community service team

observed that the majority of teachers successfully executed CT-based mathematics learning. Figure 7 illustrates one teacher's implementation, focusing on the topic of fractions. The teacher presented material on fractions, emphasizing the representation of fractions through diagrams and symbols. This approach aligns with CT skills, particularly decomposition, involving adjustments to the size of fraction representations using symbols. Additionally, the skill of determining the size of fractions is closely linked to students' number sense abilities (Witri et al., 2015).

Figure 7. Teacher Guiding students in CT-based Mathematics Learning

Implementation of Online *Workshops*: Strengthening and Reflection

The workshop on the 12th continued with online sessions strengthening CT skills featuring guest speakers from Universiti Putra Malaysia (Figure 8). The resource person provided reinforcement regarding CT skills and their relevance to mathematical modeling and its application in elementary school mathematics learning. The online workshop activities proceeded smoothly, with high enthusiasm observed among participants.

The subsequent workshop focused on reflections related to the implementation of the workshop, spanning approximately one week. Teacher representatives expressed that they gained new knowledge about CT skills and recognized the need for serious effort in implementing them in the classroom, as this was a novel concept for them. They expressed hope for future follow-ups to this workshop. Following this, the community service team administered a post-test to workshop participants to assess the improvement in their CT skills during the activity.

Figure 8. Reinforcement of CT Skills by Guest Speakers

Improving CT Skills of Teachers

The improvement in CT skills among teachers who participated in the workshop was evident from their performance in answering CT questions in the pre-test and post-test. As depicted in Figure 9, teachers' CT abilities increased from 47.25% before the workshop to 53.17% after the workshop. Despite the improvement, it remains suboptimal. This highlights that the brief duration is a contributing factor limiting a significant increase in teachers' CT knowledge. Teachers require additional processing time to absorb new knowledge effectively for later application in the classroom.

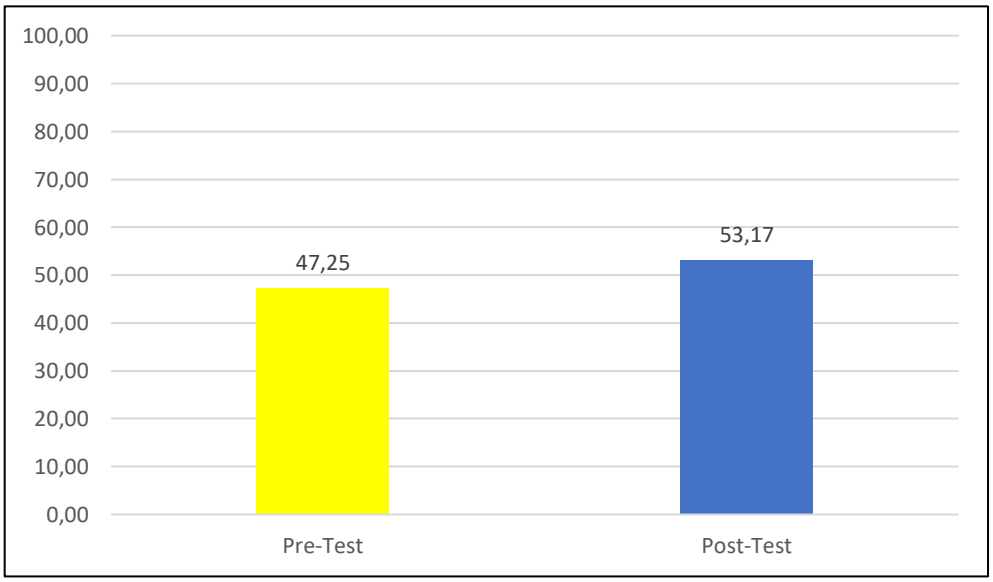

Figure 9 . Teachers' Computational Thinking Skills Before and After the Workshop

The implementation of a CT-based mathematics learning workshop for elementary school teachers in Tambang Subdistrict is progressing smoothly. Teachers have shown considerable enthusiasm for participating in both offline and online workshops. Some teachers have successfully developed CT-based mathematics learning and incorporated it into their respective classes. While there has been an increase in CT skills, it has not reached an optimal

level due to the limited duration of the workshop. Teachers have not had sufficient time to fully grasp and apply CT skills in mathematics learning within their classrooms. The modest improvement in teachers' CT skills is attributed to the fact that CT is a relatively new topic for elementary school teachers and is not yet integrated into the mathematics curriculum in Indonesia (Gunawan et al., 2023; Putra, et al., 2022; Safitri et al., 2023).

Teacher CT is currently categorized as moderate (Figure 9), aligning with findings from previous studies by Gunawan et al., (2023) Putra, Ramiati, et al., (2022) and Safitri et al. (2023), all indicating that the CT skills of elementary school students are still in the early stages of development. In response, concerted efforts are needed to enhance teacher CT, including the development of professional programs to support its improvement.

The implementation of CT workshops using a blended learning model has proven to be effective in supporting community service activities. However, to allow teachers more time for the development of their CT skills, the workshop duration should be extended across multiple sessions. Meanwhile, a study conducted by (Hermita et al., 2023) suggests that the blended learning workshop model is no more effective than hybrid learning. Therefore, future workshop implementations should consider adopting a hybrid learning model to further enhance the development of teacher CT.

Conclusion

The implementation of a CT-based mathematics learning workshop for elementary school teachers in Tambang Subdistrict has been executed effectively. Teachers have demonstrated the ability to design CT-based learning; however, there is still room for improvement in teachers' CT skills, which remained in the medium category at the conclusion of the workshop. Consequently, it is imperative to conduct additional workshops aimed at fortifying and sustaining teacher CT skills. Extending the duration of the workshops and considering a hybrid learning approach is recommended.

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