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ANALYSIS OF MATHEMATICAL CRITICAL THINKING SKILLS IN ARITHMETIC REVIEWED FROM SELF-EFFICACY

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ABSTRACT
The ability to think critically mathematically is important for students to have in mathematics learning. But the reality is that some students still have low critical thinking skills. The purpose of this study is to describe the results of the analysis of the mathematical critical thinking ability of class X students, especially in the material of Arithmetic Rows and series reviewed from self-efficacy. The research method used is qualitative descriptive. The participants of this study are three students of class X at several high schools in North Sumatra. The instruments used were a description test on arithmetic line and series material with a total of three questions and a self-efficacy questionnaire with nine statements. Based on the results of the study, it was found that students with high, medium, and low levels of self-efficacy had critical thinking skills in the high category. Thus, descriptively there is no difference between the mathematical critical thinking ability reviewed from students' self-efficacy.
Keywords: critical thinking ability; mathematics; self-efficacy

ABSTRAK
Kemampuan perpikir kritis matematis penting dimiliki oleh siswa dalam pembelajaran matematika. Namun kenyataannya beberapa siswa masih memiliki kemampuan berpikir kritis yang rendah. Tujuan penelitian ini adalah untuk mendeskripsikan hasil analisis kemampuan berpikir kritis matematis siswa kelas X khususnya pada materi Barisan dan deret aritmatika yang ditinjau dari self-efficacy. Metode penelitian yang digunakan adalah deskriptif kualitatif. Partisipan penelitian ini adalah tiga siswa kelas X pada beberapa SMA di Sumatera Utara. Instrumen yang dipakai yaitu tes uraian pada materi baris dan deret aritmatika dengan jumlah tiga soal dan angket self-efficacy dengan sembilan pernyataan. Berdasarkan hasil penelitian ditemukan bahwa siswa dengan tingkat self-efficacy diri tinggi, sedang, dan rendah memiliki nilai kemampuan berpikir kritis dalam kategori tinggi semua. Dengan demikian, secara deskriptif tidak terdapat perbedaan antara kemampuan berpikir kritis matematis ditinjau dari self-efficacy siswa.
Kata kunci: *kemampuan berpikir kritis; matematika; self-efficacy*

Introduction

One of the basics of high-level thinking skills is the ability to think critically. Critical thinking skills, which include creative thinking, problem-solving, and decision-making, are some of the higher basic thinking skills that need to be acquired first (Prajono et al., 2022). So that this ability is one of the abilities that must be possessed by students of Permendiknas No. 22, 2006 (Hidayat & Noer, 2021). Students need to develop critical thinking skills to solve problems in real-world scenarios or situations (Syafruddin & Pujiastuti, 2020)

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Critical thinking is a decision-making activity based on evidence, concepts, methods, criteria, and conditions, and depends on the purpose of making interpretations, analyses, evaluations, and conclusions (Syafruddin & Pujiastuti, 2020). Some of the skills that can be improved by critical thinking include understanding, analysis, deliberation, interpretation, finding relationships, evaluating, and making statements (Susilowati & Rusilowati, 2019). Developing critical thinking skills can enable students to consider the problem of separating related and unrelated information, connect concepts, conclude, and see the conformity or inconsistency of certain assumptions (Sulistiani & Masrukan, 2016). There are indicators of critical thinking skills according to several experts. According to (Paul, Richard; Elder, 2006), indicators of critical thinking ability consist of: (1) the Ability to identify and assess assumptions, (2) Ability to identify and assess relevant information, (3) Ability to make rational and logical conclusions, (4) Ability to produce reasoned interpretations, and (5) Ability to ask relevant questions and question information. In addition, according to Facione, 1990 (dalam Arif et al., 2017), indicators of critical thinking, namely: (1) The ability to identify and assess arguments, (2) The ability to identify premises, assumptions, and implications in an argument, (3) The ability to evaluate the strengths and weaknesses of arguments, and (4) The ability to structure and communicate coherent and reasoned arguments. Furthermore, According to (Zetriuslita et al., 2016), critical thinking means thinking logically while making decisions. There are three indicators of critical thinking, namely: (1) The ability to identify and justify concepts, namely the ability to give reasons for mastering concepts; (2) Generalizing ability, namely the ability to complete supporting data or information; (3) Ability to analyze algorithms, namely the ability to evaluate or examine an algorithm.

One of the topics that requires critical thinking skills is the concept of arithmetic lines and series which is very important to understand (Jannah & Towafi, 2020). Students who understand this topic will be better prepared to solve real-world math challenges. For example, when the speed of a car is being measured, an arithmetic row can be formed by multiple rows of numbers on a speedometer that follow a certain pattern. In addition, in the economic field, this type of information can be used to calculate population and food growth, measure income and production costs, and calculate compound interest in the banking world (Wulandari & Setiawan, 2021).

The reality in the field is that some students do not have good mathematical critical thinking skills, and students' mathematical critical thinking skills are still relatively low. The facts show that students' mathematical critical thinking skills are still not as expected. According to the results Program for International Student Assessment (PISA) in 2022, students in Indonesia obtained a math proficiency score of 366 points out of 500 points, which decreased compared to the previous PISA result of 379 points in 2018 (Situmorang, 2024). This shows that Indonesian students are at level 1a, with being in the 69th position which is included in the bottom 12 where as many as 18% of Indonesian students only reach level 2 in mathematics, much lower than the average in all OECD countries which is below 69% (Sausan et al., 2024). The results show that Indonesian students can solve basic problems but are not able to think critically to solve more complex problems. The low ability of students to work on mathematical problem-solving problems is very

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related to their low critical thinking skills. Based on the results of previous research, it show that students' critical thinking skills are included in the low group (Anita & Firmansyah, 2022). The results of other studies also show that in mathematics learning, there are no students who have mathematical critical thinking skills in the very good category (0%), while in the good category there are also no students (0%), as well as in the fair category (0%), in the poor category (19.44%), and (80.55%) in the very poor category (Zulaeha et al., 2021).

The basic concepts of critical thinking are interpretation, analysis, evaluation, inference, explanation, and confidence (Khoirunnisa et al., 2021) . Lack of confidence can be one of the causes of low mathematical critical thinking skills possessed by students due to a lack of self-efficacy students will have the ability to analyze problems and find facts in learning arithmetic rows and series. For that self-efficacy is one of the affective domains that may also affect mathematical critical thinking skills (Susanti, 2023).

Self-efficacy It is one of the psychological aspects related to self-confidence that must be possessed by students. This aspect can be one of the supports for the success of learning in schools (Hasmatang, 2018). Self-efficacy It can be defined as a person's belief in his ability and success in performing certain tasks, so that he can be encouraged to try to take action to achieve the planned goals (Juliani, 2017). Self-efficacy plays an important role in everyone's progress. Self-efficacy and critical thinking skills can help students in solving mathematical problems because mathematical problems are closely related to the systematic process of producing something right. Students who have self-efficacy will try to be more optimal when compared to students with self-efficacy low (Hidayat & Noer, 2021).

Self-efficacy Students still show low levels, with average scores from testing self-efficacy students only achieved 37.95 out of a maximum score of 100 (Kurniawati & Suparni, 2019). In other studies, it was also found that in general self-efficacy in students' mathematics tends to be low, as evidenced by the results of an interview with one of the mathematics teachers at the APIPSU Medan Business and Management Vocational School, it was found that self-efficacy students towards mathematics are classified as low (Fatimah, 2020). This is based on the fact that when asked to come forward and present the homework that he has done. In addition, the test scores that are usually carried out at the end of learning discussions, midterm exams, and student grade promotion exams are not proportional to homework scores.

Research on critical thinking and self-efficacy among them regarding the mathematical critical thinking ability of junior high school students reviewed from self-efficacy (Prajono et al., 2022) then research on the mathematical critical thinking skills of vocational school students on row and series materials (Kharisma, 2018). In addition, there is also a case study on student's critical thinking skills on row and series materials reviewed from self-efficacy (Syafruddin & Pujiastuti, 2020). Based on the report, no analysis of students' mathematical critical thinking skills in arithmetic line and series material is reviewed from self-efficacy class X students at several high schools in North Sumatra. Thus the purpose of this study is to describe mathematical critical thinking skills in arithmetic sequence and series materials reviewed from self-efficacy high school students.

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Research Methods

This type of research is descriptive research with a qualitative approach. A qualitative approach is a writing approach that sees things naturally. This approach allows for a variety of writing designs according to the predetermined plan (Wahidmurni, 2017). This study was written to analyze and describe students' mathematical critical thinking skills on arithmetic rows and series material reviewed from self-efficacy self.

The data source in this study is eight students in class X in several schools in North Sumatra. The selection and determination of research participants was carried out after participants filled out a questionnaire and the level of self-efficacy was known. Furthermore, from each level of self-efficacy, three students with high, medium, and low categories were selected, and then participants took a test of mathematical critical thinking ability, and continued with an interview.

The data collection used in this study consisted of questionnaires, test questions about arithmetic rows and series, and interviews. The self-efficacy questionnaire used in this study aims to divide the self-efficacy category of students into three groups, namely high, medium, and low. Each student with a different self-efficacy category will take a test question designed to determine their mathematical critical thinking skills. Then the interview is used to collect more detailed information about the student's mathematical critical thinking ability.

The main instrument in this study is the researcher himself, the researcher plays a direct role as a planner, analyst, data processor, and reporter of research results. The instruments used to support this research include self-efficacy questionnaires, mathematical critical thinking ability test questions, and interviews.

The critical thinking indicators used in this study are critical thinking indicators according to (Zetriuslita et al., 2016) which consist of (1) the ability to identify and justify concepts, namely the ability to give reasons for mastering concepts; (2) Generalizing ability, namely the ability to complete supporting data or information; (3) Ability to analyze algorithms, namely the ability to evaluate or examine an algorithm.

The data analysis in this study uses data analysis according to Miles and Huberman in (Sugiyono, 2017) which states that there are three steps to form a qualitative data analysis process, namely data reduction, data presentation, and conclusion and verification. For the questionnaire instrument, it was analyzed using the Likert scale with scores for SS = 5, S = 4, TS = 2, and STS= 1 for positive statements, and SS=1, S=2, TS=4, STS=5. In knowing the category of ability Self-efficacy Students are carried out by accumulating scores from all questionnaire items from all research samples. The score is then processed to determine the average ability score self-efficacy students and standard deviations. The average and standard deviation are used as a benchmark to categorize the standard deviation level of each student. For critical thinking ability test instruments and assessment instruments, it can be seen in Tables 1 and 2.

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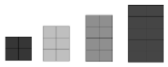
Table 1. Grid of students' mathematical critical thinking skills

Test Questions	Question Difficulty	Critical Thinking Skills Indicators
1) A grandfather gets a quiz prize of Rp. 2,000,000,-. He wanted to give some of the money to his 6 grandchildren, with the younger grandchildren getting a smaller share of the older grandchildren according to the arithmetic line. If the first grandchild gets Rp. 300,000,- and the third grandchild gets Rp. 150,000,- . How much money is left after being distributed to his 6 grandchildren?	C2	Identify
2) A number pattern is presented in the following figure:  Determine the pattern formula to n!	C3	Generalize
3) Given a number pattern 3, 6, 10, 15, … where: 3 = 1+2 6 = 1+2+3 10 = 1+2+3+4 15 = 1+2+3+4+5 …. n = 1+2+3+4+5+...+(n-1) Check if it is true that n = 1+2+3+4+5+...+(n-1) can form an arithmetic series formula i.e. Sn=n/2(2n+(n-1)b)? Give a reason!	C3	Analyzing algorithms

Then, to see and measure students' mathematical critical thinking skills from problems in the form of descriptions, it can be done by looking at the assessment rubric. The guidelines for assessing critical thinking skills can be seen in the following Table 2.

Table 2. Critical thinking ability scoring guidelines

Student responses	Score
Not answering, or giving the wrong answer.	0
Students are precise in describing the concepts contained in the given statement and do not write down the parts of the statement that are known and what will be completed	1
Students only partially write down the concepts contained in the given statement and partially write down the parts of the statement that are known and what will be completed	2
Students can write down the concepts contained in the given statement and write down the part of the statement that is known and what will be solved, but make a mistake in doing the calculation.	3
Students can write down the concepts contained in the given statement and write down the part of the statement that is known and what will be completed and correct in doing the calculation.	4
Not answering, or giving the wrong answer	0

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Student responses	Score
Students cannot complete data or problem information	1
Students partially complete the data or problem information and do not determine the general rules of the data presented.	2
Students can complete data or information that supports but does not specify general rules from the data presented.	3
Students can complete data or information that supports and determines general rules from the data presented.	4
Not answering or giving the wrong answer.	0
Students cannot examine an algorithm so that they cannot solve problems and cannot draw the right conclusions.	1
The ability of students to check an algorithm, but not to perform calculations	2
The ability of students to evaluate or examine an algorithm and be able to perform calculations but not to draw the right conclusions.	3
The ability of students to evaluate or examine an algorithm and be able to solve problems and draw the right conclusions.	4

Furthermore, the student self-efficacy questionnaire grid can be seen in Tables 3 and 4.

Table 3. Student self-efficacy questionnaire grid

Dimension	Indicator	Item	
		Positive	Negative
Magnitude	Confidence in overcoming difficult tasks	1	2,3
Strength (The Power of Belief)	Confidence in completing tasks with their abilities	4,6	5
Generality (confidence in the whole learning)	Confidence in one's ability in various situations	7,9	8

Table 4. Student self-efficacy questionnaire

No	Statement
1	I never give up when I get a difficult math assignment.
2	I lack fighting power when I get a difficult math assignment.
3	I feel that the math assignment is a burden for me.
4	I was able to complete difficult math tasks because I was confident in my abilities.

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No	Statement
5	I always avoided difficult math assignments because I wasn't sure of what I was capable of.
6	I can stay calm when facing difficulties because I am confident in my abilities.
7	I was able to complete various math tasks given by the teacher because I was confident in my abilities.
8	I can only do certain math tasks.
9	I can complete all math tasks as much as possible in any situation.

Then the level of self-efficacy of students in mathematics subjects can be seen from the following Table 5 (Sadewi et al., 2012).

Table 5. Criteria for student self-efficacy level

Interval (%)	Criterion
68 % - 100%	Tall
34% - 67%	Keep
0 – 33%	Low

Results and Discussion

In this section, the results of the research findings are written. There is one student with a low category of self-efficacy, one student in the medium category, and six students with a high category. The Self-efficacy level of 8 students can be seen in Table 6.

Table 6. Student self-efficacy

No	Participants	Student Self-efficacy Level
1	R1	Low (24%)
2	T1	High (100%)
3	T2	High (78%)
4	T3	High (78%)
5	S1	Medium (58%)
6	T4	High (68%)
7	T5	High (91%)
8	T6	High(91%)

Based on the results of the self-efficacy level of eight students, three students with high (T1), medium (S1), and low (R1) self-efficacy categories were selected to take the critical thinking ability test and interview test. The level of critical thinking skills in mathematics subjects in students can be seen in Table 7.

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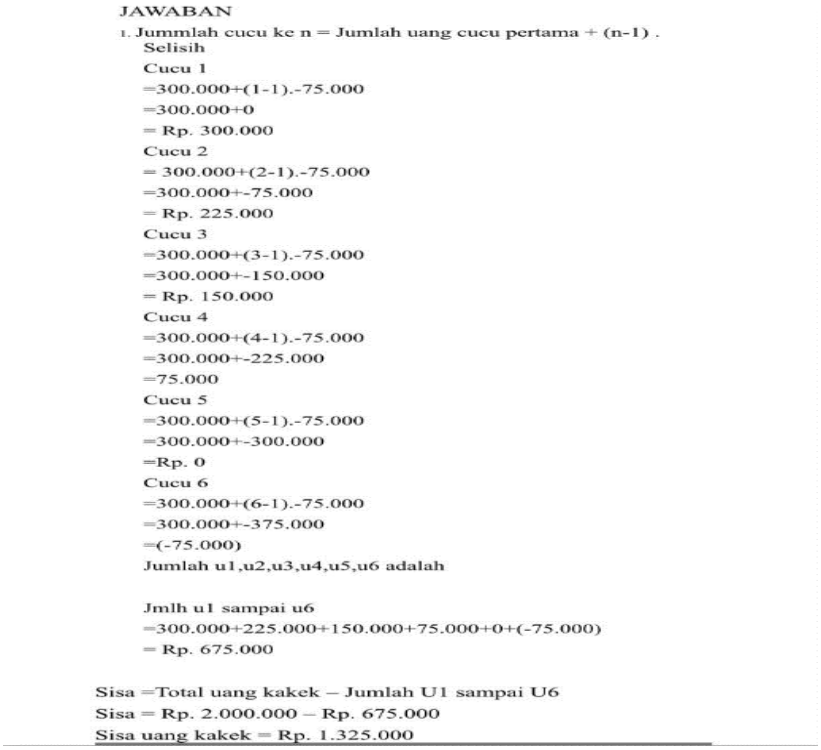
Table 7. Results of the student critical thinking ability test

Participants	Ability test results			Total score	Category
	Indicator 1	Indicator 2	Indicator 3		
T1	3	3	3	75	Tall
S1	4	4	2	83	Tall
R1	3	3	3	75	Tall

1) T1 Participants

The results of the self-efficacy questionnaire in T1 participants were in the high category, which was 100%. The results of the mathematical critical thinking ability test in T1 participants obtained a score of 83 with a high category. The results of the T1 participant's critical thinking ability test on the identifying indicator are shown in Figure 1.


JAWABAN
1. Jummlah cucu ke n = Jumlah uang cucu pertama + (n-1) .
Selisih
Cucu 1
=300.000+(1-1).-75.000
=300.000+0
= Rp. 300.000
Cucu 2
= 300.000+(2-1).-75.000
=300.000+-75.000
= Rp. 225.000
Cucu 3
=300.000+(3-1).-75.000
=300.000+-150.000
= Rp. 150.000
Cucu 4
=300.000+(4-1).-75.000
=300.000+-225.000
=75.000
Cucu 5
=300.000+(5-1).-75.000
=300.000+-300.000
=Rp. 0
Cucu 6
=300.000+(6-1).-75.000
=300.000+-375.000
=(-75.000)
Jumlah u1,u2,u3,u4,u5,u6 adalah

Jmlh u1 sampai u6
=300.000+225.000+150.000+75.000+0+(-75.000)
= Rp. 675.000

Sisa =Total uang kakek – Jumlah U1 sampai U6
Sisa = Rp. 2.000.000 – Rp. 675.000
Sisa uang kakek = Rp. 1.325.000

Figure 1. Results of the critical thinking ability test of participants T1 indicator identify

Based on Figure 1, it can be seen that Participant T1 did not write down part of the statement that is known and what will be solved but Participant T1 immediately did the calculation and was correct in doing the calculation. This was strengthened by the results of the interview where T1 participants immediately made calculations on the given questions. Then there are the results of the T1 participant's critical thinking ability test on the generalizing indicator in Figure 2.

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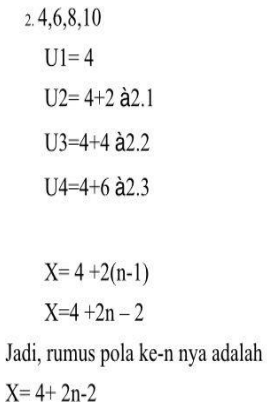
2. 4,6,8,10
U1= 4
U2= 4+2 à2.1
U3=4+4 à2.2
U4=4+6 à2.3

X= 4 +2(n-1)
X=4 +2n – 2
Jadi, rumus pola ke-n nya adalah
X= 4+ 2n-2

Figure 2. Results of the T1 critical thinking ability test generalizing indicator

Based on Figure 2, it can be seen that Participant T1 can formulate the problem and use the available information to find the nth pattern formula, but Participant T1 immediately writes Un as X and does not give a reason why to use the strategy. From the results of the interview, it is known that the T1 participant also did not give a detailed explanation regarding this. Then, the results of the T1 participant's critical thinking ability test on the indicator analyzed the algorithm in Figure 3.

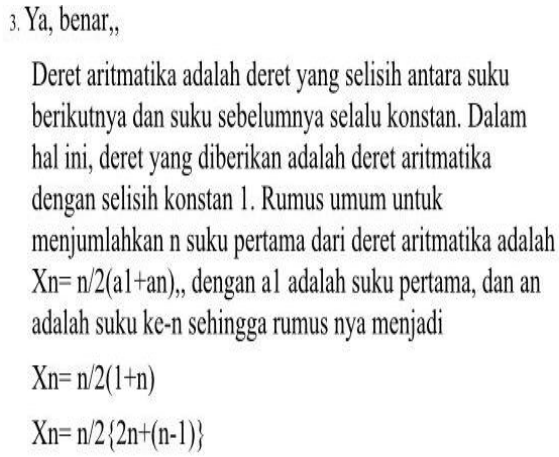
3. Ya, benar,,
Deret aritmatika adalah deret yang selisih antara suku berikutnya dan suku sebelumnya selalu konstan. Dalam hal ini, deret yang diberikan adalah deret aritmatika dengan selisih konstan 1. Rumus umum untuk menjumlahkan n suku pertama dari deret aritmatika adalah Xn= n/2(a1+an),, dengan a1 adalah suku pertama, dan an adalah suku ke-n sehingga rumus nya menjadi
Xn= n/2(1+n)
Xn= n/2{2n+(n-1)}

Figure 3. Results of the T1 critical thinking ability test indicator analyzing algorithm

Based on Figure 3, it can be seen that the T1 participant can make an explanation about the definition/theorem taken. However, the T1 participant was wrong in analyzing the statement so that the results obtained were not correct. From the results of the interview, it was revealed that the participants did not find it difficult to answer the questions. This shows that T1 participants have high confidence in answering the questions given. The following are the results of interviews that have been conducted with T1 participants.

A : How do you do questions 1, 2, and 3?

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Q1 : The number 1 thing I do is to find the money of your four grandchildren first, then I add everything up and subtract it from the amount of grandpa's money, then the rest of my grandfather's money will be known. For number 2 I use the formula Un and Different for each of the tribes, and for number three I use the arithmetic series formula to prove it.

A : Are there any obstacles in doing the questions?

T1 : No, it's just that number three is a bit confusing.

2) S1 Participants

The results of the self-efficacy questionnaire in S1 participants were in the medium category, which was 58%. The results of the mathematical critical thinking ability test in S1 participants obtained a score of 83 in the high category. The results of the S1 participant's critical thinking ability test on the identifying indicator are shown in Figure 4.

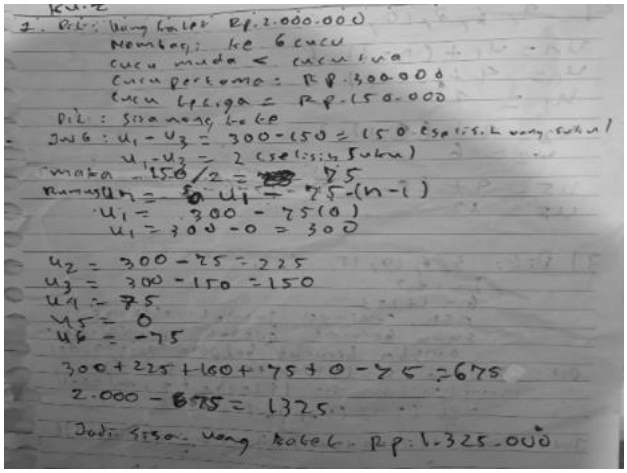

Figure 4. Results of the S1 critical thinking ability test indicator identify

Based on Figure 4, it can be seen that S1 participants can write down parts of the statement that are known and what will be completed and can do calculations correctly. Based on the results of the interview, it is also known that S1 participants have thought of a way to solve the problem. The results of the S1 participant's critical thinking ability test on the generalizing indicator are shown in Figure 5.

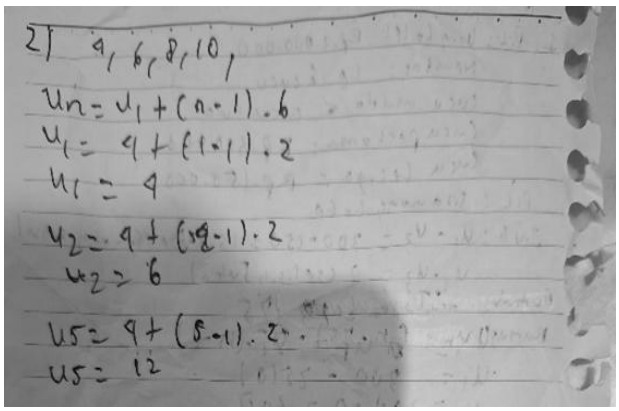

Figure 5. Results of the S1 critical thinking ability test generalizing indicator

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Based on Figure 5, it can be seen that S1 participants can formulate problems and use the available information to find the nth pattern formula, but the answers given by S1 participants are not precise. S1 participants immediately write down the value of U5 while in the problem, participants are asked to find the formula for their nth term only. From the results of the interview, it was known that the participants felt confident in the answers given because the S1 participant explained in full the answers obtained. The results of the S1 participant's critical thinking ability test on the algorithm analysis indicator in Figure 6.

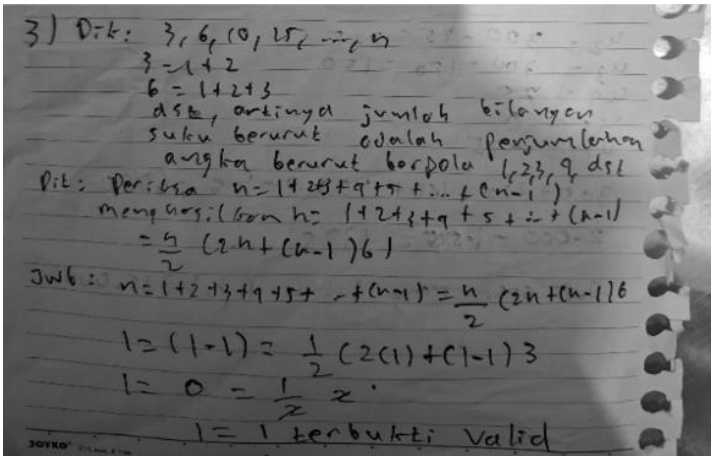

Figure 6.Results of the S1 critical thinking ability test indicator analyzing algorithms

In Figure 6, it can be seen that S1 participants can make a complete explanation of the definition/theorem taken. However, S1 participants were wrong in analyzing the statement so that the results obtained were not correct. From the results of the interview, it was also revealed that S1 participants felt that the questions given were quite difficult. The following are the results of interviews that have been conducted with S1 participants.

A : *How do you do questions 1, 2, and 3?*
Q1 : *In number 1, I did it using the arithmetic sequence formula and then calculated the amount of money to his six grandchildren. For the rest of the grandfather's money, it is deducted from the amount of all his grandchildren's money. For number 2 I use the formula Un, which is a+(n-1)b, and for number three I compare the arithmetic series with the series in your problem.*
A : *Are there any obstacles in Doing problems?*
Q1 : *Number three is difficult.*

3) R1 Participant

The results of the self-efficacy questionnaire in R1 participants were in the low category, which was 24%. The results of the mathematical critical thinking ability test in R1 participants obtained a score of 75 in the high category. The results of the R1 participant's critical thinking ability test on the identifying indicator are shown in Figure 7.

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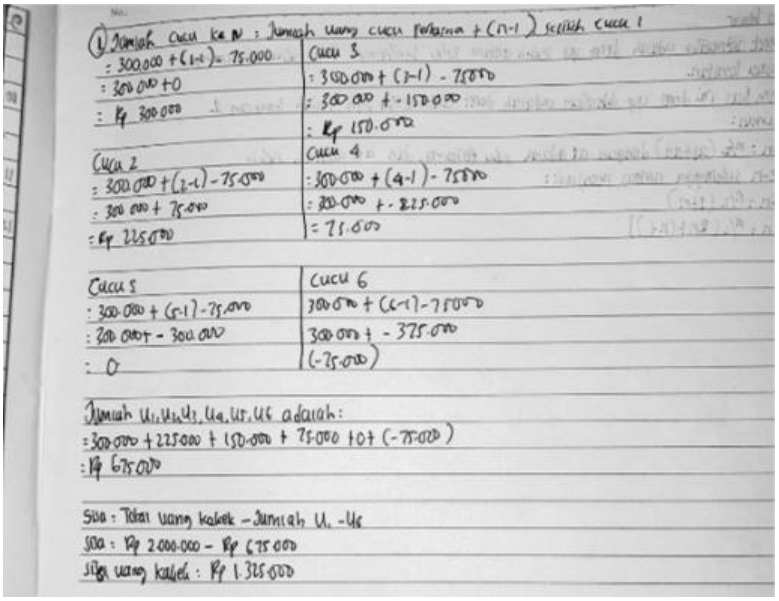

Figure 7. The results of the R1 critical thinking ability test indicator identify

Based on Figure 7, it can be seen that Participant R1 did not write down the part of the statement that is known and what will be solved but can do the calculation correctly and correctly. Based on the results of the interview, it was found that the R1 participant had explained how to solve the problem but felt unsure because there was a negative value of the nth rate. Furthermore, the results of the R1 participant's critical thinking ability test on the generalizing indicator are shown in Figure 8.

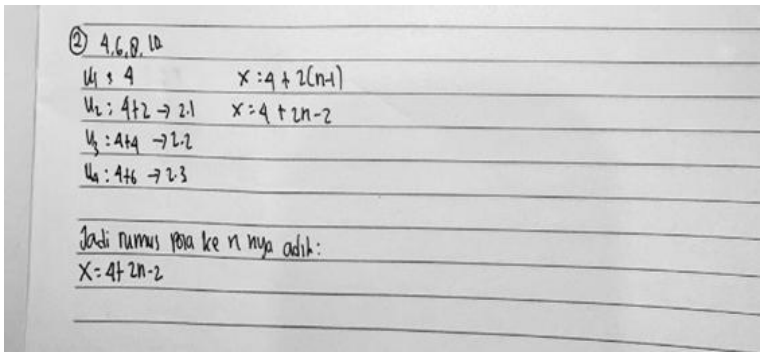

Figure 8. Results of the R1 critical thinking ability test generalizing indicator

Based on Figure 8, it can be seen that Participant R1 can formulate a problem and use the available information to find the nth pattern formula, but the answer given by Participant R1 is not precise. In the final result, the nth-term formula was also not obtained as requested in the question. From the results of the interview, it is known that the participant explained that the R1 participant used the Un formula to obtain the answer. The results of the R1 participant's critical thinking ability test on the indicator analyze the algorithm in Figure 9.

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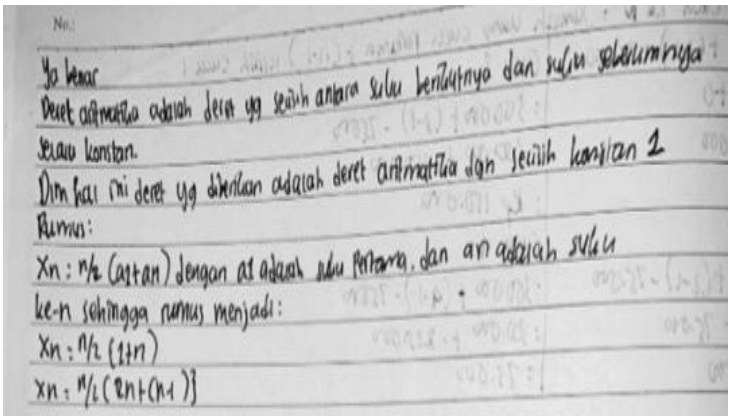

Figure 9. Results of the R1 critical thinking ability test indicator analyzing algorithm

In Figure 9, it can be seen that the R1 participant can make a complete explanation of the definition/theorem taken. However, the R1 participant only wrote down the general formula of the arithmetical series and did not associate it with the statement. From the results of the interview, it was also revealed that S1 participants felt that the questions given were quite difficult. The following are the results of interviews that have been conducted with S1 participants.

Based on interviews with R1 participants, the following results were obtained.

A : *How do you do questions 1, 2, and 3?*

R1 : Number 1 I did it using the *arithmetic sequence formula and got the difference in the grandson's money was 75,000. Then calculate the money of the 1st to the 6th grandson and subtract it from the grandfather's money. For number 2 use the formula Un and the difference is 2, and the number three is by looking at the difference but it seems to be not an arithmetic series, but not sure.*

A : *Are there any obstacles in doing the questions?*

R1 : *Number one is afraid of being wrong because there is a negative value of grandpa's granddaughter's money, and number three is difficult because I am wrong.*

Students with a high level of confidence can form confidence in themselves about their ability to never give up in the face of given problems (Sadewi et al., 2012). However, based on the results obtained by subject T1, subject S1, and subject R1 above, it can be seen that there is no relationship between mathematical critical thinking ability and self-efficacy. This is contrary to previous research conducted by (Hidayat & Noer, 2021) which concludes that students who have self-efficacy high ability to solve problems thoroughly, but on the contrary, students with *self-efficacy* low tend to be less good at solving problems. Then in the research conducted by Misbahudin (Misbahudin, 2019) that there is a significant relationship between self-efficacy and students' CTS, especially in grade XI of Vocational High School (SMK) in arithmetic row and series material. This is due to several other factors that have more to do with students' critical thinking skills compared to just measuring the level of *self-efficacy* student. In addition, the number of participants in this study is still limited with only three participants.

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Conclusion and Suggestion

Based on the results of the study, it was found that students with high, medium, and low *levels of self-efficacy* had critical thinking skills in the high category. Thus, descriptively there is no difference between the mathematical critical thinking ability reviewed from students' *self-efficacy*. However, it is necessary to conduct follow-up research by increasing the number of participants or quantitative research so that more valid conclusions are obtained.

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