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Prospective Elementary Teachers' Computational Thinking Skills: A Preliminary Study

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***Abstract*—Computational thinking refers to thinking and solving issues in the same way as computer scientists do. This study aims to evaluate the computational thinking skills of prospective elementary teachers. This study uses a quantitative descriptive research method. The research instrument uses a computational thinking skills test containing four indicators, namely decomposition, algorithm, pattern recognition, abstraction/generalization. The subjects of this study were 244 prospective elementary teachers from a Study Program of Elementary School Teacher Education at a public university in Pekanbaru, Riau, Indonesia. The results of this study indicate that the computational thinking skills of prospective elementary teachers are in the moderate category. Among the four indicators, prospective elementary teachers' skills of decomposition and pattern recognition are higher than algorithm and abstraction/generalization.**

Keywords—abstraction, algorithm, computational thinking skills, decomposition, pattern recognition

I. INTRODUCTION

A sign that the twenty-first century has begun is the advancement of digital technology. In the twenty-first century, technology is starting to take over the roles previously held by human resources, prompting individuals to continuously enhance their skills in order to stay competitive in the changing world. Skills required in this era include critical thinking, communication, leadership, teamwork, flexibility, productivity, and accountability, along with the ability to access, evaluate, and synthesize information. [1]. Therefore, individuals need to continually adapt and develop new skills in various areas, especially in the field of education. Education needs to include knowledge, attitudes, skills, and an understanding of information and communication technology to equip students for twenty-first century living [1], [2]. Amidst the intense competition of global shifts, these skills are essential. Computational thinking skills are one of the capabilities that drive the progress of information and technology. [3], [4]

Computational thinking originates in computer science but transferable to various fields, is a problem-solving approach, especially in mathematics. [5], [6], [7]. A lot of countries around the world are familiar with computational thinking, and the idea is even taught in school curricula [8]. Computational thinking is taught not just in high schools but also in junior high and primary schools [9]. But research on computational thinking is still limited in Indonesia, and its application in classrooms is still relatively new [10]. Actually, computational thinking skills must be taught to students in order for them to be able to solve problems and find a solution. This applies particularly to math classes. Additionally, future elementary educators need to learn computational thinking skills to incorporate them into teaching at the elementary level.

Essentially, computational thinking consists of four fundamental skills: decomposition, algorithms, pattern recognition, and abstraction/generalization. [7], [11], [12], [13], [14]. Decomposition corresponds to an individual's capacity to recognize and dissect issues into more manageable or easier components. An illustration of this is when 6 is broken down into 5 and 1. Someone requires this skill in order to facilitate problem-solving. Algorithmic thinking is related to a person's ability to create structured problem-solving steps. This can be analogized with a computer algorithm that runs through a series of certain stages. Furthermore, pattern recognition is related to a person's skills in learning patterns of numbers or non-numbers by using them in solving problems by recognizing the same problems in different cases. Finally, abstraction/generalization is related to a person's ability to find solutions by using information filtered from previous problems in similar cases. These four computational thinking skills are the basic foundation for everyone, including prospective elementary school teachers, in supporting students in learning and solving problems.

Several previous studies have investigated students' computational thinking skills [4], [12], [13]. Gunawan et al., [12] conducted a study on the analysis of elementary school students' computational thinking skills. The results of the study showed that students still have low computational thinking skills. Research conducted by Safitri et al. [13] also showed that elementary school students' computational thinking skills are still low. In addition, computational thinking skills do not have a significant relationship with elementary school students' self-efficacy abilities. Nevertheless, there is still a lack of research on the computational thinking abilities of future elementary educators. Thus, the goal of this research is to evaluate the computational thinking abilities of future elementary school educators.

II. METHODS

Qualitative descriptive is the research methodology employed in this study [15]. This research seeks to offer an

outline of prospective elementary teachers' computational thinking skills. This research was carried out at an Elementary School Teacher Education Study Program in a public university in Pekanbaru, Riau, Indonesia. 244 prospective elementary school teachers in their initial, second, and third year of training were the participants in this research.

This research utilizes computational thinking exercises created by Putra et al., [11] and previously employed by Gunawan et al., [12] and Safitri et al. [13] to assess the computational thinking abilities of elementary school students. The number of tasks is 22 which are divided into 4 indicators of computational thinking skills as presented in table I below:

TABLE I. CATEGORY OF PROSPECTIVE ELEMENTARY TEACHERS' COMPUTATIONAL THINKING SKILLS

No	Indicators	Number of tasks
1	Decomposition	5
2	Algorithm	4
3	Patter recognition	6
4	Abstraction/Generalization	7

Computational thinking tasks used in the form of multiple-choice questions. An example of computational thinking task is presented in figure 1. The task is to evaluate prospective elementary teachers' patter recognition skills [11], [12], [13]. The tasks were given to prospective elementary teachers using Google Form to facilitate data collection. Data collection was carried out during the 2023/2024 academic year.

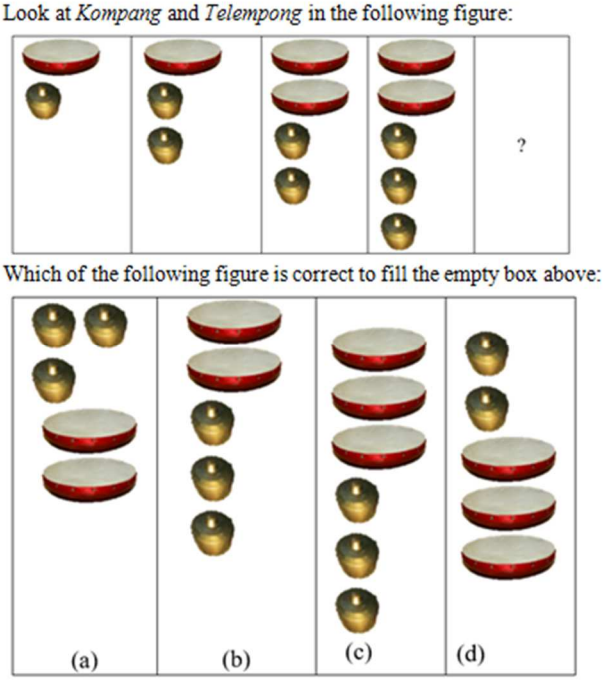

Fig. 1. A computational thinking task of pattern recognition

The data analysis technique in this study used descriptive statistical data analysis. The research data is presented in the form of a frequency distribution table as presented in Table II. The scores obtained by each prospective elementary teacher were converted to a maximum value of 100 or 100% to make it easier to categorize their computational thinking skills.

TABLE II. CATEGORY OF PROSPECTIVE ELEMENTARY TEACHERS' COMPUTATIONAL THINKING SKILLS

No	Score	Category
1	$0 \leq S \leq 20$	Very Low
2	$20 < S \leq 40$	Low
3	$40 < S \leq 60$	Average
4	$60 < S \leq 80$	High
5	$80 < S \leq 100$	Very High

III. RESULTS

Prospective elementary teachers' computational thinking skills in general are presented in table II. Although 42.21% of prospective elementary teachers are having high computational thinking skills, the mean score is 58.12% in average category with standard deviation score is 16.07. Almost 15% of prospective elementary teachers have low computational thinking skills. One prospective elementary teacher only can give 3 correct answers out of 22 computational thinking tasks, and one prospective elementary teacher could reach the score of 90.92% (only 2 incorrect answers).

TABLE III. PROSPECTIVE ELEMENTARY TEACHERS' COMPUTATIONAL THINKING SKILLS

No	Score	Category	N	Percentage
1	$0 \leq S \leq 20$	Very Low	3	1.23
2	$20 < S \leq 40$	Low	33	13.52
3	$40 < S \leq 60$	Average	96	39.34
4	$60 < S \leq 80$	High	103	42.21
5	$80 < S \leq 100$	Very High	9	3.69
Total			244	

Prospective elementary teachers' computational thinking skills of decomposition are presented in table III. 42.62% of prospective elementary teachers are having high computational thinking skills of decomposition, and the mean score is 66.72% in high category with standard deviation score is 22.82. However, it is still above 20% of prospective elementary teachers have low computational thinking skills of decomposition. It is the highest skills reaching by prospective elementary teachers comparing to the other three skills.

TABLE IV. PROSPECTIVE ELEMENTARY TEACHERS' COMPUTATIONAL THINKING SKILLS OF DECOMPOSITION

No	Score	Category	N	Percentage
1	$0 \leq S \leq 20$	Very Low	21	8.61
2	$20 < S \leq 40$	Low	34	13.93
3	$40 < S \leq 60$	Average	57	23.36
4	$60 < S \leq 80$	High	104	42.62
5	$80 < S \leq 100$	Very High	28	11.48
Total			244	

Prospective elementary teachers' computational thinking skills of algorithm are presented in table IV. 43.03% of prospective elementary teachers are having average computational thinking skills, and the mean score is only 38.52% in low category with standard deviation score is 20.07. This is the poorest skills having by prospective elementary teachers. More than 45% of prospective elementary teachers have low computational thinking skills of algorithm. None of them could reach the very high category.

TABLE V. PROSPECTIVE ELEMENTARY TEACHERS' COMPUTATIONAL THINKING SKILLS OF ALGORITHM

No	Score	Category	N	Percentage
1	$0 \leq S \leq 20$	Very Low	23	9.43
2	$20 < S \leq 40$	Low	92	37.30
3	$40 < S \leq 60$	Average	105	43.03
4	$60 < S \leq 80$	High	25	10.25
5	$80 < S \leq 100$	Very High	0	0.00
Total			244	

Prospective elementary teachers' computational thinking skills of patter recognition in table V. More than 70% of prospective elementary teachers are having high computational thinking skills of pattern recognition. The mean score is slightly below the score of decomposition skills, namely 65.78 in high category with standard deviation score is 20.24. Only less than 12% of prospective elementary teachers have low computational thinking skills of pattern recognition. This skill is also the most prospective elementary teachers reaching the very high category.

TABLE VI. PROSPECTIVE ELEMENTARY TEACHERS' COMPUTATIONAL THINKING SKILLS OF PATTERN RECOGNITION

No	Score	Category	N	Percentage
1	$0 \leq S \leq 20$	Very Low	11	4.51
2	$20 < S \leq 40$	Low	18	7.38
3	$40 < S \leq 60$	Average	44	18.03
4	$60 < S \leq 80$	High	78	31.97
5	$80 < S \leq 100$	Very High	93	38.11
Total			244	

Prospective elementary teachers' computational thinking skills of abstraction or generalization are presented in table VI. Although 60.98% of prospective elementary teachers are having high and very high computational thinking skills, the mean score is 56.03% in average category with standard deviation score is 123.39 (the highest standard deviation among others). More than 23% of prospective elementary teachers have low and very low computational thinking skills of abstraction and generalization. However, most prospective elementary teachers have an average computational thinking skill of abstraction or generalisation.

TABLE VII. PROSPECTIVE ELEMENTARY TEACHERS' COMPUTATIONAL THINKING SKILLS OF ABSTRACTION OR GENERALISATION

No	Score	Category	N	Percentage
1	$0 \leq S \leq 20$	Very Low	17	6.97
2	$20 < S \leq 40$	Low	40	16.39
3	$40 < S \leq 60$	Average	87	35.66
4	$60 < S \leq 80$	High	49	20.08
5	$80 < S \leq 100$	Very High	51	20.90
Total			244	

IV. DISCUSSION AND CONCLUDING REMARKS

The results of this study indicate that the computational thinking skills of prospective elementary teachers are in the average category. This skills is slightly higher than the skills of elementary school students, which are in the low category [12], [13]. However, with this ability, of course prospective teachers cannot be said to have adequate computational thinking skills and be able to teach elementary school students when they become teachers later. This also indicates that they do not yet have sufficient skills that are in line with 21st century skills.

Among the four computational thinking skills, prospective elementary teachers have good skills in decomposition and pattern recognition skills, while algorithm skills are in the low category. When compared with the results of a study conducted by Gunawan et al., [12] the results of this study are almost similar, namely that elementary students have better skills in pattern recognition followed by decomposition. Algorithm thinking is also the lowest skill compared to the other three skills [12].

Given the results of this study indicate that the computational thinking skills of prospective elementary teachers are still low, it is necessary to develop instructional learning that can support their computational thinking skills. For instance, Dia et al. [7] has developed a supplementary textbook of computational thinking that can be used to support the computational thinking skills of students and prospective elementary teachers. Besides, the use of technology in teaching computational thinking could be an alternative for supporting prospective elementary teachers' skills. As showed by a study conducted by Putra et al., [16] that integration of digital technology in elementary teacher education give a chance for them to develop their mathematical and didactic knowledge. Future research needs to intervene in mathematics learning in universities to support the computational thinking skills of prospective elementary school teachers.

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