M A T H L I N E
JURNAL MATEMATIKA DAN PENDIDIKAN MATEMATIKA

ISSN 2502-5872 (Print)
ISSN 2622-3627 (Elektronik)

Volume 9 Nomor 2, May 2024, 365-380

COMPUTATIONAL THINKING SKILLS IN UNDERSTANDING THE LIMIT OF ALGEBRAIC FUNCTIONS

Lisa[1*], Hasratuddin[2], Bornok Sinaga[3], E. Elvis Napitupulu[4], Asmin Panjaitan[5]
[1] Departement of Mathematics Educations, Institut Agama Islam Negeri Lhokseumawe, Aceh, Indonesia
[2,3,4,5] Departement of Mathematics Educations, Universitas Negeri Medan, North Sumatra, Indonesia
*Correspondence: lisa.iainlsm@gmail.com

ABSTRACT
The purpose of this study was to determine the evaluation of *computational thinking* ability in understanding the limits of algebraic functions for students majoring in Tadris mathematics at Lhokseumawe State Islamic Institute. The research subjects were 1st semester students, totaling 6 students. Data collection techniques in this study used *computational thinking* ability tests and interviews, and then the data were analyzed based on *computational thinking* indicators, namely decomposition, pattern recognition, algorithm thinking, generalization, and abstraction. The results obtained from high *computational thinking* ability indicators that can be completed perfectly are decomposition, pattern recognition, algorithm thinking, and generalization/abtraction. With moderate computational thinking ability, students have been able to solve problems perfectly for indicators of decomposition and pattern recognition, but for indicators of thinking algorithms and generalizations or abstractions, they are still less precise. Low computational thinking ability has been able to measure decomposition indicators, but for pattern recognition indicators, thinking algorithms are still less precise in solving, while generalization and abstraction indicators do not answer.
Keywords: Computational Thinking, Limit Function, Algebra

How to Cite: Lisa, L., Hasratuddin, H., Sinaga, B., Napitupulu, E. E., & Panjaitan, A. (2024). Computational Thinking Skills in Understanding The Limit of Algebraic Functions. *Mathline: Jurnal Matematika dan Pendidikan Matematika*, *9*(2), 365-380. http://doi.org/10.31943/mathline.v9i2.549

PRELIMINARY

21st century skills students must be equipped with the skills needed to solve problems, so that people gain knowledge from their curiosity, and the skills needed today are Computational thinking which is one of the competencies needed in science education Lamprou & Repenning (2018), Park & Green (2019), and Sengupta et. al (2013), the same thing was conveyed by Sengupta et. al (2013) and Woongbin (2022). Computational Thinking (CT) is an essential competency in the information-oriented smart society of the 21st century. Computational thinking is an alternative approach to abstract problem solving by developing the skills set within its framework; by using computational technology, individuals understand a way of thinking essential in the digital age (Alfaro-Ponce, et al., 2023).

Solving problems through computational thinking is not only applying concepts in solving problems, but focusing more on the process of solving them (Krisdiana, et al., 2018). Therefore, this is an important thing that students must have in 21st century learning to face the various challenges that exist. However, the reality is that math learning runs monotonously. This includes teachers presenting material, giving examples, practicing problems, checking student answers, and giving homework. As a result, students are less interested in developing their computational thinking skills, which results in low computational thinking skills (Marchelin, et al., 2022). In addition, students' ability to solve math problems is also still low (Zulfah, 2017). Many students are not accustomed to and even have difficulty in solving the form of problem solving problems, according to Dewi (2023) problem solving is one of the most important skills that cannot be separated from mathematics learning, one solution that can be used to overcome these problems is by applying computational thinking.

Wing (2006) defines computational thinking as problem solving using systematic and logical thinking, which includes data representation, the use of algorithms, hypothesis testing, problem decomposition, and the use of abstraction. In the world of computing, computational thinking is very important because it can help a person become more critical, creative, and analytical in solving problems, both in everyday life. In addition, computational thinking improves skills in designing and implementing effective and efficient technological solutions, as well as the ability to spot errors or weaknesses in solutions and correct them quickly. As stated by Wing (2008), computational thinking can help students solve science or math problems in school. According to (Park & Green, 2019) stated that CT is an important practice if students need to be equipped with competencies to become problem solvers in the 21st century. This is also agreed by Sengupta et al (2013) that computational thinking is expressed to indicate a thought process involved in formulating a problem and its solution so that the solution is represented in a concrete form carried out by information processors.

According to Woongbin (2022) the application of CT in science and mathematics education can help improve students' problem-solving skills, creativity, and mathematical modeling. This research shows that the application of CT in science and mathematics education can help increase students' interest and motivation in learning both subjects. This research shows that the application of CT in science and mathematics education can help prepare students to face challenges and opportunities in today's digital and information age.

The same thing was conveyed Strickland et al (2021) implemented CT education in an elementary math classroom, which adopted Scratch to teach students a series of CT concepts (e.g., sequence, repetition, and conditional) based on the learning content of fractions. The results reported that students better understood fraction knowledge and programming language applications after taking the experimental course. The above findings suggest that CT-integrated math classrooms are beneficial for students to develop math concepts in a block-based programming environment. This was also conveyed by (Fang, et al., 2023) Students are motivated to learn fractions during CT activities. This learning design provides a problem-solving learning environment for students to answer their own questions in a specific topic-fractions. However, students find it difficult to understand this concept especially when they have to perform addition or subtraction with different denominators in grade four or five. To overcome this problem, teachers need to apply different interventions to practice, apply and master mathematical concepts. (Hansen, et al., 2017). Furthermore, Ho et al (2021) highlighted that mathematics teachers should implement and create learning tasks that encourage computational thinking to forge mathematical ideas and improve mathematics learning. Based on our findings, the application of CT programming environment integrated into mathematics learning has the potential to increase students' learning motivation and interest in learning mathematics.

Previous research states the difficulty in solving problems related to the limit of algebraic functions, among others, is stated by (Nurhayati & Retnowati, 2019) Procedural errors include: incorrect writing of lim in running the limit, errors in substituting values into variables, errors in not simplifying the final result, or no answer, conceptual errors include errors in solving fractions, factoring errors, rationalization errors. The same thing was found by (Noto, et al., 2018) difficulty in connecting prerequisite material with problem limits, unable to write the limit symbol correctly, unable to apply the limit theorem, unable to determine the limit value at a point. The same thing was also conveyed by (Pratiwi, et al., 2021) students have difficulty understanding and proving the formal definition of limit. With the findings of some of the difficulties above, researchers are interested in evaluating students' computational thinking skills in understanding the limit of algebraic functions.

Awareness of the importance of improving computational thinking skills, namely the ability to solve problems with logical thinking and using computational tools (Angeli &

Giannakos, 2020). This ability is becoming relevant in an increasingly digitized world. The material of the concept of limits of algebraic functions in mathematics is a topic that often requires critical thinking and computational approaches in its understanding, through understanding this concept, students can understand the basics of calculus (Szydlik, 2000). For this reason, it is important to measure Computational Thinking: The ability of *computational thinking is* very important in today's digital era. Students need to be able to identify, analyze, and solve problems using a computational thinking approach. Developing digital learning modules with a focus on computational thinking can help students develop these skills. It is important to remember that computational thinking skills can be developed through practice, experience, and continuous learning.

Based on the explanation that has been conveyed by the researcher above, the purpose of this study is to determine the evaluation of Computational Thinking ability in understanding the Limit of algebraic functions on students majoring in tadris mathematics IAIN Lhokseumawe.

METHODS

The type of research used in this research is qualitative descriptive. Qualitative research method, meaning research method that aims to describe students' computational thinking abilities and difficulties experienced by students in solving algebra limit functions. The study was conducted at the State Islamic Religious Institute of Lhokseumawe in mathematics, the subject of the study is a student of the first semester of 6 students, after the computational thinking test of 22 students was selected 6 students to be interviewed with the details of 2 high skill students, 2 middle skill students and 2 low skill students. Data collection techniques in this study used *Computational Thinking* ability tests and interviews, then the data were analyzed based on *Computational Thinking* indicators, namely decomposition, pattern recognition, algorithm thinking, generalization and abstraction.

Data analysis in this study uses qualitative data, where data analysis is done after a learning action. The computational thinking skills test will be analyzed by six students with high, medium, and low abilities and analyzed per indicator of computational thought, while the interview results are analyzed descriptively. The data analysis technique of this research is (1) data collection, which is the collection of data by determining the score of each answer based on the guidelines of computational thinking. From the results of the test, computing ability thinking will be obtained for the take-up of the subject interview. (2)

Data reduction (data reduction) is the calculation of the result of the computerized thinking ability test to see if the computing thinking ability is categorized into high, medium, and low ability. Then, subjects with medium and lower ability will be selected to conduct the interview on the basis of their answers to the test of computing skills thinking. This is done to obtain clear information so that it can draw a conclusion. (3) data presentation (data display), re-collecting data from organized and categorized information, thus enabling the drawing of conclusions from such data. Data presentation in this study includes: presentation of data analysis of test results combined with the results of interviews with students (subjects of study) in the form of short descriptions, diagrams, and relationships between categories; and (4) verification/conclusion drawing and conclusion drafting carried out on the basis of analysis of data collected through tests, interviews, and field records.

RESULT AND DISCUSSION

The results of the study in the form of student answers related to solving computational thinking problems in understanding the limit of algebraic functions on students majoring in mathematics IAIN Lhokseumawe. Based on the results of the computational thinking ability test totaling 22 students on the limit material of algebraic functions, 2 students with high ability, 8 students with moderate ability and 12 students with low ability were obtained. From these results it can be said that the computational thinking ability of students is still low, for that it is necessary to evaluate where the difficulties of students in solving problems related to computational thinking.

Table 1. **Range of Values**

Ability level	Value Range	Number of Students
High	76 - 100	2
Medium	51 - 75	8
Low	0 - 50	12

From the data in Table 1, the interview subjects for high ability students are AN and QA, medium ability students are SP and FA, and low ability students are RA and MD. The following is a discussion of students' computational thinking abilities, while the questions used are as follows:

Sejenis penyakit menular disebabkan oleh bakteri yang memiliki spesifik kerja menyerang paru-paru. Bakteri tersebut biasanya menyebabkan batuk hebat pada orang yang terinfeksi saat jumlah bakteri mencapai 4.000. Misalkan jumlah bakteri dinyatakan sebagai fungsi N(t) = $\frac{12.000t}{15+2t}$ dalam puluhan, dengan t menyatakan waktu membelah diri dalam jam.

a. Informasi apa saja yang kamu dapatkan dari permasalahan di atas untuk menentukan jumlah maksimum bakteri tersebut selama ia hidup 5 jam?
b. Apa saja yang dibutuhkan untuk menentukan jumlah maksimum bakteri tersebut selama ia hidup 5 jam?
c. Bagaimana cara untuk menentukan jumlah maksimum bakteri tersebut selama ia hidup 5 jam?
d. Kapankah orang yang terinfeksi dapat berpotensi menularkan kepada orang lain? Apa kesimpulan yang anda peroleh?

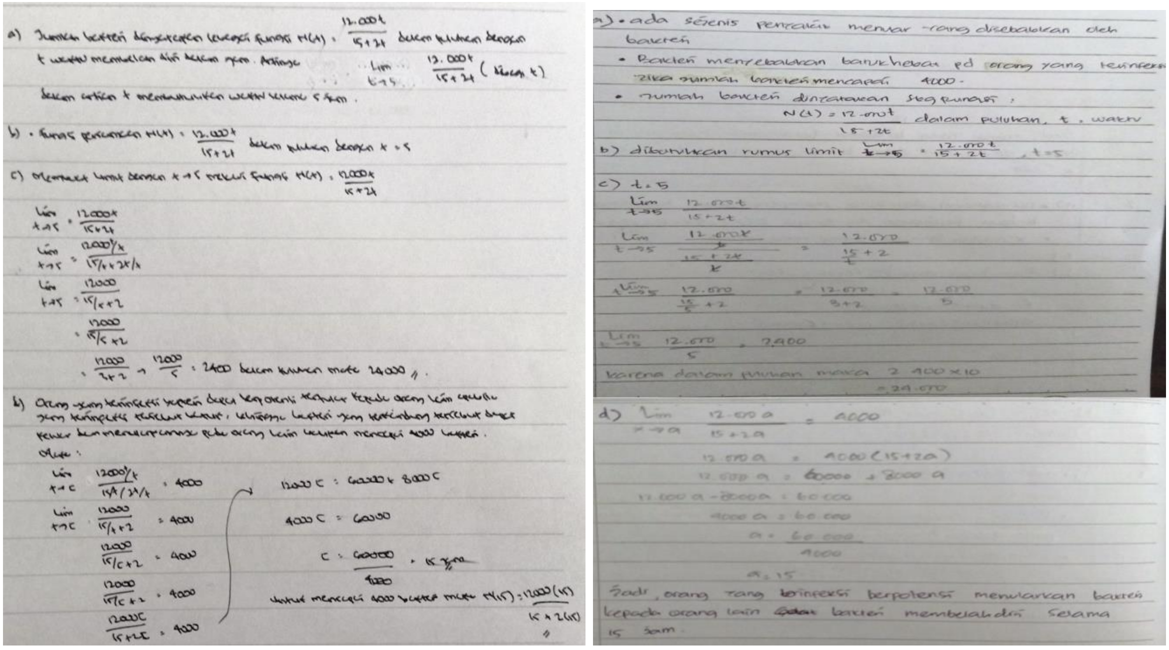
English Version

A type of infectious disease caused by a bacterium that has a specific job of attacking the lungs. The bacteria usually cause severe coughing in infected people when the number of bacteria reaches 4,000. Suppose the number of bacteria is expressed as a function N(t) = $\frac{12.000\,t}{15+2t}$ in tens. With t denoting the dividing time in hours.

a. What information can you get from the problem above to determine the maximum number ofbacteria during its 5-hour life span?
b. What is needed to determine the maximum number of bacteria during its 5-hour life?
c. How can we determine the maximum number of bacteria during its 5-hour lifetime?
d. When can an infected person potentially infect others? What conclusions did you reach?

Figure 1. ***Computational Thinking*** **Test Questions**

The answers of students who have high computational thinking ability with the subjects AN and QA completed well. The results of AN and QA's answers can be seen in Figure 2 as follows.



English Version

a) The number of bacteria is expressed as a function N(t) = $\frac{12.000\,t}{15+2t}$ in tens with t expressing the dividing time in hours. This means that $\lim_{t\to 5}\frac{12.000t}{15+2t}$ (in t)

In t takes 5 hours

b) N(t) function = $\frac{12.000\,t}{15+2t}$ in tens

c) Determining the limit with t→5 via the function N(t) = $\frac{12.000\,t}{15+2t}$

$\lim_{t\to 5}\frac{12000t}{15+2t} = \lim_{t\to 5}\frac{\frac{12000t}{t}}{\frac{15}{t}+\frac{2t}{t}} = \lim_{t\to 5}\frac{12000}{\frac{15}{t}+2} = \frac{12000}{\frac{15}{5}+2} = \frac{12000}{3+2} = \frac{12000}{5} = 2400$ in tens then 24000

d) People who are infected with bacteria can potentially be infected to orders, so that the bacteria contained can be infected and transmitted to others even reaching 4000 bacteria, than :

$\lim_{t\to c}\frac{\frac{12.000t}{t}}{\frac{15}{t}+\frac{2t}{t}} = 4000$

$\lim_{t\to c}\frac{12.000}{\frac{15}{t}+2} = 4000$

$= \frac{12000}{\frac{15}{c}+2} = 4000$

$= \frac{12000\,c}{15+2c} = 4000$

$12000\,c = 60000 + 8000\,c$

$4000\,c = 60000$

$c = \frac{60000}{4000} = 15\,jam$

To reach 4000 bacteria, N(15) = $\frac{12.000\,(15)}{15+2(15)}$

a) (1) There is a type of infectious disease caused by bacteria

(2) The bacteria cause a violent cough in infected people when the bacterial count reaches 4,000

(3) Number of bacteria expressed as a function of N(t) = $\frac{12.000\,t}{15+2t}$ in tens

b) Formula needed $\lim_{t\to 5}\frac{12.000t}{15+2t}$, t = 5

c) t = 5

$\lim_{t\to 5}\frac{12.000t}{15+2t}$

$\lim_{t\to 5}\frac{\frac{12.000t}{t}}{\frac{15+2t}{t}} = \frac{12.000}{\frac{15}{t}+2}$

$\lim_{t\to 5}\frac{12.000}{\frac{15}{5}+2} = \frac{12.000}{3+2} = \frac{12.000}{5}$

$\lim_{t\to 5}\frac{12.000}{5} = 2.400$

Because it is tens then 2.400 x 10 = 24.000

d) $\lim_{x\to a}\frac{12.000\,a}{15+2a} = 4.000$

12.000 a = 4.000 (15 +2a)

12.000 a = 60.000 + 8.000 a

12.000 a – 8.000 a = 60.000

4.000 a = 60.000

$a = \frac{60.000}{4.000} = 15$

So, an infected person has the potential to transmit the bacteria to others there are bacterial them selves for 15 hours

a) (1) There is a type of infectious disease caused by bacteria

(2) The bacteria cause a violent cough in infected people when the bacterial count reaches 4,000

(3) Number of bacteria expressed as a function of N(t) = $\frac{12.000\,t}{15+2t}$ in tens

b) Formula needed $\lim_{t\to 5}\frac{12.000t}{15+2t}$, t = 5

c) t = 5

$\lim_{t\to 5}\frac{12.000t}{15+2t}$

$\lim_{t\to 5}\frac{\frac{12.000t}{t}}{\frac{15+2t}{t}} = \frac{12.000}{\frac{15}{t}+2}$

$\lim_{t\to 5}\frac{12.000}{\frac{15}{5}+2} = \frac{12.000}{3+2} = \frac{12.000}{5}$

$\lim_{t\to 5}\frac{12.000}{5} = 2.400$

Because it is tens then 2.400 x 10 = 24.000

d) $\lim_{x\to a}\frac{12.000\,a}{15+2a} = 4.000$

12.000 a = 4.000 (15 +2a)

12.000 a = 60.000 + 8.000 a

12.000 a – 8.000 a = 60.000

4.000 a = 60.000

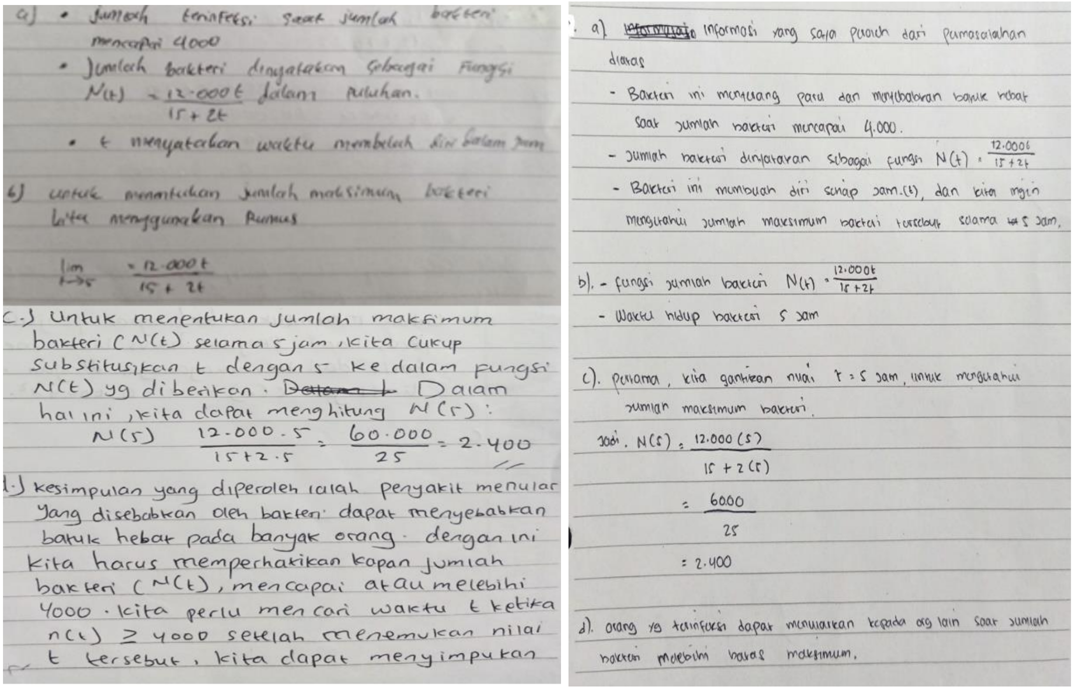
$a = \frac{60.000}{4.000} = 15$

So, an infected person has the potential to transmit the bacteria to others there are bacterial them selves for 15 hours

Figure 2. AN and QA

Based on the results of the AN and QA ... of the answers of the computational thinking te... on indicators with the question what information ... to determine the maximum number of bacteria as l... ve been able to understand and record the infor... es simpler information from the given problem. (2) Pattern recognition indicator with the question what is needed to determine the maximum number of bacteria for 5 hours? AN and QA have been able to present the information into a pattern into a design, (3) Algorithmic thinking indicator with the question How to determine the maximum number of bacteria as long as it lives 5 hours? AN and QA have been able to make solutions through the process of thinking algorithmically, (4) Indicators of generalization and abstraction with questions when can an infected person potentially infect others? What conclusion did you reach? AN and QA have been able to generalize by drawing conclusions and abstracting important objects to solve new problems. From the results above, AN and QA students have been able to outline data and problems into simple ones, decide on general patterns and similarities/differences found in the given problems, able to compile the correct sequence of steps to get a solution to a problem, able to generalize by drawing conclusions and abstracting important objects to solve new problems.

The results of the answers of students who have moderate computational thinking ability with the subjects SP and FA completed very well. The results of SP and FA answers can be seen in Figure 3 as follows.



a) • Jumlah terinfeksi saat jumlah bakteri mencapai 4000
• Jumlah bakteri dinyatakan sebagai fungsi $N(t) = \frac{12.000t}{15+2t}$ dalam puluhan.
• t menyatakan waktu membelah diri dalam jam

b) untuk menentukan jumlah maksimum bakteri kita menggunakan rumus
$\lim_{t \to 5} = \frac{12.000t}{15+2t}$

c.) Untuk menentukan jumlah maksimum bakteri (N(t)) selama 5 jam, kita cukup substitusikan t dengan 5 ke dalam fungsi N(t) yg diberikan. ~~Dalam~~ Dalam hal ini, kita dapat menghitung N(5):
$N(5) = \frac{12.000.5}{15+2.5} = \frac{60.000}{25} = 2.400$

d.) kesimpulan yang diperoleh ialah penyakit menular yang disebabkan oleh bakteri dapat menyebabkan batuk hebat pada banyak orang. dengan ini kita harus memperhatikan kapan jumlah bakteri (N(t)), mencapai atau melebihi 4000. kita perlu mencari waktu t ketika $n(t) \geq 4000$ setelah menemukan nilai t tersebut, kita dapat menyimpulkan

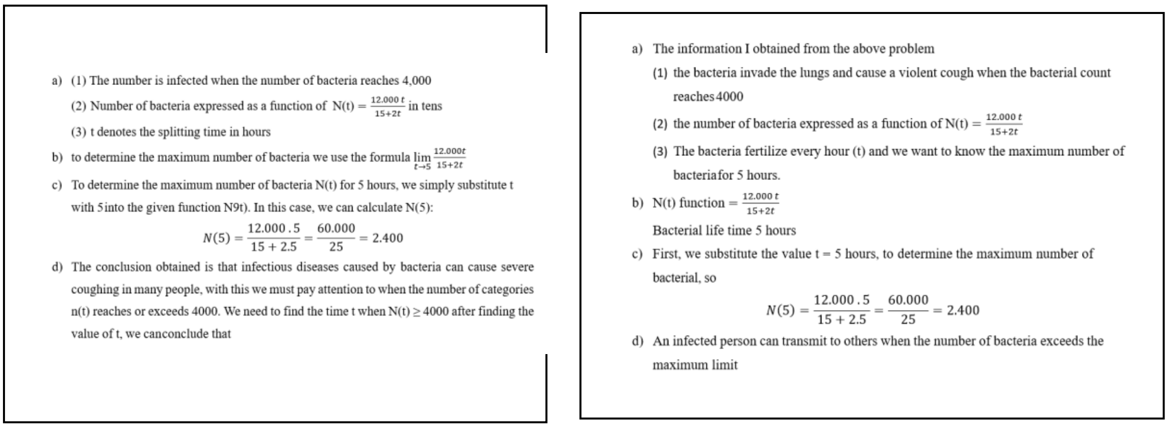
a) ~~Informasi~~ Informasi yang saya peroleh dari permasalahan diatas
- Bakteri ini menyerang paru dan menyebabkan batuk hebat saat jumlah bakteri mencapai 4.000.
- Jumlah bakteri dinyatakan sebagai fungsi $N(t) = \frac{12.000t}{15+2t}$
- Bakteri ini membelah diri setiap jam (t), dan kita ingin mengetahui jumlah maksimum bakteri tersebut selama 5 jam.

b). - fungsi jumlah bakteri $N(t) = \frac{12.000t}{15+2t}$
- Waktu hidup bakteri 5 jam

c). Pertama, kita gantikan nilai t = 5 jam, untuk mengetahui jumlah maksimum bakteri.
Jadi, $N(5) = \frac{12.000(5)}{15+2(5)} = \frac{6000}{25} = 2.400$

d). orang yg terinfeksi dapat menularkan kepada org lain saat jumlah bakteri melebihi batas maksimum.

English Version



a) (1) The number is infected when the number of bacteria reaches 4,000
(2) Number of bacteria expressed as a function of $N(t) = \frac{12.000\,t}{15+2t}$ in tens
(3) t denotes the splitting time in hours

b) to determine the maximum number of bacteria we use the formula $\lim_{t \to 5} \frac{12.000t}{15+2t}$

c) To determine the maximum number of bacteria N(t) for 5 hours, we simply substitute t with 5into the given function N9t). In this case, we can calculate N(5):
$$N(5) = \frac{12.000\,.5}{15 + 2.5} = \frac{60.000}{25} = 2.400$$

d) The conclusion obtained is that infectious diseases caused by bacteria can cause severe coughing in many people, with this we must pay attention to when the number of categories n(t) reaches or exceeds 4000. We need to find the time t when $N(t) \geq 4000$ after finding the value of t, we canconclude that

a) The information I obtained from the above problem
(1) the bacteria invade the lungs and cause a violent cough when the bacterial count reaches4000
(2) the number of bacteria expressed as a function of $N(t) = \frac{12.000\,t}{15+2t}$
(3) The bacteria fertilize every hour (t) and we want to know the maximum number of bacteriafor 5 hours.

b) N(t) function $= \frac{12.000\,t}{15+2t}$
Bacterial life time 5 hours

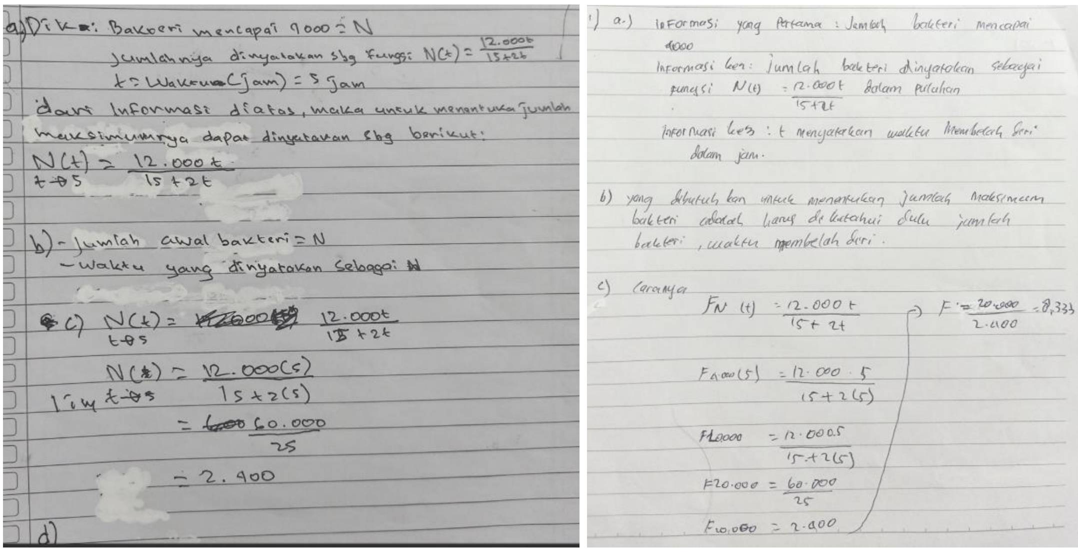
c) First, we substitute the value t = 5 hours, to determine the maximum number of bacterial, so
$$N(5) = \frac{12.000\,.5}{15 + 2.5} = \frac{60.000}{25} = 2.400$$

d) An infected person can transmit to others when the number of bacteria exceeds the maximum limit

Figure 3. SP and FA Answer Results

Based on the results of the SP and FA answers in Figure 3, then the analysis of the answers of the computational thinking test of the subject SP and the FA is (1) decomposition indicators with the question what information do you get from the problem above to determine the maximum number of bacteria as long as they live 5 hours? SP and FA have answered correctly, meaning that SP and FA have been able to understand and record the information in the problem so that it becomes simpler information from the problem given. (2) Pattern recognition indicator with the question what is needed to determine the maximum number of bacteria as long as it lives 5 hours? SP and FA's answers are correct, meaning that SP and FA are able to present information into patterns into a design, (3) Algorithmic thinking indicator with the question How to determine the maximum number of bacteria as long as it lives 5 hours? SP and FA solved the problem in a direct way without using limits, and the answers given were still incomplete, where the maximum number of bacteria in 5 hours was not resolved, meaning that SP and FA were not able to make a solution through the process of thinking algorithmically. (4) Indicators of generalization and abstraction with questions when can an infected person potentially infect others? What conclusion did you reach? SP and FA's answers were incorrect, did not answer when infected people could potentially infect others and were wrong in giving conclusions, meaning that SP and FA have not been able to generalize by drawing conclusions and abstracting important objects to solve new problems. From the results above, subjects SP and FA have been able to be able to outline data and problems into simple ones, and decide on general patterns and similarities/differences found in the given problems.

The answers of students who have moderate computational thinking ability with the subjects RA and MD completed very well. The results of RA and MD answers can be seen in Figure 4 as follows.



English Version

a) Dik: bacteria reach 4000 = N

The sum is expressed as a function of N(t) = $\frac{12.000\,t}{15+2t}$

T = time (hour) = 5 hours

From the information above, to determine the maximum amount, it can be expressed as follows:

$$\frac{N(t)}{t \to 5} = \frac{12.000\,t}{15+2t}$$

b) Initial number of bacteria = N

Time expressed as N

c) $\frac{N(t)}{t \to 5} = \frac{12.000\,t}{15+2t}$

$$\frac{N(t)}{\lim t \to 5} = \frac{12.000\,(5)}{15+2(5)} = \frac{60.000}{25} = 2.400$$

d) No answer

a) First information: The number of bacteria reached 4000

Information 2: the number of bacteria expressed as a function of N(t) = $\frac{12.000\,t}{15+2t}$

Information 3: t denotes the time to divide in hours

b) What is needed to determine the maximum number of bacteria is to first know the number of bacteria when dividing themselves

c) How

$$FN(t) = \frac{12.000\,t}{15+2t}$$

$$F4000(5) = \frac{12.000\,.5}{15+2(5)}$$

$$F20000 = \frac{12.000\,.5}{15+2(5)}$$

$$F20000 = \frac{60.000}{25}$$

$$F20000 = 2.400$$

$$F = \frac{20.000}{2.400} = 8.333$$

d) No answer

Figure 4. RA and MD Answer Results

Based on the results of the RA and MD answers in Figure 4, then the analysis of the answers of the computational thinking test of the subject RA and the MD is (1) decomposition indicators with the question what information do you get from the problem above to determine the maximum number of bacteria as long as they live 5 hours? RA and MD have answered correctly, meaning that RA and MD have been able to understand and record the information in the problem so that it becomes simpler information from the given problem. (2) Pattern recognition indicator with the question what is needed to determine the maximum number of bacteria as long as it lives 5 hours? RA and MD's answers are incorrect, meaning that SP and FA have not been able to present information into a pattern into a design, should answer The solution pattern used to determine the maximum number of bacteria as long as they live 5 hours is to use the limit of t→ 5 from $\frac{12.000t}{15+2t}$. (3) Algorithmic thinking indicator with the question How to determine the maximum number of bacteria as long as it lives 5 hours? RA solved the problem not using the limit and the solution was wrong, MD was wrong in solving the problem, meaning that RA and MD had not been able to make a solution through the process of thinking algorithmically. (4) Indicators of generalization and abstraction with questions when can an infected person potentially infect others? What conclusion did you get? The answers of RA and MD did not answer, meaning that SP and FA have not been able to generalize by drawing conclusions and abstracting important objects to solve new problems. From the above results, it can be said that the subjects RA and MD have been able to outline the data and problems to be simple.

Based on the interview, RA and MD who have low ability said the question is difficult, do not know where to start to solve it, and difficult to understand the question. The following will present the results of computational thinking ability based on computational thinking indicators.

Table 2. Ability Results based on Computational Thinking Indicators

Number	***Computational Thinking* Indicator**	**Ability**		
		High	**Medium**	**Low**
1	(Decomposition) Keeps the outline of the data and problem simple	√	√	√
2	(Pattern Recognition) Decide on common patterns and similarities/differences found in the given problems	√	√	Less precise
3	(Thinking algorithm) Able to organize the correct sequence of steps to get the solution of a problem	√	Less precise	Less precise
4	(Generalization/Abtraction) Able to generalize by drawing conclusions and abstracting important objects to solve new problems	√	Less precise	No answer

From table 2 on the results of skill based on computational thinking indicators, it can be seen that students who have the ability are still inadequate in solving problems that measure thinking algorithms and generalization/abstraction, while low-ability students are still less accurate in resolving problems and still inappropriate in the solution that measures the identification of patterns and thinking algorithms. For indicators, generalization/ abstraction students low ability do not answer.

Previous research related to difficulties in solving the ability of computational thinking has not yet been analysed, but related to the difficulty and mistakes of students in resolving questions related to algebra function limits namely, done by Essing (2022) which exposes students errors in solve about the limit function algebra, i.e. students have not too well mastered the material of the pre-requisite solve of the limitation of algebra functions, students do not know the measures used to solve the question of the function limit algebra, students are less careful, students forget the summary of the roots, students don't know the important limit notation to write, students are tired and lazy to write the limit notations of the results of interviews, and are not complete in working on the matter, as well as submitted by Robiah (2020) about the limits given on the basis of the taxonomic stages from C1 to C4 that consists of the stages of remembering, understanding, applying, analyzing This shows that the subject still feels difficulty understanding the concept and implementing the principle of solving a matter function limit. From the above exposure, which is the advantage of this research, this study analyzes the ability of computational thinking material limit algebraic function and which is analyzed not only the results of student answers but also shows more detailed where less accurate is the result of the indicator of computing thinking of the student based on the level of his ability. However, the shortcomings of this study are that the interviews are only done for 6 students, which should be more to further strengthen the answer results of students related computing ability thinking if associated with high, medium, and low levels of ability. This is supported by the results of research (Khoo et al., 2022) which states that Computational Thinking (CT) can help students solve mathematical problems logically and analytically, build students' mathematical skills and produce new mathematical solutions, increase creativity and meaning in mathematics learning, help increase the effectiveness of mathematics learning and help students understand real-world problems related to mathematics.

CONCLUSION

From the results and discussion above, it can be concluded that the ability of computational thinking is high, the indicators that can be resolved are decomposition, pattern recognition, algorithmic thinking and generalization / abstraction, meaning that students have been able to solve the limit problem of algebraic functions perfectly. Because it has fulfilled four indicators of computational thinking ability. Moderate computational thinking ability, students have been able to solve perfectly to measure indicators of decomposition and pattern recognition, but for indicators of thinking algorithms and generalization / abstraction students in solving it are still less precise, meaning that students with moderate computational thinking ability only two indicators are met, namely decomposition and pattern recognition. Low computational thinking ability, only able to measure decomposition indicators, for pattern recognition indicators, thinking algorithms are still less precise in solving, while generalization/abstraction indicators do not answer, meaning that low computational thinking ability students are only able to measure decomposition indicators. Based on this conclusion, to overcome the problem of computational thinking ability for medium and low ability students, there is a learning model that can overcome the above problems and also learning media so that students understand better in solving problems related to computational thinking. Recommendations for further research are that the evaluation results can help in identifying the strengths and weaknesses of each individual in understanding the limit of algebraic functions with computational thinking ability, can design more personalized learning and according to the needs of each student, evaluate and update the existing curriculum, lecturers also need improvement in supporting the development of students' computational thinking ability, then additional training can be held to improve their skills in delivering material with appropriate approaches.

REFERENCES

Alfaro-Ponce, B., Patiño, A., & Sanabria-Z, J. (2023). Components of computational thinking in citizen science games and its contribution to reasoning for complexity through digital game-based learning: A framework proposal. *Cogent Education*, *10*, 1–17. https://doi.org/10.1080/2331186X.2023.2191751

Angeli, C & Giannakos, M. (2020). Computational thinking education: Issues and challenges. *Computers in Human Behavior*, *105*(January). https://doi.org/10.1016/j.chb.2019.106185

Essing. N.B., Salajang. S.M., & Manurung, O. (2022). Analisis Kesalahan Siswa dalam Menyelesaikan Soal Limit Fungsi Aljabar Kelas XI IPA SMA Negeri 1 Lirung. *MARISEKOLA: Jurnal Matematika Riset Edukasi Dan Kolaborasi*, *3*(1), 13–22. https://doi.org/https://doi.org/10.53682/marisekola.v3i1.1082

Fang, X., Kit-Ng, D.T., Tung, T.M., & Yuen, M. (2023). Integrating computational thinking into primary mathematics: A case study of fraction lessons with Scratch programming activities. *Asian Journal for Mathematics Education*, *22*(22), 220–239. https://doi.org/10.1177/27527263231181963

Hansen, N., Jordan, N. C., & Rodrigues, J. (2017). Identifying learning difficulties with fractions: A longitudinal study of student growth from third through sixth grade. *Contemporary Educational Psychology*, *50*, 45–59. https://doi.org/10.1016/j.cedpsych.2015.11.002

Ho, W. K., Looi, C. K., Huang, W., Seow, P., & Wu, L. (2021). Computational thinking in mathematics: To be or not to be, that is the question. *In Mathematics—Connection and Beyond: Yearbook 2020 Association of Mathematics Educators*, 205–234. https://doi.org/10.1142/9789811236983_0011

Khoo. N.A.K.A.F., Ishak. N.A.H.N., Osman, S., Ismail. N., & Kurniati, D. (2022). Computational thinking in mathematics education: A systematic review. *AIP Conf. Proc*, *2633*(1). https://doi.org/10.1063/5.0102618

Krisdiana, I., Masfingatin, T & Murtafiah, W. (2018). Kemampuan Mahasiswa Calon Guru Matematika dalam Pemecahan Masalah Pembuktian Teorema Geometri. *Jurnal Mercumatika: Jurnal Penelitian Matematika Dan Pendidikan Matematika*, *2*(2), 41–50. https://doi.org/10.26486/jm.v2i2.272

Lamprou, A, & Repenning, A. (2018). Teaching how to teach computational thinking. *ITiCSE 2018: Proceedings of the 23rd Annual ACM Conference on Innovation and Technology in Computer Science Educaton, July 2-4, Larnaca, Cyprus*, 69. https://doi.org/10.1145/3197091.3197120

Marchelin, L.E., Hamidah, D., & Resti, N. C. (2022). Efektivitas Metode Scaffolding dalam Meningkatkan Kemampuan Berpikir Komputasi Siswa SMP Pada Materi Perbandingan. *Jurnal Pengembangan Pembelajaran Matematika (JPPM)*, *4*(1), 16–28. https://doi.org/10.14421/jppm.2022.41.16-29

Noto, M.S., Pramuditya, S.A ., & & Fiqri, Y. . (2018). Design Of Learning Materials On Limit Function Based Mathematical Understanding. *Infinity.V7i1.P61-68*, *7*(1), 61–68. https://doi.org/https://doi.org/10.22460/

Nurhayati, R & Retnowati, E. (2019). An Analysis of Errors in Solving Limits of Algebraic Function. *Journal of Physics*, *1320*(1320 012034). https://doi.org/10.1088/1742-6596/1320/1/012034

Park, Y-S. & Green, J. (2019). Bringing computational thinking into science education. *Journal of the Korean Earth Science Society*, *40*(4), 340–352. https://doi.org/10.5467/JKESS.2019.40.4.340

Pratiwi, D., Caecilia & Simangunsong, L. (2021). The impact of problem based learning model on problem-solving ability to prove the limits of algebraic function. *AIP Conf. Proc*, *2330*(040037). https://doi.org/10.1063/5.0043387

Robiah, S. S. (2020). Analisis Kesulitan Siswa Kelas XII dalam Menyelesaikan Soal Pada Materi Limit Fungsi. *Jurnal Equation*, *3*(1), 65–75. https://core.ac.uk/reader/288209433

Sengupta, P., Kinnebrew, J. S., Basu, S., Biswas, G., & Clark, D. (2013). Integrating computational thinking with K-12 science education using agent-based computation: A theoretical framework. *Education and Information Technologies*, *18*(2), 351–380. https://doi.org/10.1007/s10639-012-9240-x

Strickland, C., Rich, K.M., Eatinger, D., Lash, T, Andy Isaacs, A., Israel, M, & Franklin, D. (2021). Action fractions: The design and pilot of an integrated math+ CS elementary curriculum based on learning trajec_tories. In Proceedings of the 52nd A. *In Proceedings of the 52nd ACM Technical Symposium on Computer Science Education*, 1149–1155. https://doi.org/10.1145/3408877.3432483

Szydlik, J. E. (2000). Mathematical Beliefs and Conceptual Understanding of the Limit of a Function. *National Couchil Of Teachers Of Mathematics*, *31*(3), 258–276. https://doi.org/10.2307/749807

Wing, J. M. (2006). Computational Thinking. *COMMUNICATIONS OF THE ACM*, *49*(3), 33–35. https://doi.org/10.1145/1118178.1118215

Wing, J. M. (2008). Computational thinking and thinking about computing. Philosophical Transactions of the Royal Society A: Mathematical. *Physical and Engineering Sciences*, *366*(1881), 3717–3725. https://doi.org/10.1098/rsta.2008.0118

Zulfah. (2017). Pengaruh Penerapan Model Pembelajaran Kooperatif Tipe Think Pair Share Dengan Pendekatan Heuristik Terhadap Kemampuan Pemecahan Masalah Matematis Siswa MTs Negeri Naumbai Kecamatan Kampar. J. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, *1*(2), 1–12. https://doi.org/10.31004/cendekia.v1i2.23