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How Prospective Mathematics Teachers Do Computational Thinking (CT) Task? : An Analysis Of CT Prior Knowledge

Dwi Maulida Sari [1], Suhendra[2*], Elah Nurlaelah[3]
[1,2,3] Program Studi Pendidikan Matematika, Universitas Pendidikan Indonesia, Indonesia.
*Corresponding Author. E-mail: suhendra@upi.edu[2]
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Abstract

The purpose of writing this article is to find out about the initial Computational Thinking ability of prospective mathematics teacher students. This is because the 21st century demands changes in human resources (HR) to be more superior and competitive. Excellent and competitive human resources require the ability of Computational Thinking (CT), because it can help a person develop critical, creative, and analytical thinking skills in solving complex problems, both in the context of computing and everyday life. Improving the quality of human resources cannot be separated from the implementation of education in preparing this requires an educator who has the capability to be able to provide good and effective learning. Students that are expected to become professional teachers in the field of mathematics education in the future must have good CT ability. So, the condition of prior CT ability of Tadris Mathematics Education students as mathematics teacher candidates needs to be investigated. The method used in this article is qualitative research with a descriptive approach, with the aim of describing the prior CT abilities of prospective mathematics teachers, namely Tadris Mathematics Education students. Based on the analysis of the answers and further interviews of students which are prospective mathematics teachers, it is concluded that the CT ability is still low and not good, especially in the indicators of pattern recognition, algorithms, abstraction and generalization. So it is necessary to develop a learning or approach that can improve the CT ability of prospective mathematics teachers.

Keywords: computational thinking ability, prospective mathematics teachers, CT prior knowledge

INTRODUCTION

The 21st century are characterized by the Industrial Revolution Era 4.0 and the society era 5.0 which requires world become progressively competitive. This challenges requires changes in human resources (HR) to become more superior and competitive ((Sajidan et al., 2021; Teknowijoyo & Marpelina, 2021)). This means that to face the

changes and challenges of the 4.0 and 5.0 eras, it is necessary to improve the quality of human resources to be superior and competitive through increasing the abilities that must be possessed. One of the abilities that must be possessed to create superior and competitive human resources is the ability of Computational Thinking (CT). In accordance with what was conveyed by OECD, 2018 and Tresnawati et al., 2021 and Supiarmo et al., 2022 which states that Computational thinking is needed in 21st century because it helps and facilitates students in solving mathematical problems by involving various skills and techniques that train students to break down problems into small parts that are easy to solve. In addition, computational thinking can also stimulate students to think creatively in solving problems.

Computational thinking is a skill in solving problems effectively in formulating problems to provide answers by decomposition, pattern recognition, algorithmic thinking, abstraction and generalization. Abstraction is the process of focusing on the data needed in problem solving (Ezeamuzie, 2023). In the decomposition indicator, complex problems can be solved into easy to understand and simpler and easier to solve (Nuraisa et al., 2019) In solving a given problem, algorithmic thinking is the skill of stating step by step in an organized manner. Generalization is the ability to recognize known parts of the problem, or solutions that have been found on a given problem, thus leading to an easier way to design algorithmic. (Kılıç et al., 2021). Based on the explanation above, the indicators of CT ability that will be measured in this article are decomposition, pattern recognition, algorithms, abstraction and generalization.

CT ability is very important because it can help a person develop critical, creative, and analytical thinking skills in solving complex problems, both in the context of computing and everyday life. This is in accordance with Christi & Rajiman (2023) and Isharyadi and Isharyadi & Juandi (2023) who stated that CT helps a person develop skills in designing and implementing effective solutions, being able to identify errors or weaknesses in a solution and correct them quickly, besides that CT can also help learners to solve math or science problems more easily.

In PISA 2021 computational thinking ability is one of the aspects measured in mathematics, globally based on OECD average results it was found that 69% of students globally had achieved at least Level 2 in mathematics, Indonesia is much lower than the average across OECD countries which obtained only 18%. Almost no students in Indonesia excel in math, meaning they reach Level 5 or 6 in the PISA math test while the OECD average is 9% (OECD, 2023). At this level, students can model complex situations mathematically, and can select, compare and evaluate appropriate problem-solving strategies to address them. Based on the PISA results, it can be seen that the computational thinking ability of students at levels 5 and 6 is still very low, seen in the indicators of pattern recognition, abstraction, algorithms and also generalization.

The importance of CT skills is in line with the objectives of mathematics education formulated by the government of the Republic of Indonesia where the thinking skills that must be possessed by students are problem solving skills, the ability to think logically, critically, systematically creatively and many other abilities. Based on Permendikbud No. 5 of 2022 (KEMENDIKBUDRISTEK RI, 2022).In line with the explanation above, CT ability is one of the important abilities to have because this CT aspect is one of the abilities

measured in the mathematics assessment in PISA in 2021. (OECD, 2018). Zahid (2020) said that the measurement of students' computational thinking ability in PISA 2021 indicates that the government must have begun to realize the importance of computational thinking to be implemented in the education curriculum. Based on the explanation above, it can be seen that the ability to think computationally is very important to be owned by students and also cannot be separated from teachers to be able to realize the development of human resources in Indonesia.

Improving the quality of human resources cannot be separated from the implementation of education, the same also applies in Indonesia. The government and educational institutions must change the paradigm to continue to pay attention to the function of the implementation of education. The development of education, especially in Indonesia, needs to be carried out continuously, namely by making changes and preparing superior and innovative graduates with the required skills. In preparing this, an educator who has the ability to deliver learning well and effectively is needed. This is in accordance with what is conveyed by (CUPM, 2004) where it is said that an educator must have the ability to help learners to develop solid knowledge, thinking skills and communication skills, understanding and experience and motivation.

Students majoring in tadris / mathematics education (TMM) are expected to become professional teachers in the field of mathematics education in the future, who also contribute to realizing the goals of education in Indonesia to form superior and competitive human resources so that TMM students are also required to have qualified prerequisite competencies as proposed by the government, namely having sufficient experience, qualified knowledge, good and correct attitudes to have a positive impact on improving achievement, learning outcomes and mathematical abilities, including CT abilities. Based on this explanation, the condition of CT ability of TMM students also needs to be investigated to determine the condition of the ability of prospective teachers who will carry out education in the future professionally.

METHODS

The method used in this article is qualitative research. According to Sugiyono (2020), qualitative research methods are research methods based on the philosophy of postpositivism, used to research on natural object conditions, (as opposed to experiments) where the researcher is the key instrument, sampling of data sources is done purposively and snowbaal, collection techniques with triangulation (combined), data analysis is inductive / qualitative, and qualitative research results emphasize meaning rather than generalization. A qualitative research is explored and deepened from a social phenomenon or a social environment consisting of actors, events, places and times. Qualitative research is conducted because researchers want to explore non-quantifiable phenomena that are descriptive in nature such as the process of a work step, the formula of a concept, the notions of a diverse concept, the characteristics of a good and service, images, styles, procedures of a culture, physical models of an artifact and so on (Arikunto, 2019).

Sample used in this article are 48 tadris mathematics students in 3rd semester from one university in Padangsidimpuan city. Data is obtained through the question of instruments that have already been valid and reliable. There are 3 questions, each question contains 4 indicators of computational thinking ability, namely decomposition, pattern recognition, algorithms and abstraction and generalization. From the answers given by students, additional validation was carried out through more in-depth interviews. The qualitative research approach that the author uses in this research is descriptive with the aim of describing the prior CT abilities of prospective mathematics teacher candidates for mathematics education, so that the condition of CT ability of prospective mathematics teacher candidates is known. So that teachers, lecturers also the prospective mathematics teacher candidates can develop an appropriate learning process to be able to develop the CT abilities of prospective mathematics teacher candidates.

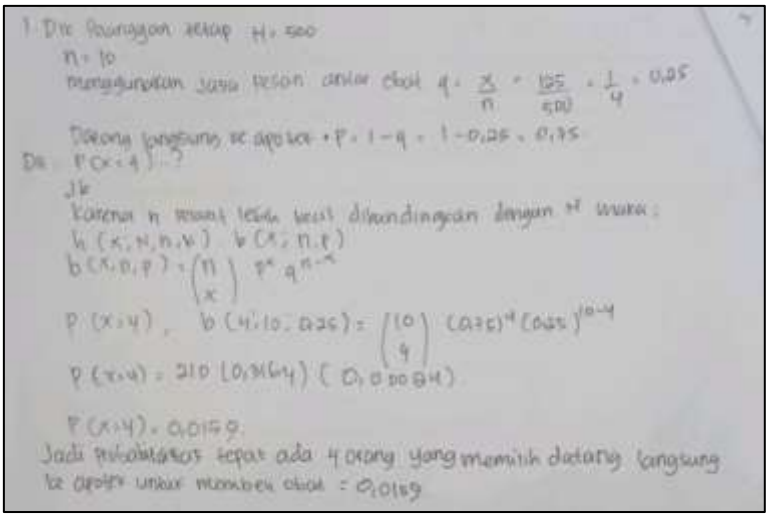
RESULTS AND DISCUSSION

The results in this article are the answers given by students as the prospective mathematics teacher to the CT ability test, and it was found that the overall condition of the CT ability of prospective mathematics teacher students was not in good condition. A total of 48 students who took this test showed that there were difficulties experienced by prospective mathematics teachers. The following are the test questions, answers and excerpts from interviews conducted with prospective math teacher students. Students who have high CT ability are able to solve each problem correctly up to the algorithm and abstraction stages. Students who are only able to solve problems correctly up to the pattern recognition stage, are students with moderate CT ability, this is because students have been able to decompose the problem, and find the appropriate pattern for the given problem. Students with low CT ability are students who only managed to answer correctly at the decomposition indicator stage.

In problem number 1, prospective math teacher students were asked to determine the exact probability that there were 4 customers who chose to shop directly at the pharmacy. This problem is structured by containing CT ability indicators, namely decomposition, pattern recognition, abstraction algorithms and generalization. These four indicators require students to write the required information clearly, and show the pattern of answers that can be arranged to carry out the algorithmic process as well as abstraction and generalization or convey the final conclusion on the entire series of answers.

A pharmacy reports that among their 500 regular customers, 125 people choose to use the phone delivery service. If 10 of the regular customers are taken at random, what is the probability that exactly 4 of them choose to come to the pharmacy to buy medicine?

Figure 1. CT proficiency test question number 1



Known : Reg. Customer N = 500, n =10, using online to shop $q = \frac{x}{n} = \frac{125}{500} = \frac{1}{4} = 0,25$
Customer shop on the spot : p= 1-q = 1-0,25 =0,75
Question : P (x=4) = ...?
Answer:
Since n is relatively smaller than N, h(x;N,n,k), b(x;n,p) so

$$b(x,n,p) = \binom{n}{x} p^x q^{n-x}$$

$$p(x=4), b(4,10,0.25) = \binom{10}{4} 0,75^4(0,25)^6$$

$$P(x=4) = 0,0159$$

so the probability that there are exactly 4 people who choose to come directly to the pharmacy to buy medicine is 0.0159.

Figure 2. Student 1's answer to question number 1 in Indonesia and English

Based on the results of the answers and interviews conducted with prospective mathematics teacher 1, prospective mathematics teachers wrote in detail the information needed to be able to solve this problem, this shows that prospective mathematics teachers already have decomposition indicators in CT ability. on the pattern recognition indicator, prospective mathematics teachers have also been able to sort the required patterns, namely on the probability of customers shopping directly to pharmacies and shopping via delivery messages, and use this pattern to perform the solution algorithm with the appropriate steps so that prospective mathematics teachers get the appropriate results and continue with the abstraction and generalization indicators by making the final conclusion of the given problem. Based on the interview, prospective mathematics teacher 1 said that after reading the problem, the first step is to compile what is needed to be able to solve the problem and then use the information needed to solve the problem. This shows that prospective mathematics teacher 1 students on question number 1 have good CT skills. But of the 48 prospective mathematics teachers who took the test, only 5 were able to answer like this, the rest were not perfect and made mistakes in solving the problems given. As seen in the answer of prospective mathematics teacher student number 2 below.

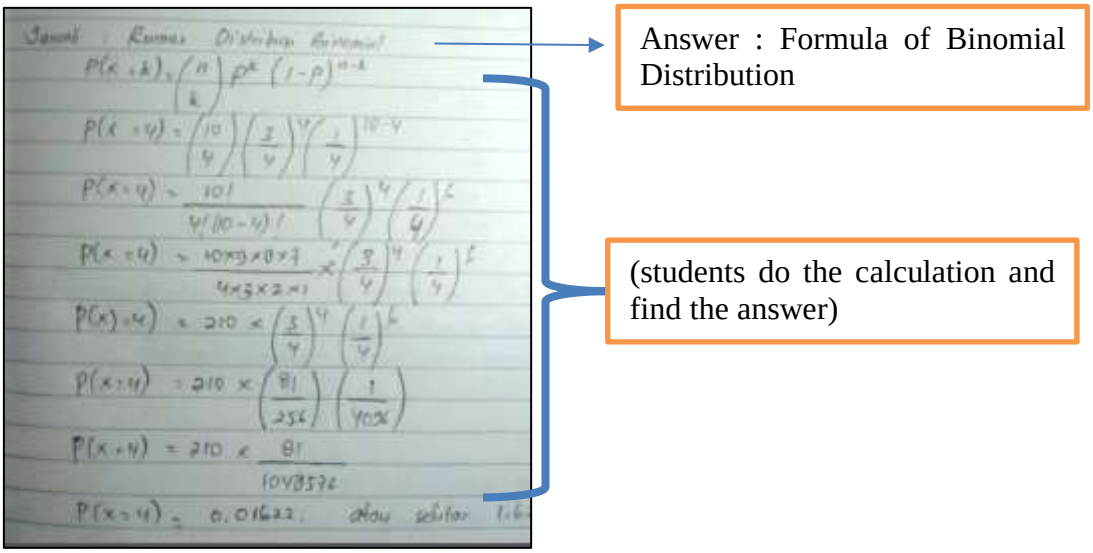


Figure 3. answers of Student prospective mathematics teacher 2 for question no. 1

From the results of the answers of prospective mathematics teacher student number 2, it can be seen that students don't do the decomposition indicator, Students do fairly good pattern recognition, where prospective mathematics teacher students have written down the needs to solve the problem, but in the algorithm and abstraction indicators, prospective mathematics teacher students do not use the information they found and instead write down the initial information so that when doing the algorithm there is an error in the calculation, Although this error is only a small distance, it shows that prospective mathematics teacher 2 does not use the information he has obtained properly from the indicators of decomposition and pattern recognition to make it easier for him to solve the problem given, and prospective mathematics teacher 2 also does not perform abstraction and generalization so that the answer only stops at P (X = 4) = 0.1622 which does not describe what this number describes or explains. This shows that prospective mathematics teacher 2 and other prospective mathematics teachers who answered almost like the answer of prospective mathematics teacher 2 found problems in the algorithm, abstraction and generalization indicators of this CT ability. This may be because prospective mathematics teachers are accustomed to solving routine problems that do not describe the problem or a real condition from life or the environment.

In problem No. 2, prospective mathematics teacher students were asked to determine the amount of raw material production in July and determine the average production for the remaining months in 2023. This problem is prepared by containing CT ability indicators, namely decomposition, pattern recognition, abstraction algorithms and generalization. These four indicators require prospective mathematics teachers to write the information needed clearly, and show the pattern of answers that can be arranged to carry out algorithmic processes and abstraction to determine the solution to the problem given and generalize or convey the final conclusion on the entire series of answers.

A Paper Mill in 2023 can produce an average of 692kg of paper raw materials in 8 months. The amount of raw materials produced each month is presented in the table below.

Month	Paper Raw Materials (kg)
January	678
February	890
March	850
April	600
May	689
June	700
July	X
August	500

What was the production quantity of paper raw materials in July? If the company gives a target of increasing the average production of paper raw materials to at least 850 kg in one year 2023, then what is the average amount of paper raw materials that must be produced in the remaining months in 2023.

Figure 4. CT Ability Question Number 2

In problem number 2, almost all students answer with almost the same steps, but students do not perform indicators of decomposition and pattern recognition, students immediately answer without giving the required pattern in sequence or immediately starting the algorithm and abstraction, because they directly solve the problem without any sorting (abstraction) on the required data so that. Students at the time of generalization also did not adjust to the questions given in the problem, as a thought process students should be able to state the average in students in the last 4 months is 1166kg, and this is the minimum number. There are things that should not be written, and become wrong, and there are missing steps. The answer given by the student at the end is correct, but there is a missing pattern recognition step, this shows that students only memorize a problem solving process without understanding well why the step or problem solving process must be done. The student's answer is shown in the picture below.

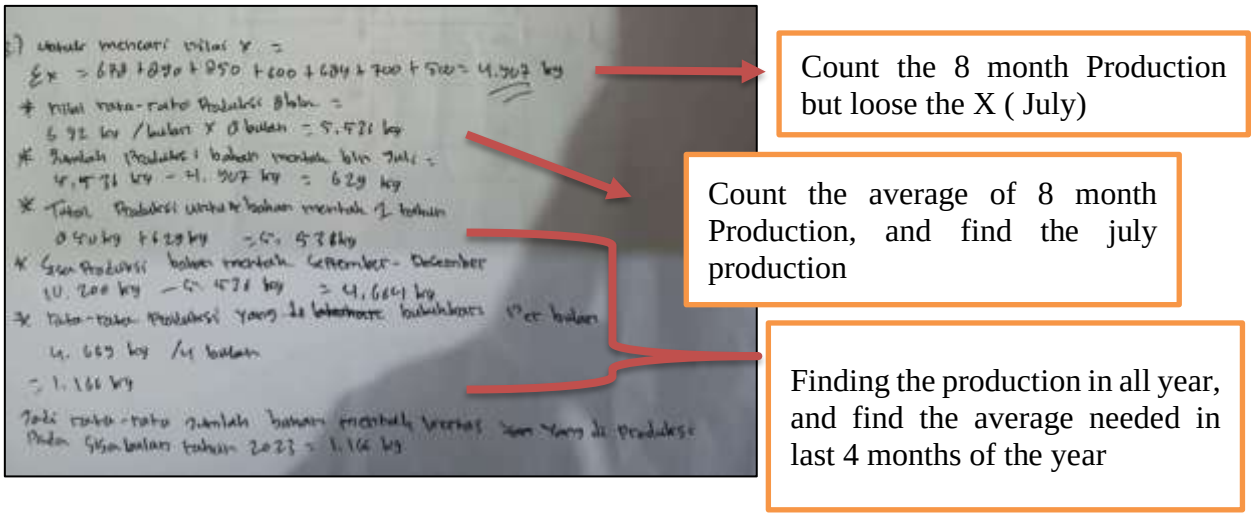


Figure 5. Answers of prospective math teacher 3 Problem Number 2

Based on this answer, it shows that prospective mathematics teachers do not arrange problem solving according to the order of the information obtained, prospective mathematics teachers solve problems with the experience they have, this shows that the CT ability of prospective mathematics teachers still has problems in the process of solving problems sequentially, this is not a problem if the problem given is clear with numbers and exact answers such as in problem no. 2 because they will get the appropriate answer even though the solution steps are not sequential and there are steps from the algorithm indicator missing. This becomes a problem if the pattern recognition is given using the nth order. As in problem no 3.

Bacterial colonies were released on a plate and observed every 15 minutes, resulting in the following data.

Growth Phase (15 minutes)	0	1	2	3	4
bacterial count	50	100	200	x	800

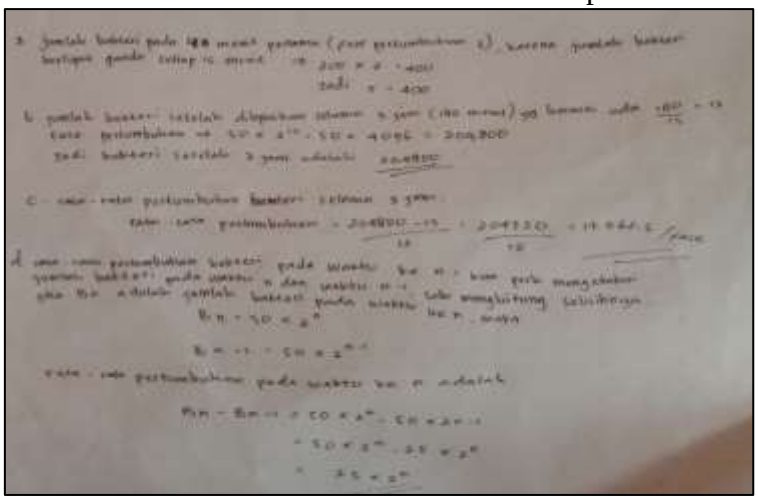
Based on the table, can you predict the number of bacteria in the first 45 minutes? What is the number of bacteria after being released for 3 hours? What is the average bacterial growth for 3 hours? What is the average bacterial growth at time n?

Figure 6. CT Ability Question Number 3

In problem no. 3, prospective mathematics teacher students were asked to determine the number of bacteria in the first 45 minutes and determine the number of bacteria at 3 hours and the average growth of bacteria at time n. This problem was designed to contain indicators of CT ability, namely decomposition, pattern recognition, abstraction algorithms and generalization. This question was prepared by containing CT

ability indicators, namely decomposition, pattern recognition, abstraction algorithms and generalization. These four indicators require prospective mathematics teachers to write the information needed clearly, and show the pattern of answers that can be arranged to carry out the algorithm and abstraction process to determine the solution to the problem given and generalize or convey the final conclusion on the entire series of answers.

Based on the answers of prospective mathematics teacher students, it can be seen that all prospective mathematics teacher students did not succeed in solving this problem, prospective mathematics teacher students were only able to answer the first question which asked for the number of bacteria in the first 45 minutes. They did not perform decomposition and pattern recognition, so they could not determine the pattern to get the nth number of bacteria and also the average bacteria at the nth time. Through interviews, it was found that prospective mathematics teacher students only followed their friends' answers without understanding the meaning of the problem. This shows that prospective mathematics teacher students are not accustomed to and very rarely have the opportunity to build their understanding to separate the information needed and form patterns for a problem condition as a step to solve the problem so that during the problem solving process there are steps missing and even wrong in using information. The answers of prospective mathematics teacher students can be seen in the picture below.



a) The number of bacteria in the first 45 minutes, because the number of bacteria doubles every 15 minutes.
$200 \times 2 = 400$, so $X = 400$

b) the number of bacteria after being released for 3 hours (180 minutes) means there are
$180 \div 15 = 12$

growth phase → $50 \times 212 = 50 \times 4096 = 204800$, so the bacteria after 3 hours is 204800

c) the average bacterial growth for 3 hours is average bacterial growth at time n, need to know the number of bacteria at time n and time n-1. then calculate the difference. If B_n is the number of bacteria at time n and n-1
$B_n = 50x\ 2^n$
$B_{n-1} = 50 \times 2^{n-1}$
average growth at time n adl
$B_n - B_{n-1} = 50 \times 2^n . 50 \times 2^{n-1}$
$= 25 \times 2^n$

Figure 7. Answers of prospective mathematics teachers 4 question no. 3

Based on the answers of other prospective mathematics teacher students and also interviews with prospective mathematics teacher students, it was found that students are not accustomed to solving problems that require them to take steps to find suitable answer patterns, prospective mathematics teacher students are accustomed to solving problems according to the material or context with the formulas that are already available, not taking the step of introducing the information needed, prospective mathematics teacher students are accustomed to solving problems only with direct solving steps. The answers of prospective mathematics teacher students can be seen in the picture below.

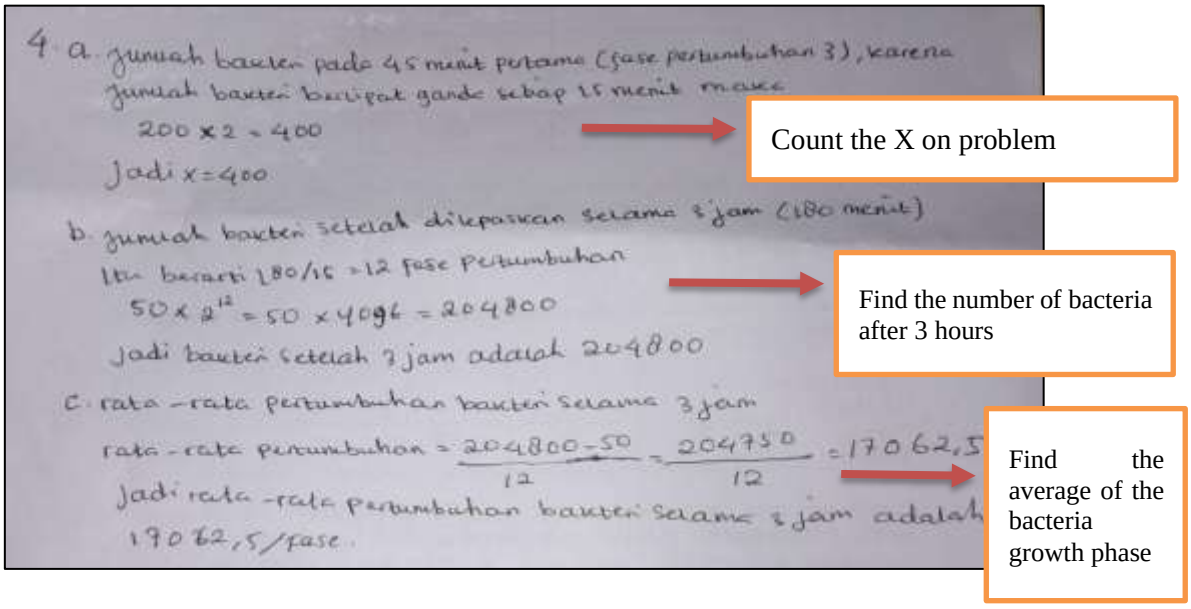


Figure 8. Student answers of prospective mathematics teachers 5 Problem No. 3

Based on the explanation above on questions with indicators of CT ability to prospective mathematics teachers at UIN Sheikh Ali Hasan Ahmad Addary Padangsidimpuan, it was found that the CT ability of prospective mathematics teachers was still low, and indicators of CT both decomposition, pattern recognition, algorithms, abstraction and generalization were not well owned by prospective mathematics teachers. Prospective mathematics teacher students are able to solve problems only on routine problems that use available formulas, not on problems that require prospective mathematics teacher students to develop patterns that are in accordance with the expected problem solving. This also shows the limited context in understanding the problems experienced by prospective mathematics teachers. The problem found is that prospective mathematics teacher students are unable to solve problems correctly due to their limited knowledge of basic statistical concepts related to averages. In addition, prospective mathematics teachers are accustomed to solving problems without understanding what information can be known and what is asked by the problem. This means that the CT ability of prospective mathematics teachers is still in poor condition, especially in the indicators of pattern recognition, abstraction algorithms and generalization. This is also shown from the overall test results, only 5 prospective mathematics teacher students who get a score greater than 70, meaning that 43 other

prospective mathematics teacher students are still below the minimum standard score determined by the study program.

The same thing was also found by Azmi & Ummah (2021) who suggested that the CT ability of prospective mathematics teachers is still low, indicated by the low ability of prospective mathematics teachers in solving problems, abstracting concepts and concretizing these concepts. Agreed by Angraini et al., (2022)who stated that the research carried out was motivated by the low ability of Computational Thinking (CT) of prospective mathematics teacher students as prospective teachers, even though this CT ability is needed by prospective mathematics teacher students because it will help prospective mathematics teacher students to get used to thinking logically, structurally and critically, besides that through CT this will make successive thinking processes that will be easier for others to understand, so a prospective teacher, especially prospective mathematics education teachers, really needs and is important to have this CT ability. This is strengthened by Marom et al., n.d. (2023) who states that Computational thinking ability has been characterized as a fundamental skill of the 21st century, and several trends are developing in various educational contexts to focus on the acquisition of computational thinking skills for teachers and probationary students. However, very little attention has been paid to prospective teachers in terms of CT skills and non-optimal computational thinking processes which lead to low CT ability .

CONCLUSION

Based on the analysis it can be concluded that the CT ability of prospective mathematics teachers is still low and poor, especially in the indicators of pattern recognition, algorithms, abstraction and generalization. The low CT ability because of limited context of understanding, difficult to e understanding the stages of solving and generalizing the problems given is due to not being accustomed to solving problems that require pattern recognition, this is due to the limited learning delivered to prospective mathematics teacher students not emphasizing CT skills, so it is needed to find a way to teach this course to prospective mathematics teachers which will improve their CT skills.

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