

CRITICAL THINKING ABILITIES STUDENTS SOLVING SOCIAL ARITHMETIC NUMERACY PROBLEMS BASED ON INITIAL MATHEMATICS PROFICIENCY

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ABSTRACT

This study aims to present the results of the analysis of critical thinking skills of students with low, medium, and high initial abilities in solving social arithmetic numeracy problems and to determine the critical thinking skills of students in each critical thinking indikator. Critical thinking ability is an important skill that students must have to evaluate information, make rational decisions, and solve problems effectively. Students trained in critical thinking have the ability to face problems, examine them, and find appropriate solutions. This research is qualitative research with descriptive qualitative method. The research subjects were seventh grade junior high school students in Surakarta. Data were collected through written tests, student interviews, and observations. The results and conclusion of this study indicate that students' mathematical critical thinking skills on social arithmetic material in terms of initial ability are still relatively low, from the results of the analysis based on the four critical thinking indicators that are the reference in this study students tend not to be able to fulfill the four critical thinking indicators.

Keywords : Critical Thinking, Initial Mathematics, Numeracy

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PRELIMINARY

Mathematics is one of the disciplines that contributes greatly to the progress of the world of education. One of the subjects that students are required to study at school is mathematics (Suryani et al., 2020). Mathematics is one of the subjects closest to the real world because many things or problems are related to mathematics (Chotimah et al., 2018). Suharsono stated that mathematics is one of the important lessons in school that has the ability to form systematic, logical, creative, and critical thinking patterns (Putri, 2019). Learning mathematics at school aims to familiarize students with being able to think systematically, creatively, logically, and critically, especially being able to develop students' critical thinking (Amini et al., 2020). So by studying mathematics, it can develop a logical, systematic, analytical, creative, and critical thinking mindset (Faiziyah & Priyambodho, 2022).

Critical thinking is an important throught that requires deep understanding and analysis (Razak, 2017). One of the higher-order thinking skills is critical thinking (Nashrullah & Cahyono, 2023). Higher-order thinking includes a combination of creative thinking, critical thinking, and thinking about basic knowledge (Liang et al., 2014). According to Krulik and Rudnick, critical thinking is analytical thinking, this is because in critical thinking we carry out stages by linking all data (Anita & Ramlah, 2021). Meanwhile, according to Nurhadi, critical thinking is the ability to criticize, analyze, and draw coclusions based on the same considerations or inferences (Anita & Ramlah, 2021). Meanwhile, according to Glaser, critical thinking is an attitude that wants to consider a problem thoroughly and used a rational examination and reasoning approach (Putri, 2019). One of the essential basic abilities that is important for students to have is the ability to think critically (Hartati et al., 2019). Critical thinking skills are described as the ability to think through problems, use ideas that have been learned, and evaluate the responses presented (Mursari, 2020).

According to Hutabarat, there are four indicators used to measure critical thinking skills which include interpretation, analysis, judgment, and inference (Hutabarat et al., 2019). The ability to present problems mathematically, the ability to find relevance, and the ability to reason usiing principle are indicators of critical thinking are indicators developed by (Wahyuni & Angraini, 2019). According to Marasabessy (Astra & Nurjanah, 2021) critical thinking consists of several indicators is justification, focus, inference, context, situation, clarity, and review (Pradana & Noer, 2023).

This study aims to present the results of the analysis of critical thinking skills of students with low, medium, and high initial abilities in solving social arithmetic numeracy problems and to determine the critical thinking skills of students in each critical thinking indikator by (Facione, 2020). Some studies that use critical thinking indikators according to Facione among them are (Faiziyah & Priyambodho, 2022), (Hidayati, 2016), (Yustika & Yarman, 2019), (Martyanti et al., 2017). The critical thinking indicators considered in this study are undertanding the problem (interpretation) making plans and solving models (analysis), implementing models or plannig sollution and calculations (evaluation), and drawing conclusions and decisions (inferens). And obtained the description of each indicator put forward by (Martyanti et al., 2017). These indicators are explained below.

Table 1. Indicators of critical thinking according by Facione and Martyanti

Indicator	Explanation
Interpretation	a. The ability to understand or communicate the meaning of data or situations presented in a mathematical problem.
Analysis	a. Ability to reason arguments and find connections between data. b. Ability to model solution.
Evaluation	a. Ability to find and point out errors in mathematics problem.
Inferens	a. The ability to make inferences and make decisions about mathematical problems.

To be able to analyze critical thinking skills in mathematics learning in the classroom can be reviewed by knowing the initial mathematics proficiency. because students still face many challenges in their initial mathematical abilities in understanding concepts, the process of solving mathematical critical thinking problems has not been fully facilitated. One of the requirements that students must have in order for the learning process to run well is the initial ability of mathematics. Students' initial ability is one of the factors that determine their success in learning mathematics (Zuyyina et al., 2018). Students' initial ability is defined as the ability that students already have before starting to learn. It also shows that students are ready to receive new information provided by the teacher. Initial ability is useful for determining whether students have prerequisite knowledge to evaluate learning and the extent to which students understand the teaching material to be presented, for teachers to have the ability to make better learning (Suryani et al., 2020). Teachers must know the initial abilities of students before learning begins: a) have students had an understanding as a prerequisite for participating in learning activities; b) how deep is the student's understanding of the material to be presented (Razak, 2017). Since students will quickly feel bored if given material they already know, knowing these two things will allow teachers to create better learning.

One of the efforts to analyze the critical thinking process of students in terms of initial mathematical ability is by solving mathematical numeracy-based problems. Numeracy refers to knowledge, skills, and practices related to the use of mathematics in non-mathematical contexts or the application of mathematics in everyday life (Queensland College of Teacher, 2015). Steen in (Substansi et al., 2020) emphasizes the scope of numeracy which does not only consist of numbers and their operations, there are seven aspects of numeracy, namely belief in mathematics, appreciation of mathematics including its history and how important it is for understanding problems in the real world, the ability

to think logically and make decisions, the use of mathematics in solving everyday problems in many situations, understanding of numbers and mathematical symbols, data reasoning, and the ability to utilize various mathematical resources and knowledge. Cognitive levels on numeracy-based written test questions include knowing, applying, reasoning (Substansi et al., 2020).

METHODS

This research is a qualitative research with descriptive method, where the focus of this research is based on facts that will be carried out by means of observation or observation and studying or analyzing the results that have been obtained. Informants in extracting data in this study were students and math teachers. In this study, students were selected by purposive sampling based on teacher data on student learning outcomes, namely six students including two students with low initial abilities, two students with moderate initial abilities, and two students with high initial abilities whose work will be analyzed by researchers, and teachers as sources who will be asked for information related to the students' initial mathematical proficiency. After the data is collected, qualitative analysis is carried out with the stages of the process of indicators that have been determined by the researcher. The numeracy based sosial arithmetic written tests and interview guidelines were used as instruments in this study which was conducted on May 21, 2014. Data analysis was carried out by analyzing student answers based on four critical thinking indicators developed by Facione is interpretation, analysis, evaluation, inferens. Unstructured interviews with the six students to find out and ensure understanding of the written test questions and used to support data from the written test result whether students really answered all written test questions independently according to student understanding.

RESULT AND DISCUSSION

The following is a presentation of the results of the analysis of the answers of six students, with the questions given as follows.

Question no. 1

YEAR-END DISCOUNT

Towards the end of the year, at Tanah Abang Market, there are several grocery stores offering various discounts. Here are some of the discounts offered.

Sinar Store



Maju Store

Jaya Store



Makmur Store

- a. At the end of the year, discounts or price cuts offered at several stores in Tanah Abang Market are very diverse, one of the stores that offer discounts is Maju Store. From the illustration above, it is known that Maju Store discount is? Give an arrow to the correct answer!

Maju Store

• 30% + 20%

• 40% + 10%

• 50%

• Half Price

Why is this the case? Give an explanation.

- b. If Diki buys groceries at Makmur Store for 100.000 (IDR). How much does Diki have to pay? Write down the complete solution steps!
- c. Consider the discounts at Jaya Store and Maju Store above. Put a check mark (✓) on one of the correct and incorrect columns below! Give an explanation!

Statement	Answer	
	Correct	Incorrect
The ammount of discount at Jaya Store in the same as the discont at Maju Store		

1. Critical thinking skills of students with low initial ability

a. Berikan tanda panah pada jawaban yang benar!

Toko Maju

30% + 20%

40% + 10%

50%

Setengah harga

Mengapa demikian? Berikan penjelasan.

Karena itu jawaban yang benar dan sesuai dengan pernyataan.

Jika Diki beli $40\% + 10\% = 50\%$

b. Berapa Diki harus membayar belanjanya?

toko makmur = Bayar setengah harga

$100000 : \frac{1}{2} = 50.000$

Jadi Diki harus membayar 50.000

c. Berikan tanda ceklis (✓) pada salah satu kolom benar dan salah di bawah ini!

Pernyataan	Jawaban	
	Benar	Salah
Benar diskon di Toko Jaya sama dengan diskon di Toko Maju	✓	

Penjelasan:

toko Jaya = $30\% + 20\% = 50\%$

toko Maju = $40\% + 10\% = 50\%$

Jawab

Keduanya benar, karena diskon toko Jaya dan toko Maju sama

Figure 1. Student 1 of low initial ability

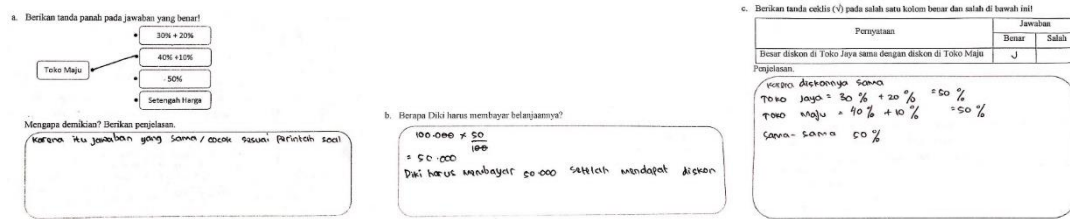


Figure 2. Student 2 of low initial ability

Based on the picture above, it can be seen that the two students with low initial ability have not been able to fulfill the four indicators of critical thinking on numerical problems on social arithmetic material. The results of the analysis based on critical thinking indicators found that student 1 can identify the relationship of the data presented and provide arguments (analysis), and can draw a conclusion and decision (inferens). However, student 1 cannot understand and express the meaning of the data (interpretation). And could not find and prove the calculation in question 1c (evaluation). The results of student 1's interview showed that *"I don't really understand discounts of almost the same size and the form of summation discounts, so I add up the discounts first and then write the answer in my own way"*. Likewise with student 2, the results of the analysis based on indicators of critical thinking ability that can fulfill three indicators, namely interpretation, analysis, and inference. Student 2 could not fulfill the evaluation indicator in question 1c. from the results of the student interview, information was obtained that *"I had difficulty working on problem 1c because I thought the most appropriate step was to add the two discounts"*.

2. Critical thinking skills of students with medium initial ability

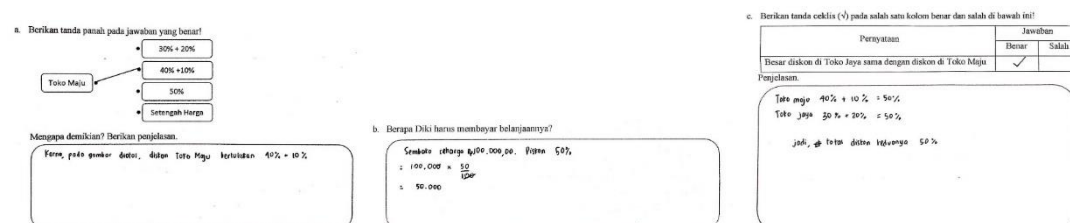


Figure 3. Student 1 of medium initial ability

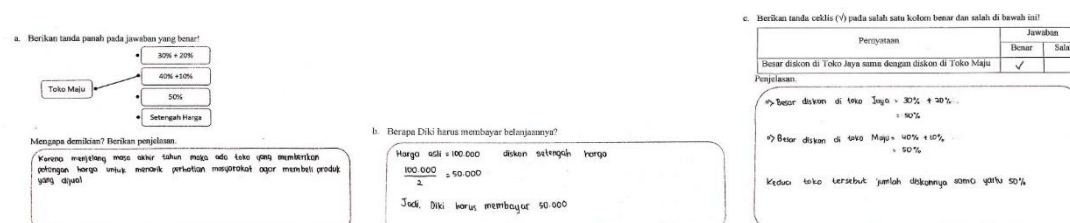


Figure 4. Student 2 of medium initial ability

Based on the picture above, it can be seen that the two students with moderate initial ability have not been able to fulfill the four indicators of critical thinking on numerical problems of social arithmetic material. The results of the analysis based on critical thinking indicators found that students can understand and communicate about the data presented (interpretation), students can reason arguments and find the relationship between the data given and the question asked (analysis), and students can draw a conclusion and decision (inferens). However, both of them did not fulfill the evaluation indicator, which is not able to find, prove errors, and calculate correctly in problem 1c. the results of student 1's interview showed that *"the steps I took in problem 1c were that I read the data presented in the problem then I read the problem several times so that I understood the question then I added up each discount and the results I got the two stores had the same size"*. The results of student 2's interview showed information that was not much different from the results of student 1's interview.

3. Critical thinking skills of students with high initial ability

a. Berikan tanda panah pada jawaban yang benar!

Toko Maju → 30% + 20%
40% + 10%
50%
Setengah Harga

Mengapa demikian? Berikan penjelasan.

Karena tulisan diskon pada soal seperti itu.

b. Berapa Diki harus membayar belanjanya?

harga sembako di Toko Makmur = Rp 100.000,00
diskon Toko Makmur = $\frac{1}{2}$ harga
Jawab: $\frac{1}{2}$ harga = $\frac{1}{2} \times 100.000$
= 50.000
Jadi, harga sembako tersebut Rp 50.000,00

c. Berikan tanda ceklis (✓) pada salah satu kolom benar dan salah di bawah ini!

Pernyataan	Jawaban	
	Benar	Salah
Benar diskon di Toko Jaya sama dengan diskon di Toko Maju	✓	

Penjelasan.

Toko Jaya = 30% + 20%
= 50%
Toko Maju = 40% + 10%
= 50%
Jadi, besar diskon di Toko Jaya sama dengan Toko Makmur

Figure 5. Student 1 of high initial ability

a. Berikan tanda panah pada jawaban yang benar!

Toko Maju → 30% + 20%
40% + 10%
50%
Setengah Harga

Mengapa demikian? Berikan penjelasan.

Karena pasar tanah abang pada akhir tahun menawarkan potongan harga di beberapa toko pada pasar tanah abang

b. Berapa Diki harus membayar belanjanya?

Sembako seharga 100.000,00 x $\frac{1}{2}$ = 50.000
100.000 - 50.000 = 50.000
50.000 x $\frac{1}{10}$ = 5.000
50.000 - 5.000 = 45.000
Jadi, Diki harus membayar sebesar 45.000

c. Berikan tanda ceklis (✓) pada salah satu kolom benar dan salah di bawah ini!

Pernyataan	Jawaban	
	Benar	Salah
Benar diskon di Toko Jaya sama dengan diskon di Toko Maju		✓

Penjelasan.

Toko Jaya
100.000 x 30% = 30.000
100.000 - 30.000 = 70.000
70.000 x 20% = 14.000
70.000 - 14.000 = 56.000
Toko Jaya = 56.000

Toko Maju
100.000 x 40% = 40.000
100.000 - 40.000 = 60.000
60.000 x 10% = 6.000
60.000 - 6.000 = 54.000
Toko Maju = 54.000

Figure 6. Student 2 of high initial ability

Based on the picture above, it can be seen that students with high initial ability only student 2 can fulfill four indicators of critical thinking on numerical problems of social arithmetic material. The results of the analysis based on critical thinking indicators obtained by both students can understand and communicate about the data given (interpretation), students can identify and design solution modeling (analysis), students can draw conclusions and decisions (inferens). Student 1 could not find and complete the calculation (evaluation), from the results of the interview student 1 obtained information

that "I was a little hesitant and had a little trouble with the discount in the form of adding two discounts". In contrast to student 1, student 2 can find and complete the calculation (evaluation), from the results of student 2's interview obtained information that "I can analyze and find a solution by doing calculations with the same number, then I will be able to write the conclusion correctly".

Question no. 2

Consider the story problem below.

PROFIT AND LOSS OF DURIAN SELLER

Hello friends, I am a durian seller who is usually called Mas Aji, one day I bought 120 durians at a price of 6.000.000 (IDR). Then I intend to resell the durians at various prices with different sizes, there are also some durians that are rotten and unsold as in the table below. And help me solve the questions below.

Durian Size	Quantity	Price per piece
Super	5 pieces	80.000,00 (IDR)
Great	40 pieces	75.000,00 (IDR)
Medium	15 pieces	60.000,00 (IDR)
Small	50 pieces	50.000,00 (IDR)
Unsold rot	... pieces	0,00 (IDR)

- From the story of Mas Aji the durian seller above, how many durians are rotten? Give the complete answer.
- If it is assumed that each durian fruit costs the same at initial purchase, which of the following statements is correct? Put a check mark (✓) on one of the Correct and Incorrect columns below! Give an explanation!

Statement	Answer	
	Correct	Incorrect
The initial price per durian fruit is 54.545,00 (IDR)		
The initial price per durian fruit is 50.000,00 (IDR)		

- From Mas Aji's sales above, did Mas Aji experience a profit or loss? Determine the amount of profit or loss experienced by Mas Aji!

4. Critical thinking skills of students with low initial ability

a. Dari cerita Mas Aji maka berapa banyak durian yang busuk?

120 buah - Super (5) - Great (40) - Medium (15) - Small (50) = 10

Jadi banyak durian yg busuk 10.

b. Berikan tanda ceklis (✓) pada salah satu kolom benar dan salah di bawah ini!

Pernyataan	Jawaban	
	Bener	Salah
Harga awal per buah durian Rp. 54.545,00		✓
Harga awal per buah durian Rp. 50.000,00	✓	

Penjelasan:

Rp 6.000.000,00 : 120 (total buah) = Rp 50.000

jumlahnya 50.000 per buah

c. Dari penjualan Mas Aji diatas, apakah Mas Aji mengalami keuntungan atau kerugian?

Jadi, penjualan Mas Aji mengalami kerugian sebesar Rp 4.750.000

total pembelian - penjualan

6.000.000 - (50.000 x 75.000 + 40.000 x 60.000 + 15.000 x 50.000)

= 6.000.000 - 1.125.000

= 4.750.000

Figure 7. Student 1 of low initial ability

a. Dari cerita Mas Aji maka berapa banyak durian yang rusak?

(20 buah - Super < 5 buah)
 Besar < 40 buah
 Sedang < 10 buah
 Kecil < 50 buah
 rusak tidak terjual = 10 buah

b. Berikan tanda ceklis (✓) pada salah satu kolom benar dan salah di bawah ini!

Pernyataan	Jawaban	
	Benar	Salah
Harga awal perbuah durian Rp. 54.545,00		✗
Harga awal perbuah durian Rp. 50.000,00	✓	

Penjelasan:
 $6.000 : 110 = 54.545$
 harga yang naik dikali adalah 54.545
 jadi, Pernyataan 1 yang benar

c. Dari penjualan Mas Aji diatas, apakah Mas aji mengalami keuntungan atau kerugian?

mas aji mengalami kerugian
 $= \text{Total Penjualan} - \text{total pembelian}$
 $= 6.000.000$
 $- 1.150.000$
 $= 4.850.000$
 Jadi, penjualan Mas Aji mengalami kerugian sebesar Rp. 4.850.000

Figure 8. Student 2 of low initial ability

Based on the picture above, it can be seen that the two students with low initial ability have not been able to fulfill the four indicators of critical thinking on numerical problems of social arithmetic material. From the analysis based on critical thinking indicators, it is found that both students can understand and communicate about the data given (interpretation), students can draw conclusions and a decision (inferens). Student 1 can identify the relationship between data and develop a solution model (analysis), but student 2 cannot fulfill the analysis indicator. Both students could not find and prove the error in the problem and could not implement the solution model (evaluation). The results of student 1's interview showed that *"I didn't understand the profit and loss material, so I calculated the price in the table then I just added it and then I subtracted it from the initial price written in the story problem"*. From the results of student interviews, information was obtained that was not much different that student 2 also lacked understanding and did not understand how to calculate the entire price requested.

5. Critical thinking skills of student with medium initial ability

a. Dari cerita Mas Aji maka berapa banyak durian yang rusak?

total buah rusak :
 $120 \text{ buah} - (5 + 40 + 10 + 50) = 80 \text{ buah}$

b. Berikan tanda ceklis (✓) pada salah satu kolom benar dan salah di bawah ini!

Pernyataan	Jawaban	
	Benar	Salah
Harga awal perbuah durian Rp. 54.545,00		✓
Harga awal perbuah durian Rp. 50.000,00	✓	

Penjelasan:
 total pembelian 10 buah = 6.000.000,00
 harga 1 buah : total pembelian : jumlah buah
 $= 6.000.000,00 : 120$
 $= \text{Rp. } 50.000,00$

c. Dari penjualan Mas Aji diatas, apakah Mas aji mengalami keuntungan atau kerugian?

Penjualan yg diperoleh Mas Aji : total pembelian, total penjualan
 $= 6.000.000,00 - 1.150.000,00$
 $= 4.850.000,00$
 Kerugian = -
 Jadi, penjualan Mas Aji mengalami kerugian sebesar Rp. 4.850.000,00

Figure 9. Student 1 of medium initial ability

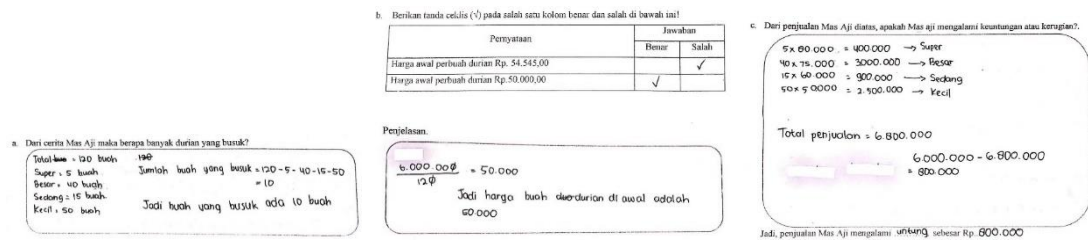


Figure 10. Student 2 of medium initial ability

Based on the figure above, it can be seen that students with moderate initial ability only student 2 can fulfill four indicators of critical thinking on numerical problems of social arithmetic material. The results of the analysis based on critical thinking indicators found that both students can understand and communicate about the data given (interpretation), students can reason arguments, find relationships between data, and design a solution model (analysis), students can draw conclusions and decisions (inferens). Student 1 cannot determine, prove errors, and implement the solution model appropriately (evaluation), but student 2 can fulfill the evaluation indicator. From the results of student 1's interview, information was obtained that "I missed one stage that I had to calculate the overall sale by multiplying the number of fruits sold by the price according to their size and then deducting the purchase price."

6. Critical thinking skills of students with high initial ability

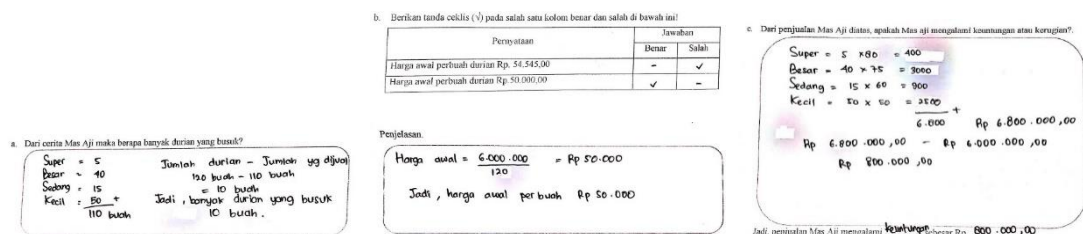


Figure 11. Student 1 of high initial ability

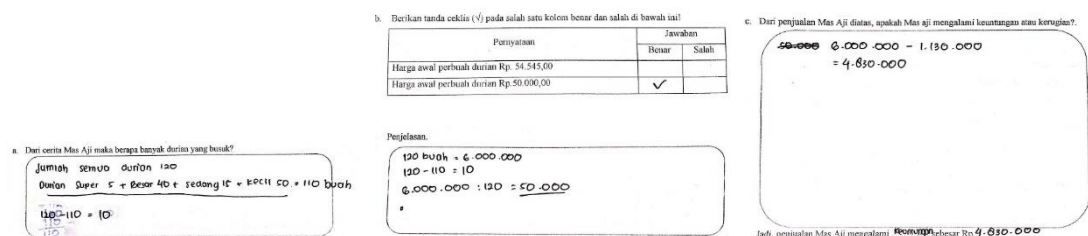


Figure 12. Student 2 of high initial ability

Based on the picture above, it can be seen that students with moderate initial abilities are only student 2 who can fulfill four indicators of critical thinking on numerical problems in social arithmetic material. The results of the analysis based on critical thinking

indicators that both students can fulfill the interpretation indicator, namely students can know or communicate the meaning of the data presented. Both students can fulfill the analysis indicator, namely students can find the relationship between the data and the argument given and can design a solution model. Both students can fulfill the inferens indicator, namely students can draw conclusions and decisions from the calculation results. However, in the evaluation indicator, only student 2 can fulfill this indicator, namely students can find, prove the error requested in the problem, and carry out the design of the solution model. The results of student 1's interview showed that *"I understood the data given in the problem, but I was not careful in reading question number 2c and I was less careful so I skipped the stage of calculating the selling price of the fruit which should be multiplied by the number of fruits sold by the price contained in the problem and then the conclusion of profit or loss can be found"*.

Based on the explanation of the analysis of students' critical thinking in solving numeracy-based social arithmetic problems carried out by six students with low, medium and high initial abilities with indicators of students' critical thinking put forward by Facione, the results are still relatively low, because students have not been able to fulfill all indicators of critical thinking. In other words, students have not been able to think critically to solve numeracy-based social arithmetic problems optimally. This study is in line with a study conducted by (Faiziyah & Priyambodho, 2022). In addition, this study is related to a study conducted by (Afandi, 2016) which states that students with high initial mathematical ability can fulfill all critical thinking indicators. In accordance with the results of this study which show that one of the students with high initial ability can fulfill all indicators of critical thinking in other words, students with high initial ability can think critically in solving numeracy-based social arithmetic problems. Meanwhile, students with medium and low initial abilities have not been able to fulfill all critical thinking indicators. This is in line with research conducted by (Nugraha et al., 2017). In addition, according to (Agnafia, 2019) states that students with moderate category levels are lacking in their ability to think critically and need to improve again. For more detailed research results, it can be noted in the form of a table as below.

Table 2. Conclusion of critical thinking skills analysis

Critical thinking indicators	Students with Initial Ability					
	Low		Medium		High	
	Student 1	Student 2	Student 1	Student 2	Student 1	Student 2
Question no.1						
Interpretation	-	√	√	√	√	√
Analysis	√	√	√	√	√	√
Evaluation	-	-	-	-	-	√
Inferens	√	√	√	√	√	√
Question no.2						
Interpretation	√	√	√	√	√	√
Analysis	√	-	√	√	√	√
Evaluation	-	-	-	√	-	√
Inferens	√	√	√	√	√	√

CONCLUSION

Based on the results of the analysis of answers and discussion for each indicator above, the results state that the six student samples in the study did not meet the four criteria for critical thinking indicators on numeracy-based social arithmetic material questions. Meanwhile, the interview results show that students do not meet the critical thinking indicators because students do not read the statements contained in the problem carefully, students do not understand the material, students do not understand the form of true and false choice questions, students also tend to have low initial math skills. So it can be concluded that students' critical thinking skills on social arithmetic material in terms of initial ability are still relatively low.

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