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ORIGINAL PAPER

Analysis of Critical Thinking Ability in Solving Linear Inequalities with One Variable Reviewed from a Mathematical Disposition

Siti Fatimah, Sunardi Djamaluddin(*), Vanesa Palijama, Veronika J. Kaitelapatay, Anderson Palinussa
Universitas Pattimura, Jalan Ir. M. Putuhena, Kampus Unpatti, Poka, Ambon, Indonesia

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Abstract
This study aims to describe students' critical thinking skills in solving linear inequality problems with one variable in terms of mathematical disposition. This type of research combines quantitative and qualitative approaches. The subjects in this study were three students selected from a class of 31 students in class VIII-4 of SMP Negeri 4 Ambon, categorized as having high, medium, and low mathematical dispositions. The results of the study showed that subject JA, with a high mathematical disposition, could fulfil every indicator of critical thinking. Subject JFT, with a medium mathematical disposition category, demonstrated that he could fulfill the critical thinking indicator on some questions, but was unable to fulfill it on other questions. Meanwhile, subject JK, with a low mathematical disposition category, could only fulfil two indicators of critical thinking. Based on the percentage of the results of filling out the mathematical disposition questionnaire, the high mathematical disposition category is 41.94%, the moderate mathematical disposition category is 48.39%, and the low mathematical disposition category is 9.68%, which means that the largest percentage of mathematical disposition of class VIII-4 students is in the moderate mathematical disposition category.

Keywords:
Mathematical Disposition
Critical Thinking Ability
Linear Inequalities of One Variable

Corresponding Author:
Name: Sunardi Djamaluddin
Email: djardhy28@gmail.com

INTRODUCTION

21st-century learning is shaped by the development of technological advancements that provide a broad range of learning opportunities for humans. The development of technology in the 21st century has permeated all fields, including education. As a result of technological developments, there has been a change in the way of viewing 21st-century education in a more substantive way, which means that 21st-century education is not only a concept of how to teach but also changes the way of viewing the concept of education itself (Surani, 2019, p. 457). With the development of technology in the 21st century, it is essential to develop skills that enable students to face life's challenges.

Development of skills in 21st-century learning that can help students face increasingly complex life challenges, namely creative thinking skills, critical thinking, problem-solving, and collaboration (Septicasari & Rendy, 2018, p. 108). In the context of current mathematics learning, critical thinking skills play a crucial role in solving various problems that require a deep understanding and the ability to apply concepts and procedures appropriately.

One of the mathematical materials that requires students' critical thinking skills is the material on linear inequalities of one variable. This material teaches students to understand the concept of inequality and apply mathematical rules to solve problems. Although this material is basic in algebra, many students struggle to solve problems involving linear inequalities of one variable. Therefore, critical thinking has a major role in developing problem-solving skills and a deep understanding of mathematical material (Permata and Yusi, 2023: 2)

In 21st-century mathematics learning, mathematical disposition —namely, attitudes, beliefs, and thinking habits towards mathematics—plays a crucial role in influencing students' levels of success in critical thinking. Positive mathematical dispositions, such as self-confidence and perseverance, can improve students' ability to think critically when solving mathematical problems. In addition, good mathematical dispositions also include flexibility and openness of thinking, allowing one to see perspectives and approaches in understanding mathematical concepts (Wirawan et al., 2023). Therefore, understanding how students' mathematical dispositions affect their abilities, especially in the context of procedural and logical material, such as linear inequality material in one variable, is crucial.

This study was conducted at SMP Negeri 4 Ambon, where students demonstrated sufficient basic mathematical abilities but still struggled with solving problems related to the material of linear inequalities of one variable. In the context of 21st-century learning, it is essential to examine the relationship between mathematical disposition and students' critical thinking skills in problem-solving. This study aims to provide a deeper understanding of the influence of mathematical disposition on students' critical thinking skills in the material of linear inequality of one variable.

METHOD

The research approach employed is a mixed-methods design, combining quantitative and qualitative methods. In this study, initial data were collected by providing questionnaire sheets to measure the level of mathematical disposition of students, which would then be classified quantitatively. Then, to see critical thinking skills, students were given sheets containing story questions about linear inequality problems with one variable, which would later be described qualitatively.

The subjects in this study were three students with high, medium, and low mathematical disposition categories, selected from a class of 32 students in class VIII-4 of SMP Negeri 4 Ambon. This study employed two types of data: quantitative and qualitative. To obtain the required data, the instruments used were mathematical disposition questionnaires, critical thinking test sheets for solving linear inequality problems with one variable, and interview guidelines. The results of students' work in solving linear inequality problems with one variable will then be analysed using the data triangulation technique developed by Miles and Huberman (Sugiyono, 2017). The triangulation technique involves three steps to analyze data comprehensively regarding the subject being studied, rather than testing hypotheses or theories. The triangulation steps include: 1) Data reduction, 2) Data presentation, and 3) Concluding.

RESULTS & DISCUSSION

Based on the completion of the mathematical disposition questionnaire, the results are presented in Table 1.

Table 1. Percentage of Results of Completing the Disposition Questionnaire M

No.	Value Interval	Category	Amount	Percentage
1	$x \geq 74$	High	13	41,94%
2	$60 \leq x < 74$	Medium	15	48,39%
3	$x < 60$	Low	3	9,68%

Based on Table 1, it can be seen that the mathematical disposition ability in Class VIII-4 is mostly in the medium mathematical disposition category, with a percentage of 48.39% and a total of 15 students. Then, in the high category, there are 13 students with a percentage of 41.94%, and in the low category, there are three students with a percentage of 9.68%.

Furthermore, based on the results of the critical thinking ability test and the percentage of results from completing the mathematical disposition questionnaire, three students were selected for an interview: one student in the high category, one student in the medium category, and one student in the low category. The following is a list of research subjects interviewed:

Table 2. List of Research Subjects

Student Code	Mathematical Disposition Categories	Interview Subject Code
JA	High	JA
JFT	Medium	JFT
JK	Low	JK

From Table 2, 3 research subjects will be analysed, namely JA with a high mathematical disposition category, JFT with a medium mathematical disposition category, and JK with a low mathematical disposition category. The following is an analysis of the results and interviews of the three subjects, as seen through the critical thinking indicators in completing the application of linear inequality of one variable.

1. JA Subject (High Mathematical Disposition Category)

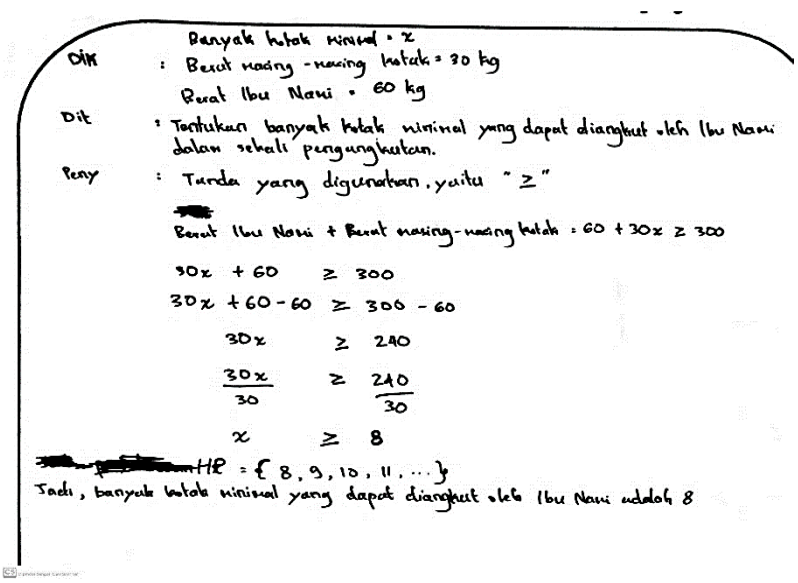

Figure 1. Results of Work Number 1 Subject JA

Based on the results of the subject JA's work, the researcher conducted an interview related to the critical thinking indicators. The following is an excerpt from the interview with subject JA:

P101	:	After reading the question, what is known and what is asked in the question?
JA101	:	The weight of each box is 30 kg. Nami's mother weighs 60 kg. I asked to determine the minimum number of boxes that Ms Nami can transport in one transport.
P102	:	From what is known, that is all there is to it; nothing else is known.
JA102	:	Yes. The carrying capacity of the boxcar is less than 300 kg.
P103	:	How do you model the problem in the question into a linear inequality of one variable? Please explain.
JA103	:	Okay. First, I assume the number of boxes is at least x. Because the carrying capacity of the box car is less than 300 kg, the sign used is more than or equal to (≥). Then I added the weight of Mrs. Nami and the weight of each box, previously assumed to be 30x + 60, so the form of the inequality I obtained was 30x + 60≥ 300.
P104	:	After modelling the problem in the form of an inequality, how do you solve it?
JA104	:	I solved the inequality by subtracting 60 from both sides, which resulted in the following (the subject pointed to the work), and I obtained 30x ≥ 240. Then I divided both sides by 30: 30x/30 = x, 240/30 = 8, so I got x ≥ 8.
P05	:	Besides solving it by subtracting 60 from both sides, is there any other way?
JA05	:	There is.
P06	:	Can you explain?
JA06	:	60 is moved to the left side so that 30x≥300-60 gets 30x≥240, and then it's the same. Namely, both sides are divided by 30.
P107	:	Okay. Is x≥8 the final answer to question number 1?
JA107	:	Not yet. Since the question concerns the minimum number of boxes, the smallest number from the solution set of x> 8 is 8.
P108	:	From the answers you gave, what can you conclude?
JA108	:	So, the minimum number of boxes that Mrs. Nami can transport in one shipment is eight boxes.

Based on the results of the work and interviews of subject JA that have been explained previously, subject JA meets all indicators of critical thinking skills in each question, where subject JA can determine what is known and asked from the question even though in questions 1 and 2 subject JA has not completely written it in the work results but can complete it well during the interview process. In the analysis indicator, subject JA can model the problem from the question in the form of a linear inequality of one variable.

In the evaluation indicator, subject JA can apply strategies such as assuming the weight of each box with the symbol x (question number 1) and calculating the area of the rectangle that will be used to find the maximum width of the land (question number 2). Then, in this indicator, subject JA can also accurately and precisely carry out the calculation steps. Furthermore, subject JA fulfills the evaluation and explanation indicators, as they can clearly explain the conclusions that will be given and correctly provide these conclusions. This is in line with what Hayudiyani et al. (2017) said, namely that students with high abilities can understand the meaning of the question (interpretation) well, understand the concept used (analysis) in working on the question, complete the solution of the question (evaluation), so that they can conclude (inference). When viewed from a mathematical disposition, Susilo et al. (2020) also argue that students with high positive mathematical dispositions have very good abilities in analysing problems and good abilities in providing explanations, evaluating, and choosing strategies, and mathematical dispositions can also show that there is a tendency for increased achievement in each indicator of critical thinking skills.

2. JFT Subject (Medium Mathematical Disposition Category)

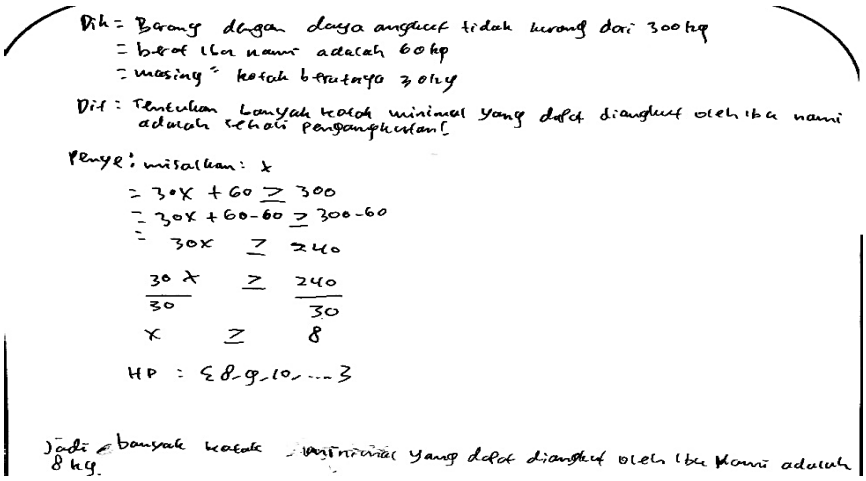

Figure 2. Results of Work Number 1 Subject JFT

Based on the results of the JFT subject's work, the researcher conducted an interview related to critical thinking indicators. The following is an excerpt from an interview with the JFT subject:

P101	:	After reading the question, what is known and what is asked in the question?
JFT101	:	The carrying capacity is not less than 300 kg, Mrs. Nami's weight is 60 kg, and each box weighs 30 kg. I asked to determine the minimum number of boxes that Mrs. Nami could transport in one shipment.
P102	:	The carrying capacity is not less than 300 kg; what is the carrying capacity? Box car? Mrs Nami? Or boxes?
JFT102	:	The carrying capacity of a boxcar.
P103	:	How do you model the problem in the question into a linear inequality of one variable? Try to explain.
JFT103	:	First, I assume x for each box. Then I add Mrs. Nami's weight and the weight of each box that has been assumed before, so it becomes 30x + 60 (explaining while showing the results of his work). The carrying capacity of the box car is less than 300 kg, so the sign used is more than or equal to (≥). The model or form of the inequality is $30x + 60 \geq 300$.
P104	:	After modelling the problem into an inequality, how do you solve it?
JFT104	:	I solved it by subtracting 60 from both sides, so it becomes like this (the subject points to the results of his work), which yields $30x \geq 240$. Then divide both sides again by 30 to get $x \geq 8$.
P105	:	Besides solving it by subtracting 60 from both sides, is there an alternative method?
JFT105	:	There is, but I understand it better this way.
P106	:	Can you explain a little?
JFT106	:	(The subject is silent.)
P105	:	Okay, let us continue then. Is $x \geq 8$ the final answer to question number 1?
JFT105	:	No. The solution set of $x \geq 8$ is 8, 9, 10, and so on, so the smallest number is 8.
P106	:	Based on the answer you gave, what can you conclude?
JFT106	:	Therefore, the minimum number of boxes that Mrs. Nami can transport in one trip is eight boxes, not kilograms (as indicated by the results of the subject's work, which show an error).

Based on the results of the work and the JFT subject interviews previously explained, the JFT subject demonstrates several indicators of critical thinking skills in each question. The JFT subject can meet the interpretation indicator in both questions; this is evident from the JFT subject's ability to determine, write, and explain what is known and asked for completely in the results of their work and during the interview process. In the analysis indicator, the JA subject can correctly model the problem from the question in the form of a linear inequality of one variable. However, the JFK subject has not been able to meet the evaluation indicator, whereas in question number 2, the JFK subject is unable to complete the calculation process. This results in the JFK subject also not being able to meet the evaluation, explanation, and inference indicators in question number 2. This finding aligns with research by Ristanti (2017), which revealed that students with a moderate level of mathematical disposition, most of whom have demonstrated the indicators of critical thinking skills, namely the ability to prove the truth of a statement. However, they have not met the indicators of being able to organise information systematically and accurately, nor have they been able to argue in depth correctly. Additionally, they have not been able to perform systematic and accurate calculations on the question.

3. JK Subject (Low Mathematical Disposition Category)

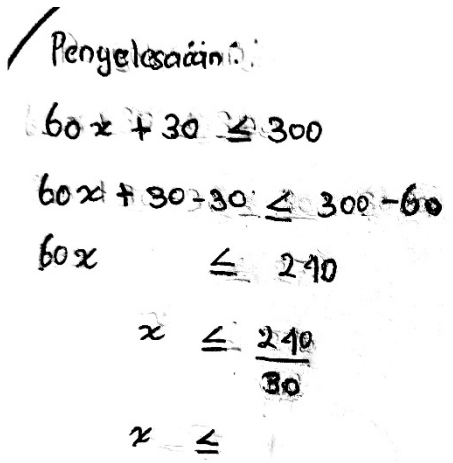

Figure 3. Results of Work Number 1 Subject JK

Based on the results of the subject JK's work, the researcher conducted an interview related to critical thinking indicators. The following is an excerpt from an interview with subject JK:

P101	:	After reading the question, what is known and what is asked in the question?
JK101	:	The carrying capacity of the box car is not less than 300 kg, Mrs. Nami's weight is 60 kg, and each box weighs 30 kg. I asked to determine the minimum number of boxes that Mrs. Nami could transport in one shipment.
P102	:	You know what is known and asked in the question, but why don't you write it down in the work results?
JK102	:	Forgot, Mom (laughs while scratching her neck).
P103	:	Okay. How do you model the problem in the question into a linear inequality of one variable? Try to explain.
JK103	:	Because Mrs. Nami's weight is 60 kg and each box weighs 30 kg, the model I obtained is $60x + 30 \leq 300$.
P104	:	Where do the ≤ and 300 signs come from?
JK104	:	Obtain it from the car's carrying capacity of at least 300 kg.
P105	:	Are you certain you did not make an error in modeling?
JK105	:	(The subject is silent and does not respond.)

P106 : Okay, let us continue. After modelling the problem into an inequality, how do you solve it?
JK106 : I solved it by subtracting 30 from the left side and subtracting 60 from the right side, like this (showing the result of his work). He got $60x \geq 240$. Then $\geq 240/30$, $x \geq 8$.

P107 : Why from $60x \geq 240$ to $\geq 240/30$? How did you calculate it?

JK0107 : It is the same as dividing by 60 and 30; therefore, dividing the left side by 60 yields $60x/60 = x$, and dividing the right side yields $24/30 = 8$.

P108 : Why do different numbers divide both sides?
JK108 : (No answer while scratching his neck)
JK109 : Is there an alternative approach to solving this problem?
JK09 : None.
P110 : Okay, let us continue then. Is $x \geq 8$ the final answer to question number 1?
JK110 : (no answer)
P111 : Based on the answer you gave, can you conclude?
JK111 : So, the minimum number of boxes that Mrs. Nami can transport in one transport is eight boxes.

Based on the results of the work and the interview, JK can only fulfill one indicator of critical thinking ability, namely the interpretation indicator, overall. Subject JK can write and explain what is known and what is asked for each question. However, in the analysis, evaluation, explanation, and inference indicators, subject JK has not been able to fulfill these four indicators. This can be seen from the fact that subject JK can perform mathematical calculations correctly and systematically; however, subject JK cannot choose the appropriate strategy to use when solving the given questions. This also results in subject JK being unable to model the question into a one-variable linear inequality form; consequently, a conclusion cannot be given, even though subject JK was able to provide a conclusion in question number 1. This is in line with research from Yasin et al. (2023), namely, subjects with a low category of mathematical disposition are only able to fulfil the indicators of mathematical critical thinking ability correctly in 2 indicators, one of which is the interpretation indicator, while for other critical thinking ability indicators, such as the analysis indicator and the inference indicator, the subject is unable to fulfil it properly and correctly.

CONCLUSION

Based on the results and discussion, it can be concluded that critical thinking on the linear inequality material of one variable of class VIII students of SMP Negeri 4 Ambon which is reviewed from the mathematical disposition is as follows: (1) Subject JA with a high mathematical disposition category can work on the questions given and fulfill the four indicators of critical thinking, namely interpretation, analysis, evaluation, explanation, and inference on questions number 1 and 2; (2) Subject JFT with a medium mathematical disposition category in working on the questions given, can fulfill the four indicators of critical thinking, namely interpretation, analysis, evaluation, explanation on question number 1, but on question number 2 subject JFT only fulfills the indicators of critical thinking, namely interpretation and analysis; (3) Subject JK with a low mathematical disposition category in working on the questions given only fulfills the indicators of critical thinking, namely interpretation and inference

on question number 1 and on question number 2 only fulfills the indicator of critical thinking, namely interpretation.

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