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Analysis of junior high school students' critical thinking skills in solving HOTS questions viewed from learning style

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Abstract
Currently, junior high school students' critical thinking abilities are relatively low. To address this, one effective approach is through the use of HOTS (Higher Order Thinking Skills) questions. However, students' abilities to solve HOTS questions often vary due to differences in learning styles. While this study emphasizes the relationship between learning styles and critical thinking, it does not include a gender-specific analysis or a comprehensive exploration of HOTS questions across all levels of Bloom's taxonomy. This research analyzes junior high school students' critical thinking abilities in solving HOTS questions regarding learning style. The descriptive research used a qualitative approach. Data collection techniques were carried out by distributing questionnaires, tests with HOTS question instruments covering Bloom's C4 to C6 levels, and interviews. The interactive analysis model uses data collection, condensation, display, and conclusion drawing/verification. The research results show that students with a visual learning style tend to write answers completely and systematically, can identify problems in a structured manner, and have high accuracy, so they often recheck students' answers. Students with an auditory learning style have difficulty writing complete and structured answers but have good storytelling skills and often explain answers verbally even though they do not write them in detail. Kinesthetic students tend to write answers in sketch form, only recording a few steps and do not double-check answers because they cannot sit still for too long.

Keywords: *critical thinking, learning styles, HOTS*

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INTRODUCTION

The ability to think critically is an important aspect of facing developments in the 21st-century era especially 4C skills (Octaviana & Setyaningsih, 2022). This skill empowers people to adapt to diverse situations and tackle challenges with reasoned, innovative approaches, making it an indispensable competency in modern life. This is characterized by the rapid progress of technology, information, and communication, which has brought changes to the landscape of human life (Sari & Wardhani, 2020; Susandi et al., 2019). The ability to think critically is a need that has emerged as a response to the challenges that occur in the 21st century. Often there is various information that is difficult to verify as true (Cahyono et al., 2022). The difficulty in verifying the truth of certain information emphasizes the importance of critical thinking and media literacy to assess and evaluate the validity of the data being consumed. Critical thinking skills are key in facing challenges in disseminating information. Each individual can sort and filter accurate information through critical thinking skills (Basari et al., 2019). Critical thinking skills can prevent someone from invalid or misleading information (Machete & Turpin, 2020). These skills empower individuals to differentiate between factual, credible data and deceptive or manipulated content, ensuring they make informed decisions and avoid being influenced by misinformation or propaganda. This proactive approach to information assessment is vital in a world saturated with diverse and often conflicting information sources. For students, critical thinking skills are used to study problems systematically to face challenges in an organized manner, formulate innovative questions, and design problem solutions (Kania et al., 2023; Zakiah & Lestari, 2019). Junior high school students' critical thinking abilities are important in evaluating information, understanding mathematical concepts better, and connecting students' knowledge with real-world situations (Fatmarani & Setianingsih, 2022; Sakinah & Nasution, 2023). In addition, at this level, students begin to engage in more complex mathematical concepts (Hikayat et al., 2020; Syam et al., 2020). Critical thinking skills are needed in solving mathematical problems Mathematics is one material that can train critical thinking skills. Through the learning

process in mathematics material, students are expected to be able to master logical, analytical, systematic, critical, and creative thinking skills and can work together (Rohim & Rofiki, 2024; Widana, 2018). Critical thinking skills are included in the category of high-level thinking skills (Munawaroh & Siswono, 2020; Sarifuddin et al., 2021). In mathematical concepts, critical thinking consists of identifying problems, formulating various conjectures, choosing the right strategy, finding relationships between material, rationalizing, proving, retesting, analyzing processes and results, and generalizing conclusions (Afriansyah et al., 2021; Martha et al., 2022). Critical thinking skills are needed by students in the development of mathematical thinking (Hikayat et al., 2020; Wulandari & Warmi, 2022). Students are said to have the ability to think critically mathematically if during the mathematics learning process, they can master all the indicators in critical mathematical thinking (Lestari & Roesdiana, 2022) .

Ennis (1996) explains that critical thinking skills are a way to intelligently process information received in making decisions, generating new ideas, and finding ways to solve problems. Ennis (1996) also explains that someone is said to have critical thinking skills if they fulfil the six indicators, namely focus, reason, inference, situation, clarity, and overview (Widyastuti & Jusra, 2022). Aspect F (focus) means identifying the main focus or attention. The R (reason) aspect means identifying and assessing the acceptability of reasons. Aspect I (inference) mean assessing the quality of the conclusion, assuming the reasons are acceptable. The S (situation) aspect means paying close attention to the situation. Aspect C (clarity) means, checking the use of language clearly. Aspect O (overview) means correcting the previous step and looking at it as a whole (Ennis, 1996) . The aspect of I (Inference) refers to the process of evaluating the quality of a conclusion based on the assumption that the reasons or premises provided are valid and acceptable. This aspect emphasizes the importance of logical reasoning and the ability to draw well-supported conclusions. The S (Situation) aspect highlights the need to carefully consider and pay close attention to the context or circumstances in which the reasoning occurs, ensuring that decisions or conclusions align with the nuances of the specific scenario. The C (Clarity) aspect focuses on the importance of clear and precise language to avoid ambiguity, ensuring that the information, arguments, and conclusions are easily understood and unambiguous. Lastly, the O (Overview) aspect involves revisiting and reviewing the reasoning process as a whole, ensuring that all steps are coherent and the overall conclusion aligns with the intended purpose and logic. Together, these aspects form a comprehensive framework for critical evaluation and reasoning.

However, students' critical thinking abilities in Indonesia are currently relatively low. Based on the PISA results in 2022, it shows a decline in students' mathematical thinking abilities by 13 points. This can be seen from 2018, with a score of 379 to 366 in 2022. This means that the level of the critical thinking ability category in Indonesia is low. In line with the research by Susandi et al. (2022) , which explains that in solving mathematical problems, students in Indonesia have low critical thinking skills. Students only fulfil the analysis aspect of 25%, evaluation 18.75%, and conclusion 9.375%. Apart from that, research by Safrida (2018) in Widyastuti & Jusra (2022) explains that around 23.33% of students meet the critical thinking indicators which are tested through tests.

Based on the results of an interview conducted with one of the junior high school teachers in Malang City, the critical thinking abilities of junior high school students, especially grade 8, are currently relatively low. The teacher also revealed that students were less creative in working on the questions given. This is due to differences in students' ability to receive information and students' lack of motivation to learn. One solution that teachers use to train students' critical thinking skills is by providing HOTS-based practice questions at every meeting. HOTS (Higher Order Thinking Skills) questions were chosen because they encourage deep thinking, analyze complex situations, and help develop students' critical thinking skills. Apart from that, students' learning styles are closely related to their ability to solve HOTS questions. This is because learning style is the way students receive information and face problems.

Questions HOTS are designed to push students to think in a way critical, creative, and innovative (Melawati et al., 2022; Tonra et al., 2019). In the 21st century HOTS is aspect crucial in supporting the ability think critically student (Ningrum et al., 2022; Utami et al., 2024). Students are not only asked to remember facts, but also to analyze information, link cause-effect relationships, and produce more complex solutions (Kuncoro et al., 2022; Pratiwi, 2022). Giving HOTS questions not only measures understanding but also develops students' critical thinking abilities (Hadi & Wijaya, 2020; Zana et al., 2022). In addition, HOTS questions not only measure factual knowledge, but also students' ability to solve problems, present arguments appropriately, and generate relevant new ideas (Rosyadi et al., 2022; Yuaidah et al., 2022). HOTS questions refer to Bloom's Taxonomy at levels C4 (Analyzing), C5 (Evaluating), and C6 (Creating). HOTS questions are not always categorized as difficult questions. HOTS questions measure students' abilities in these three aspects (Kamila et al., 2020; Putri et al., 2020). Students are not only able to remember or understand concepts but are also able to carry out in-depth analysis (Putri et al., 2023).

Students at the junior high school level are less able to meet the C6 level indicators (creating) from the HOTS questions given (Fikriani & Nurva, 2020; Milenia et al., 2022). Research by Fasha et al. (2021) explains that students meet level C6 with the lowest results at a percentage of 24.76%. This shows the low level of students' ability to solve HOTS questions at level C6. Students are only able to solve HOTS questions at levels C4 and C5 (Nurhayati et al., 2022; Widhiyani et al., 2019). Research by (Kusuma & Ratu, 2018) explains that students' ability to solve HOTS questions is categorized as low.

The implementation of HOTS is very important in the world of education, especially in supporting ability think critically student (Purnomo et al., 2021). The demands of the 21st century make HOTS important for students to have as an educational skill survival. Implementing HOTS in schools can help students to build long-term knowledge and filter information (Tonra et al., 2019). HOTS not only aims to measure students' understanding of basic mathematical concepts but also to encourage students to think "*out of the box*" and produce new solutions to a problem (Ismail et al., 2022). Critical thinking skills show students' independence in solving problems, students who do not have critical thinking skills are less able to solve the problems they face (Arifah et al., 2022). This ability not only is it needed by students in learning in class, but it will also have an impact and be useful for living their daily lives (Anggraini et al., 2019).

Students have different critical thinking abilities in solving HOTS questions. Even though they are different, the aim of critical thinking skills is the same namely analyzing and finding solutions to the problems faced (Veriansyah & Nurhakim, 2022). The diversity of students' critical thinking abilities in solving HOTS questions is due to differences in learning information received by students (Wasqita et al., 2022). Student learning style is one of the important factors that influences success in the learning process (Dhamayanti et al., 2022; Rizaldi et al., 2021). Learning style refers to the way a person processes, understands and remembers new information (Rahmah et al., 2022; Setiana & Purwoko, 2020)

Deporter & Hernacki (1992) defines learning style as a combination of a person's ability to absorb, organize and process information. Deporter & Hernacki (1992) categorized learning styles into three main categories namely visual, auditory, and kinesthetic (Fuadi & Walidin, 2024). Characteristics of students with a visual learning style will tend to remember information through direct observation such as looking at instructions, computers, books, art, and interactions with other people. Characteristics of students with an auditory learning style are that they tend to be good speakers and learn through discussions with other people (Ishartono et al., 2021). Meanwhile, students with a kinesthetic learning style have a tendency to remember information through physical actions and direct activities (Setiana & Purwoko, 2020).

Numerous studies have investigated students' critical thinking abilities in various contexts. Study (Afriansyah et al., 2021) related with analysis ability to think critically students in application learning RME based study (Setiana et al., 2020) explain the ability to think critically reviewed from aspect overview. Study (Fatmarani & Setianingsih, 2022) which discusses the ability to think critical student in finish question algebra. Study (Ayu et al., 2023) about the process think critical student in solve problems. Study (Veriansyah & Nurhakim, 2022) related with the ability think critical and reviewed of the student's gender. Study (Susandi et al., 2019) about ability think critical student reviewed from style cognitive. Study (Setiawan et al., 2020) which discusses influence from style Study to ability think critical student in finish problem trigonometry. Study (Rosmalinda et al., 2021) explain ability think critical student in finishing PISA.

Although there has been significant research on students' critical thinking skills in solving Higher Order Thinking Skills (HOTS) problems, there is a significant gap in understanding how these skills are influenced by students' learning styles. This study seeks to address this gap by analyzing the interaction between learning styles and critical thinking development in the context of HOTS-based problems. Although critical thinking is a critical competency for the 21st century, as highlighted by PISA 2022 findings and various preliminary studies, the practical application of this research in the classroom and its long-term impact on student learning outcomes remains largely unexplored. To bridge this gap, it is important to propose instructional strategies that are tailored to different learning styles, ensuring that critical thinking skills are effectively nurtured in all students. HOTS-based problems play a significant role in fostering critical thinking, but differences in learning styles have a significant impact on student performance. By identifying these differences and proposing targeted strategies, this study aims to provide actionable insights for educators, offering both theoretical contributions and practical solutions to enhance critical thinking development in a variety of educational settings.

METHOD

The type of research used was descriptive with qualitative research approach. The research location is in one of the junior high schools in Malang city due to the observed low critical thinking skills among its students, as evidenced by preliminary assessments and academic performance. Additionally, the school was

chosen because it provides a diverse range of student learning styles, offering a suitable context for analyzing the relationship between learning styles and critical thinking abilities. This setting ensures the relevance of the study in addressing critical educational challenges. The subjects of this research were 33 class VIII students. Subject selection was carried out using a *purposive technique* by selecting two subjects for each type of learning style consisting of two students with a visual learning style, two students with an auditory learning style, and two students with a kinesthetic learning style. The research procedure starts from the preparation stage to the conclusion drawing stage. The chart of the research procedures is shown in Figure 1.

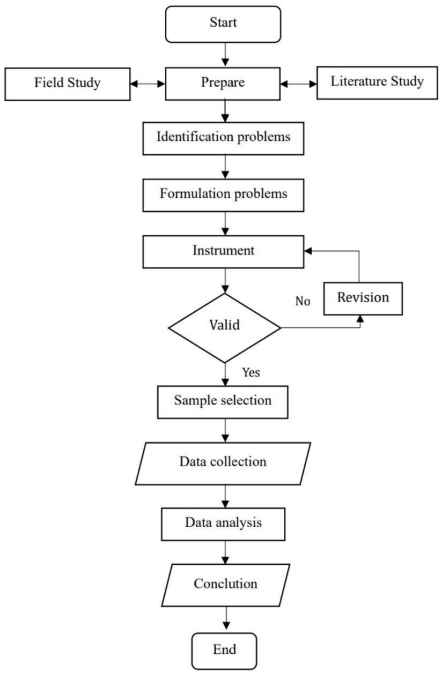


Figure 1. Research procedure

This research instrument consists of the researchers, a learning style questionnaire sheet, an interview guide sheet, and a test sheet. The instruments prepared have been validated and are suitable for use in the field. Primary data in this research was obtained through learning style questionnaires, tests and interviews. Secondary data in this research comes from book literature and journal articles as references. Data collection techniques were carried out by distributing learning style questionnaires, tests and interviews. Data collection was carried out in a natural setting. Data collection in research consists of three stages. The first stage is collecting data on student learning styles. Learning style questionnaires are distributed to students in the form of an online form to discover student learning styles. After getting the results for each student's learning style, the next stage is continued, namely carrying out the test. The test given consists of two Algebra material questions in accordance with the HOTS level C4 and C5 question criteria. Finally, interviews were conducted according to interview guidelines which were prepared in depth based on student answers. The preparation of the questionnaire instrument was based on the learning style characteristics of Deporter & Hernacki (1992) which consisted of 52 statement items. Item the visual questionnaire consisted of 20 statements, 14 auditory questionnaires and 18 questionnaires kinesthetic Score determination is based on the Likert Scale Model with 4 alternative answers. Each answer choice has a score of 1-4. The score for the question “always” is 4, “often” is 3, “rarely” is 2 and “never” is 1. Next , for determination category style Study student determined from dominant scoreThis is by the provisions: a) If there is a highest score for a particular learning style, it is concluded that the subject is categorized as including that learning style and b) If there are two identical highest scores from two learning styles, then the subject is included in the "Combination of Two Learning Styles" and c) If there are two highest scores from two learning styles that differ by 1 point, then the subject is included in "Combination of Two Learning Styles" (Putri & Suryati, 2020) . The category scores for student learning styles are shown in Table 1.

Table 1. Student learning style category scores

Learning Style Category	Total Answer Score	Information
Visual	68-83	Very good
	52-67	Good
	36-51	Pretty good
	20-35	Not good

Learning Style Category	Total Answer Score	Information
Auditory	47-57	Very good
	36-46	Good
	25-35	Pretty good
	14-24	Not good
Kinesthetic	60-73	Very good
	46-59	Good
	32-45	Pretty good
	18-31	Not good

Source : Adaptation from Isnanto (2022 :550)

The test instrument consists of two questions with HOTS criteria at levels C4 and C5. The test instrument corresponds to the test grid and is accompanied by a scoring rubric. The questions are arranged according to the FRISCO critical thinking indicators with aspects of each indicator in Table 2.

Table 2. FRISCO critical thinking indicators

Aspect	Indicator
Focus	Identify focus/ attention main
Reason	Identify and assess reception reason
Inference	Evaluate quality conclusion with assumption reason can be accepted
Situation	Notice situation with carefully
Clarify	Inspect use Language with clear
Overview	Corrected previous steps and look at it as a whole

Source: Ennis (1996: 20)

The tests that students have taken are assessed according to the answer assessment rubric that has been prepared. The scores from these student test results show the level of students' critical thinking abilities in solving HOTS questions based on their respective learning styles. The score criteria for student test results are in Table 3.

Table 3. Criteria based on test results

Value Interval	Criteria
$80 < \bar{x} \leq 100$	Very high
$60 < \bar{x} \leq 80$	High
$40 < \bar{x} \leq 60$	Currently
$20 < \bar{x} \leq 40$	Low
$00 < \bar{x} \leq 30$	Very low

Source: Adaptation from Setiana et al. (2020)

Next, interviews were conducted between researchers and six students who had different learning style characteristics. The interview corresponds to the thirteen questions in the interview guide according to the FRISCO critical thinking indicators. The data analysis technique used is an interactive model analysis Miles et al. (2014). Data analysis refers to data collection, data condensation, data presentation and drawing conclusions/verification. Data credibility testing is done using method triangulation (tests and interviews).

RESULTS AND DISCUSSION

Based on the results of the learning style questionnaire distributed to 33 students, there were 13 visual students, 4 auditory students, 6 kinesthetic students and 10 combination students. Next, 6 students were selected as research subjects consisting of 2 students in each learning style. Subjects in the visual learning style category are symbolized V1 and V2, subjects in the auditory learning style category are symbolized A1 and A2, and subjects in the kinesthetic learning style category are symbolized K1 and K2. Next, 6 research subjects with each learning style were asked to work on two questions. The results of students' answers are given a score according to the assessment rubric prepared with the results in Table 4.

Table 4. Mathematical ability test results

Subject	Learning Style Category	Score	Criteria
V1	Visual	100	Very high
V2	Visual	87.5	Very high
A1	Auditory	62.5	high
A2	Auditory	70.83	high
K1	Kinesthetic	87.5	Very high
K2	Kinesthetic	95.83	Very high

Based on Table 4, it is found that students in the visual learning style category have higher scores compared to students with other learning styles. The assessment criteria for students' Mathematical Ability Test Results are in accordance with Table 3. Meanwhile, students' critical thinking abilities are in accordance with visual, auditory and kinesthetic learning styles based on the FRISCO indicators in Table 5.

Table 5. Students' critical thinking ability based on FRISCO indicators

Subject	Learning Style Category	Question	F	R	I	S	C	O
V1	Visual	1	✓	✓	✓	✓	✓	✓
		2	✓	✓	✓	✓	✓	✓
V2	Visual	1	✓	✓	✓	✓	✓	-
		2	✓	✓	✓	✓	✓	-
A1	Auditory	1	-	✓	✓	-	✓	-
		2	-	✓	-	-	-	✓
A2	Auditory	1	✓	✓	-	✓	✓	-
		2	✓	-	✓	-	✓	✓
K1	Kinesthetic	1	✓	✓	✓	✓	✓	-
		2	✓	✓	✓	✓	✓	-
K2	Kinesthetic	1	✓	✓	✓	✓	✓	-
		2	✓	✓	✓	✓	✓	-

Based on Table 5, the results of visual, auditory and kinesthetic students' critical thinking abilities were analyzed through test and interview answers according to the FRISCO indicators. The results of the analysis and interviews that have been carried out are adjusted to the FRISCO critical thinking indicators. There is a complete discussion of the results of the analysis of test answers and interviews of 6 students with visual, auditory and kinesthetic learning styles.

Visual Subject Question Number 1.

Based on the answers of subjects V1 and V2, the visual learning style in number 1 fulfils the focus aspect. This is because subjects V1 and V2 are able to identify the main focus or attention that is the problem. Both subjects wrote down things they knew and were asked about from question number 1. The answers from subjects V1 and V2 are in Figure 2 and Figure 3.

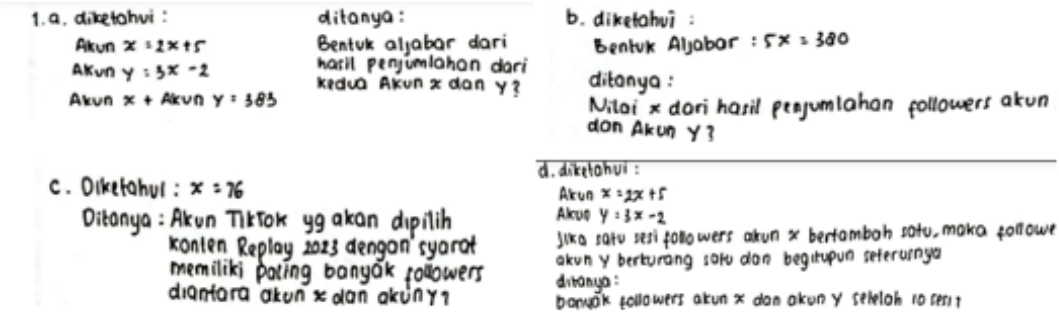


Figure 2. Results of student V1's answer number 1

In English

1a. Known :
Account X = 2x + 5
Account Y = 3x − 2
Account X + Account Y = 385
Asked :
Algebraic form of the sum of both accounts X and Y?

1b. Known :
Algebraic form : $5x = 380$
Asked : x value from the sum of followers X and Y?

1c. Known : x = 76
Asked : The TikTok account that will be selected for Replay 2023 content is provided that it has the most followers from account X and account Y?

1d. Known :
Account X = 2x + 5
Account Y = 3x + 2
If in one session followers of account X increase by one, then followers of account Y decrease by one and so on.
Asked:

Many followers of account X and account Y after 10 sessions

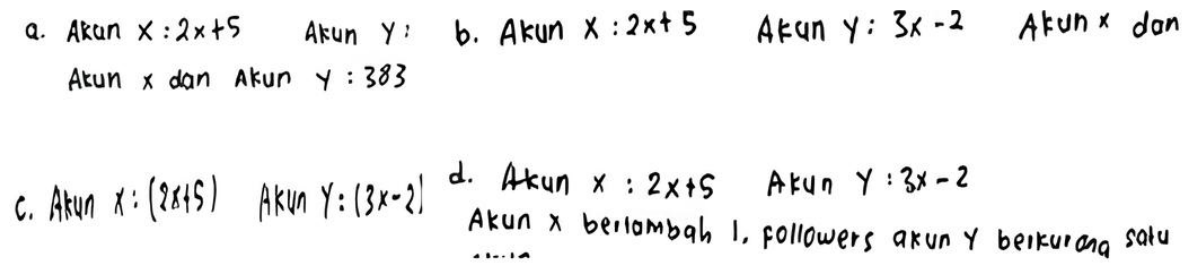


Figure 3. Results of student V2's answer number 1

In English

a.Account X : $2x + 5$ Account Y :

b. Account X : $2x + 5$ Account Y : $3x - 2$ Account X dan Account X and Account Y : 383

c. Account X : $2x + 5$ Account Y : $3x - 2$

d. Account X : $2x + 5$ Account Y : $3x - 2$
If X's followers increase by 1 then Y's followers decrease by 1

Apart from that, based on the results of the interviews, the two subjects were also able to explain the problems and reasons for the emergence of problems in question number 1. Subjects V1 and V2 fulfilled the reason aspect because they were able to explain the reasons for choosing and the steps for solving them. Both subjects also fulfilled the inference aspect because they were able to write conclusions at the end of the answer and explain the conclusions obtained. Subjects V1 and V2 fulfil the situation aspect because they are able to write down the information in the questions separately and explain the information in the questions. Subjects V1 and V2 fulfil the clarity aspect by checking the clear use of language in the answers they provide. This is based on the results of interviews conducted by subjects who can explain the terms and answers written. The following is a quote from the V1 interview that meets the clarity aspect.

P : "Can you explain the terms you understand in that question?"
V1 : "Oh, there is account X, account Y, combined means the amount and form are in algebraic form"
P : "Re-explain what you wrote until you get the final answer!"
V1 : "In 1a first, ma'am. I just add it up and get the final result $5x = 380$*. 1b I divided 380 by 5 to get 76, I found the x value was 76 ma'am. Then I substitute 1c and I add 1d and then subtract 10."*

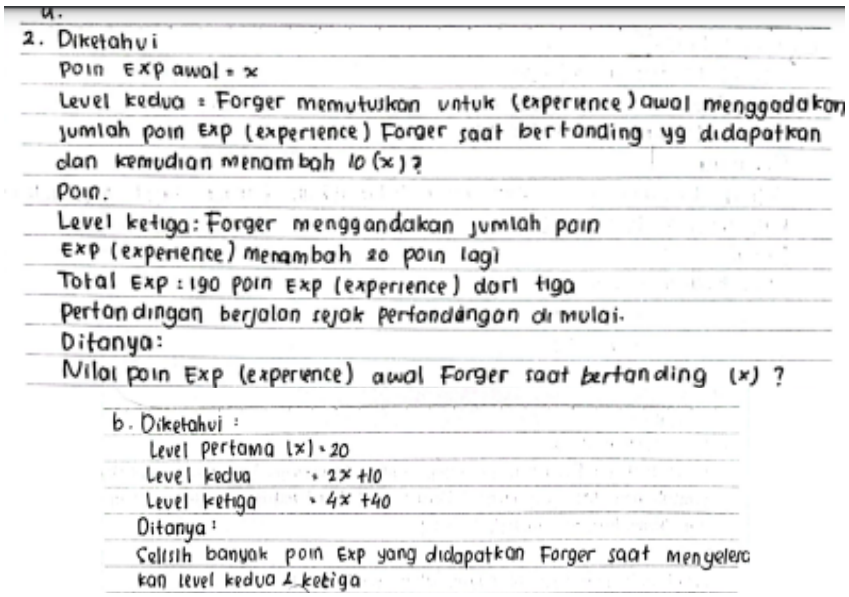
The following is an excerpt from the V2 interview which meets *the clarity aspect.*

P : "Can you explain the terms you understand in that question?"
V2 : "TikTok, 2023 replay content and combined means it is added up"
P : "Re-explain what you wrote until you get the final answer"
V2 "So, I added the number of followers from Account"

Subject V1 fulfils the overview aspect by making corrections to the previous answer to see it as a whole. Meanwhile, subject V2 did not fulfil the overview aspect because he did not make corrections to his answers. This was revealed through interviews, the subject explained the reasons for doing and not making answer corrections.

Visual Subject Question Number 2.

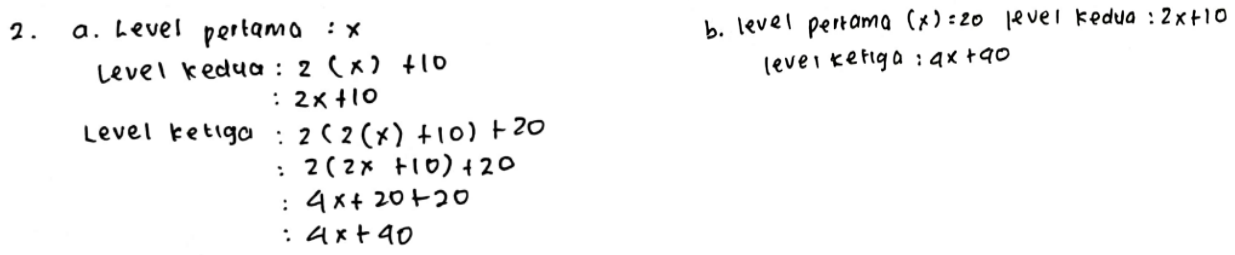
Based on the answers of subjects V1 and V2, the visual learning style in number 2 fulfils the focus aspect This is because subjects V1 and V2 are able to identify the main focus or attention that is the problem in the question. The answers from subjects V1 and V2 are shown in Figure 4 and Figure 5.


2. Diketahui
poin exp awal = x
Level kedua = Forger memutuskan untuk (experience) awal menggadakan jumlah poin exp (experience) Forger saat bertanding yg didapatkan dan kemudian menambah 10 (x) ?
poin.
Level ketiga: Forger menggandakan jumlah poin exp (experience) menambah 20 poin lagi
Total exp : 190 poin exp (experience) dari tiga pertandingan berjalan sejak pertandingan di mulai.
Ditanya:
Nilai poin exp (experience) awal Forger saat bertanding (x) ?

b. Diketahui :
Level pertama (x) = 20
Level kedua = 2x + 10
Level ketiga = 4x + 40
Ditanya :
Selisih banyak poin exp yang didapatkan Forger saat menyelesaikan level kedua & ketiga

Figure 4. Results of student V1's answer number 2

In English
Known :
initial EXP points = x
Second level = Forger decides to double the number of EXP (experience) points gained and then adds 10 points.
Third level = Forger doubles the number of EXP (experience) points adding another 20 points.
Total EXP: 190 EXP (experience) points from three running matches since the match started
Asked :
Forger's initial EXP (experience) point value when competing (x)?
b. Known
First level(x) =20
Second level = $2x + 10$
Third level = $4x + 40$
Asked :
The difference in the number of EXP (experience) points a Forger gets when completing the second and third levels


2. a. Level pertama : x
Level kedua : 2 (x) + 10
: 2x + 10
Level ketiga : 2 (2 (x) + 10) + 20
: 2 (2x + 10) + 20
: 4x + 20 + 20
: 4x + 40

b. level pertama (x) = 20 level kedua : 2x + 10
level ketiga : 4x + 40

Figure 5. Results of answer number 2 student V2

In English
2a. First level = x
Second level = $2\ (x) + 10$
$= 2x + 10$
Third level = $2\ (2(x) + 10) + 20$
$= 2(2x + 10) + 20$
$= 4x + 20 + 20$
$= 4x + 40$

2b. First level(x) =20 Second level = $2x + 10$ Third level = $4x + 40$

Subjects V1 and V2 wrote down what they knew and asked questions about the problems posed in questions 2a and 2b. The results of the interviews showed that both subjects could also explain the problems and why the problems occurred. Subjects V1 and V2 fulfil the reason aspect because they can explain the reasons for choosing and the steps for completion. Both subjects fulfilled the inference aspect because they wrote conclusions at the end of the answer and explained the conclusions obtained. Subjects V1 and V2 fulfil

the situation aspect because they can write information separately and detail the information in the questions. Both subjects also fulfilled the clarity aspect in examining the clear use of language from the answers to questions number 2a and 2b. This is based on the results of interviews conducted with subjects V1 and V2. The following is a quote from the interview with subject V1 that meets the clarity aspect.

P : "Can you explain the terms you understand in that question?"
V1 : "RPG, EXP, Doubling means times 2, AoE"
P : "Can you explain again what you wrote until you get the final answer?"
V1 : "For 2a I wrote down what I knew in the problem and continued working on it
P "Okay, what about 2b?"
V1 "I substitute at each level and I subtract"

The following is a quote from the interview with subject V2 that meets *the clarity aspect*

P : "Can you explain the terms you understand in that question?"
V2 : "You know, ma'am, EXP is points, the difference is a deduction if you double it and multiply it by two."
P "Re-explain what you wrote until you get the final answer
V2 "Yes, ma'am. No. 2a, I started to note down the information given in the question and then I added it up. Step 2b asked to find the difference in EXP points so I subtracted the number of points"

Subject V1 fulfils *the overview aspect* in carrying out an overall check on the answers. Like question number 1, subject V2 does not fulfil the *overview aspect* because it does not make corrections to the answers that are done. This was revealed through interviews, the subject explained the reasons for doing and not making answer corrections.

Auditorial Subject Number 1.

Based on the answer from subject A1, the auditory learning style in number 1 does not fulfil the focus This is because subject A1 was unable to identify the main focus or attention that was the problem. Meanwhile, subject A2 is able to fulfil the focus aspect. The answer number 1 from subject A1 is shown in Figure 6 and Figure 7.

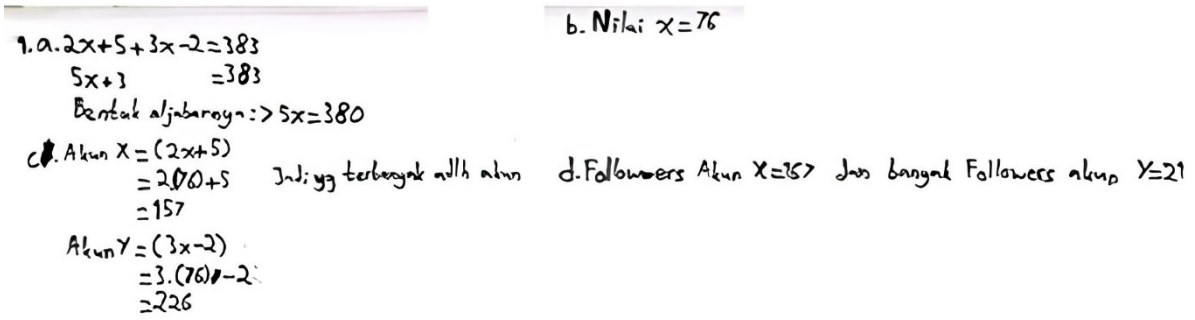


Figure 6. results of student A1's answer number 1

In English

$2x + 5 + 3x - 2 = 383$
$5x + 3 = 383$
The algebraic form is:> $5x = 380$
Account X = $(2x + 5)$
$= 2.76 + 5$
$= 157$
Account Y = $(3x - 2) = 3.76 - 2$
$= 226$
So the most numerous are Y accounts

Value $x = 76$

Followers of Account X = 167 and number of Followers of account Y = 216

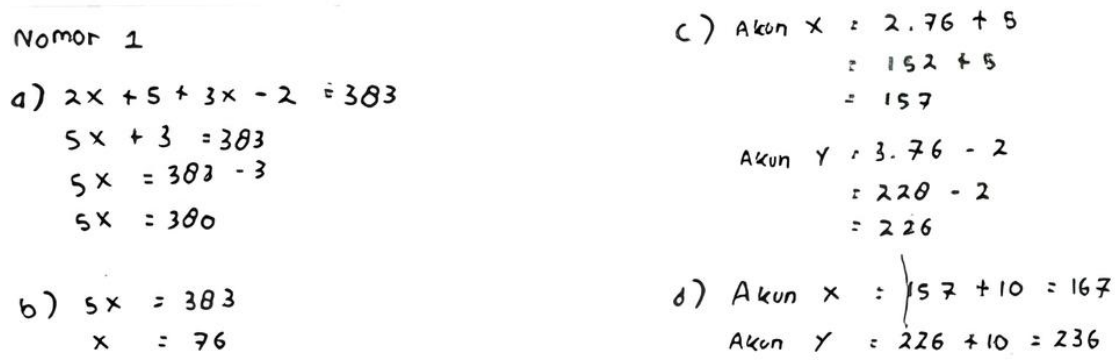


Figure 7. Results of student A2's answer number 1

In English

a. $2x + 5 + 3x - 2 = 383$

$5x + 3 = 383$

$5x = 383 - 3$

$5x = 380$

b.

$5x = 383$

$x = 76$

c. Account X = $2.76 + 5$

$= 152 + 5$

$= 157$

Account Y = $3.76 - 2$

$= 228 - 2$

$= 226$

d. Account X = $157 + 10 = 167$

Account Y = $226 + 10 = 236$

Based on the interview, subject A1 did not explain in detail the things that were problematic in question number 1. Meanwhile, A2 was able to explain the problem and the occurrence of problems in number 1. From the results of the interview, subjects A1 and A2 fulfilled the reason aspect in identifying and assessing the acceptability of reasons. Subject A1 can fulfil the inference aspect in assessing the quality of conclusions assuming the reasons are acceptable. Meanwhile, subject A2 did not fulfil the inference aspect because he could not assess the quality of the conclusion assuming the reasons were acceptable. Subject A1 does not fulfil this situation aspect because he cannot pay close attention to the situation. Subject A2 meets the situation aspect because he can pay close attention to the situation.

Subjects A1 and A2 fulfil the clarity aspect in checking the clarity of the language of the answers provided. This was revealed through interviews. The following is a quote from the interview with subject A1 which meets the clarity aspect.

P : "Can you explain the terms you understand in that question?"
A1 : "Yes, I understand ma'am, but at first I was almost fooled that there were so many X's"
P : "Re-explain what you wrote until you get the final answer"
A1 : "1a is about the number of algebraic forms of adding up the accounts in the question so I immediately added it. 1b determines the value of x which I divide from 1a 1c I substitute for each follower 1d because there are orders to add and subtract each session so I adjust 10 sessions"

The following is a quote from the interview with subject A2 which meets *the clarity aspect.*

P : "Can you explain the terms you understand in that question?"
A2 : "Yes, you understand ma'am, like combination is addition, followers are followers"
P : "Re-explain what you wrote until you get the final answer"
A2 : "1a was asked to determine an algebraic form so I increased the number of followers. If 1b determines the value of x that I divide from 1a. In 1c I substituted x = 76 for followers of accounts X and Y. 1d is because there are orders to add and subtract each session so I adjusted it."

Subjects A1 and A2 did not fulfil the overview aspect because they did not make overall corrections. This was revealed from the results of the interview by the two subjects that they did not re-correct because they were not used to doing it.

Auditorial Subject Number 2.

Based on the answer from subject A1, the auditory learning style in number 1 does not fulfil the focus aspect. This is because subject A1 was unable to identify the main focus or attention that was the problem. Meanwhile, subject A2 is able to fulfil the focus aspect because it can identify the main focus or attention that

is the problem. Both subjects immediately wrote down the solutions to the questions without writing down the things they knew and were asked about in the questions. As for answer number 1 from subject A1 in Figure 8.

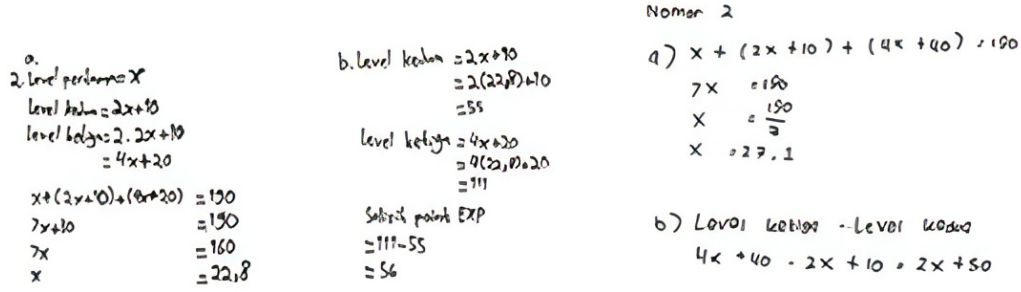


Figure 8. Results of answers number 2 for students A1 and A2

In English

2a. First Level = x

Second Level = $2x + 10$

Third Level = $2.2x + 10$

$= 4x + 20$

$x + (2x + 10) + (4x + 20) = 190$

$7x += 190$

$7x = 160$

$x = 22{,}8$

b.Second Level = $2x + 10$

$= 2(22{,}8) + 10$

$= 55$

Third Level = $4x + 20$

$= 4(22{,}8) + 20$

$= 111$

Difference in EXP points

$= 111 - 55$

$= 56$

b. Third Level – Second Level

$4x + 40 - 2x + 10 = 2x + 50$

The results of the interview showed that subject A1 was unable to explain the problem and the reasons why the problem occurred. Even though he did not write down the problem in the question, subject A2 was able to explain the problem and the reasons why the problem occurred. Subject A1 fulfils the reason aspect because it can identify and assess the acceptability of reasons. Meanwhile, subject A2 did not fulfil the reason aspect because he could not identify and assess the acceptability of the reason. This was revealed through interviews. Subject A1 does not fulfil the inference aspect because he cannot explain the conclusions obtained. Meanwhile, subject A2 can explain the concept of conclusions and write conclusions in the answers even though they are not quite right. Subjects A1 and A2 did not meet the situation, did not explain the final conclusion and could not detail the information in the questions.

Subject A1 did not fulfil the clarity aspect in checking the clear use of language in the answers. Meanwhile, A2 fulfils the clarity aspect because it can check language usage clearly from the answers. This was revealed through interviews. The following is a quote from the interview with subject A1 which does not meet the clarity aspect.

P : "Can you explain the terms you understand in that question?"
A1 : "I don't understand a lot, like doubling, ma'am."
P : "Okay then, can you explain again what you wrote?"
A1 : "I don't really understand number 2 ma'am, so I just wrote what I know"

The following is a quote from the interview with subject A2 which does not meet the *clarity aspect*

P : "Can you explain the terms you understand in that question?"
A2 : "What is duplicated again is confusing but can be done"
P : "Okay, then can you explain again what you wrote?"
A2 : "2a is looking for the starting point, so I started doubling the level first ma'am. Then I calculated the sum and divided it which should be 140 divided by 7, ma'am, I didn't check that."

Subjects A1 and A2 fulfill the *overview aspect* in correcting the answer as a whole.

Kinesthetic Subject Number 1.

Based on the answers of subjects K1 and K2, the kinesthetic learning style in number 1 fulfils the focus aspect. This is because the subject is able to identify the main focus or concern that is the problem. Subjects K1 and K2 wrote down information and known problems in the questions. The answer number 1 from subjects K1 and K2 is in Figure 9 and Figure 10.

Figure 9. Results of answer number 1 of K1 students

In English

a.Account X $= 2x + 5$
Account Y $= 3x - 2$
Account X + Account Y = 383
c.$x = 76$

b.Account X $= 2x + 5$
Account Y $= 3x - 2$
Account X + Y = 383
d. Account X = 157
Account Y = 226

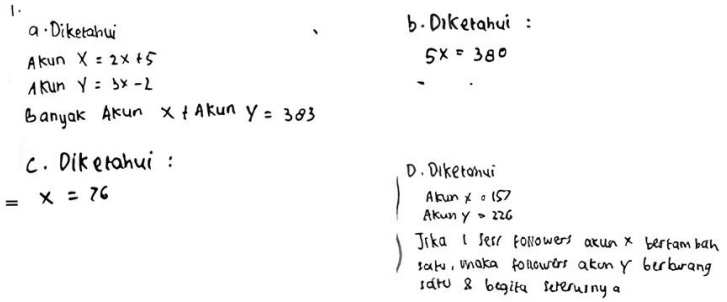


Figure 10. Results of answer number 1 for K2 students

In English

a. Known :
Account X = $2x + 5$
Account Y = $3x - 2$
Number of Accounts X + Account Y = 383
c. Known : $x = 76$

b. Known :
$5x = 380$

d. Known :
Account X = 157
Account Y = 226
If in one session followers of account X increase by one, then followers of account Y decrease by one and so on

Apart from that, the results of the interview revealed that K1 and K2 could explain the problems and reasons for the emergence of problems in question number 1. Subjects K1 and K2 fulfilled the reason aspect because they could explain the reasons for choosing and the steps for solving them in the answers. Both subjects also fulfilled the inference aspect because they wrote conclusions and were able to explain the conclusions from the answers obtained. The subject also fulfilled the situation aspect because he wrote down the information and was able to explain that the information written was appropriate to the existing question.

Subjects K1 and K2 fulfil the clarity aspect because they can check the use of language clearly from the answers they make. This was revealed through interviews. The following is an excerpt from the interview with subject K1 which meets *the clarity aspect.*

P : "Can you explain the terms you understand in that question?

K1 : "Yes ma'am, for example "account X" and "account Y" , "many followers" and "combined"
P : "Re-explain what you wrote until you get the final answer"
K1 : "1a first write down the number, ma'am, up to 5x+3=383, ma'am. I'll finish 1b" straight away x. "For 1c, I first looked for each follower of accounts X and Y with substitution. 1d, I just added 10 and minus 10."

The following is a quote from the K2 subject interview which meets *the clarity aspect.*

P : "Can you explain the terms you understand in that question?
K1 : "I understand, ma'am, it's like the combination is added up, followers are followers and Replay 2023 content, I know it's like an annual event on TikTok
P : "Re-explain what you wrote until you get the final answer"
K1 : "I added up account X and account Y and finished it until I got the answer 5x=380. I immediately divided 1b to get 76. I substituted 1c and found it and for 1d I added 10 and subtracted 10 from the answer 1c"

Based on the interview results, subjects K1 and K2 did not fulfil the overview aspect because the subjects did not make overall corrections to the answers they had worked on.

Kinesthetic Subject Number 2.

Based on the answers of subjects K1 and K2, the kinesthetic learning style in number 2 fulfils the focus aspect. Both subjects were able to identify problems by writing down things they knew in the questions and were able to explain the problem and the reasons why the problem occurred. The answers to subjects K1 and K2 are shown in Figure 11 and Figure 12.

Figure 11. Results of answer number 2 for K1 students

In English

a.Known
x = initial points
Second level = $2x + 10$
Third level = $4x + 40$

b.Known
First level = 20
Second level = $2x + 10$
Third level = $4x + 40$
$x = 20$

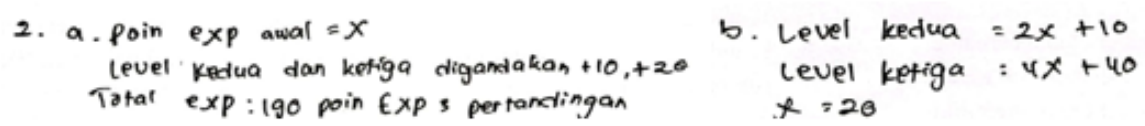


Figure 12. Results of answer number 2 for K2 students

In English

a.
Initial EXP points = x
The second and third levels are doubled +10, +20
Total EXP: 190 EXP points for 3 matches

b.
Second level = $2x + 10$
Third level = $4x + 40$
$x = 20$

Apart from that, the results of the interview revealed that K1 and K2 could explain the problems and reasons for the emergence of problems in question number 2. Subjects K1 and K2 fulfilled the reason aspect because they could explain the reasons for choosing and the steps for solving them in the answers. Both subjects also fulfilled the inference aspect because they wrote conclusions and were able to explain the conclusions from the answers obtained. The subject also fulfilled the situation aspect because he wrote down the information and was able to explain that the information written was appropriate to the existing question. Subjects fulfil the clarity aspect by checking the clear use of language in the answers they make. This is

revealed through interviews, being able to explain foreign terms and the way they are written. The following is a quote from the K1 interview that meets the clarity aspect.

P : "Can you explain the terms you understand in that question?"
K1 : "I understand but at first I was confused about duplicating but I finally found it"
P : "Re-explain what you wrote until you get the final answer"
K1 : "So I added 2a first level + second level + third level until I found the final result 20. For question number 2b I substituted but I didn't get to the difference or subtracted between levels two and three, ma'am."

The following is a quote from the K2 interview that meets *the clarity aspect* .

P : "Can you explain the terms you understand in that question?
K2 : "Understand, ma'am, if it's just an RPG, EXP is like a game, ma'am, and points are points."
P : "Re-explain what you wrote until you get the final answer"
K2 : "Number 2a, I started by writing down what I needed to calculate, ma'am, instead of reading too many questions. I added them up until I found x, then 2b, I knew the number was 190, then the first level was 20, the second level was 50, so I added 70, now for level all three are 190 minus 120 so 70 then I subtract the third and second levels"

Like number 1, based on the interview results, subjects K1 and K2 did not fulfil the *overview aspect* because the subjects did not make overall corrections to the answers to number 2 that were carried out.

Based on the research results show that learning styles are related to students' critical thinking abilities. This is because learning style is a student's way of obtaining, storing and using information to respond to various situations experienced (Darmayanti et al., 2022). Students' critical thinking abilities will be honed when students are able to identify relevant information, evaluate the truth or accuracy of information and conclude or make logical conclusions based on the understanding obtained (Afnia & Setyawan, 2021). Therefore, students have different learning styles in absorbing and processing the information they receive (Setiawan et al., 2020). Each learning style has advantages and disadvantages in every aspect of mathematical critical thinking (Purwanto et al., 2020). Apart from that, refer to Arifah et al. (2022) who reports that critical thinking abilities are also caused by gender differences. This gender brings characteristics to each person's critical thinking abilities and learning styles. Although men and women have genetics that influence critical thinking abilities and learning styles, they do not dominate.

In this study, 13 students were found with a visual learning style, 4 students with an auditory learning style, 6 students with a kinesthetic learning style and 10 students with a combination learning style. Most students' learning styles in this study are visual learning styles involving sight. In line with research (Ishartono et al., 2021; Safitri & Miatun, 2021; Setiana & Purwoko, 2020) which explains that the majority of students' learning style is visual. This is caused by the teacher's tendency to write material on the board during the learning process.

Research results show that students with a visual learning style have higher critical thinking abilities than students with an auditory and kinesthetic learning style (Cahyono et al., 2022; Lutfiyah & Fitriana, 2023). Based on the test results, visual learning style students obtained an average score of 93.75, auditory students obtained an average score of 66.665, and kinesthetic students obtained an average score of 91.665. This means that visual students get the highest test scores compared to auditory and kinesthetic students (Isnanto & Hanu, 2022). This is in line with research by Wilujeng and Sudihartinih (2021) which explains that students with a visual learning style are superior to students with an auditory and kinesthetic learning style. Research by Amalia and Hadi (2021) reveals that visual students are able to fulfil critical thinking aspects very well and can solve HOTS-based questions at the level of analyzing, evaluating and creating compared to auditory and kinesthetic students.

In this research, the first visual students with a visual learning style met all aspects of the critical thinking indicators of focus, reason, inference, situation, clarity and overview. Meanwhile, the second visual student meets the five aspects of focus, reason, inference, situation, clarity in numbers 1 and 2. Visual students' critical thinking abilities exceed auditory and kinesthetic learning styles. This is because students meet almost all critical thinking indicators. Based on the results of the test answers, students visually write down the things they already know and what is asked in the questions neatly and in order. Someone who has a visual learning style has the characteristic of doing things neatly and orderly (Deporter & Hernacki, 1992). Another characteristic of this visual learning style is that it is easier to remember by writing it down, so visual students' answers show more writing than other learning styles. Wasqita et al. (2022) explains that visual learning style students are able to solve problems neatly and coherently, remember and use knowledge from reading and

material presented by the teacher. Apart from that, students can write down the final results of the answers or conclusions obtained (Setiana & Purwoko, 2020).

Table 6. Students' critical thinking ability based on FRISCO indicators based on interview

Research Subject	Learning Style Categories	Question	F	R	I	S	C	O
V1	Visual	1	✓	✓	✓	✓	✓	✓
		2	✓	✓	✓	✓	✓	-
V2	Visual	1	✓	✓	✓	✓	✓	-
		2	✓	✓	✓	✓	✓	-
A1	Auditory	1	✓	✓	✓	-	✓	-
		2	-	✓	-	-	-	✓
A2	Auditory	1	✓	✓	-	✓	✓	✓
		2	✓	-	-	✓	✓	-
K1	Kinesthetic	1	✓	✓	✓	✓	✓	-
		2	✓	✓	✓	✓	✓	-
K2	Kinesthetic	1	✓	✓	✓	✓	✓	-
		2	✓	✓	✓	✓	✓	-

Based on the results of the interviews, the two students in the focus aspect were able to explain the problems and reasons for the emergence of problems in questions 1 and 2. The first visual and second visual students fulfilled the reason aspect, namely by identifying and assessing the acceptability of the reasons for the answers. The reason aspect cannot be seen clearly in the answers, although through interviews the reason aspect can be explored from the students' explanations. Visual first student express reasons clearly, although sometimes in short form. Meanwhile, the second visual student was also able to state the reasons for the answer. However, sometimes, they are not able to explain the answer clearly. This is because the characteristics of the visual learning style are that they often know what to say and are not good at choosing words (Deporter & Hernacki, 1992). The first visual and second visual students fulfil the inference aspect because they assess the quality of the conclusion by assuming the reasons are acceptable. From the results of the first visual student answers, students can be seen writing conclusions at the end. The first and second visual students fulfil critical thinking skills in the situation aspect by paying close attention to the situation. This is based on the results of interviews conducted. The interview results showed that the first visual and second visual students were able to explain the existing information in detail and show a good understanding of the requested information. Even though they only focus on information that is considered important, visual-first students are still able to provide appropriate answers.

The first and second visual students fulfil the clarity aspect by checking the clear use of language in the answers they have worked on. Both students could explain the terms in the questions and explain the answers clearly. In line with research by (Ishartono et al., 2021)with research that explains that visual students can describe information clearly and in detail, outline steps systematically, and present solutions in a more structured manner according to the mathematical concepts used. Apart from that, visual students explain mathematical objects well before solving problems (Safitri & Miatun, 2021). In addition, when interviewed, visual students often use the opinion sentence "in my opinion". This shows the characteristics of visual students who express themselves in the form of sight /visuals (Deporter & Hernacki, 1992). The first visual student fulfils the overview aspect by stating that the way to check is by rereading the book and matching the answers. The first visual students expressed by double checking added confidence to the answers written in detail. Meanwhile, the second visual student did not fulfil the overview aspect. In an interview with the second visual student, he stated that the student did not double-check his answers and immediately submitted them without revision. In line with Setiana and Purwoko (2020) explained that visual students only make quick corrections or only look at the final result.

The first auditory student with an auditory learning style fulfils three aspects of reason, inference, clarity in number 1. Meanwhile in number 2, the first auditory student only fulfils two aspects of reason and overview. The second auditory student fulfils the four aspects of focus, reason, situation, clarity in number 1 and fulfils the three aspects of focus, clarity, overview. There is a difference in fulfilling the auditory learning style indicators in number 1 and number 2, this is because students' abilities to absorb and process information are different. This means that the information absorbed and processed by the first auditory and second auditory students in working on questions number 1 and 2 is different. Even with the same learning style, there are other factors that influence students' critical thinking abilities (Afnia & Setyawan, 2021).

Auditory students' critical thinking abilities are lower than visual and kinesthetic learning styles, this is because auditory students only fulfil several aspects of the indicators. Based on the answers, auditory

students did not write complete answers. These characteristics are in accordance with the characteristics of someone with a learning style who often finds it difficult to write or engage in visualization activities (Deporter & Hernacki, 1992). In addition, auditory students cannot write down the final results obtained or conclusions. This is because auditory students are not used to writing completely. Even though they don't have writing skills, auditory students can explain the answers listed without writing them down (Ishartono et al., 2021; Setiana & Purwoko, 2020). Based on the results of interviews conducted, students can explain the reasons for their selection, the steps for completing answers and explain the conclusions made. Although the two students have differences in fulfilling critical thinking indicators, this is because the process of receiving information is different (Purwanto et al., 2020). In accordance with (Deporter & Hernacki, 1992)the characteristics of someone with an auditory learning style are being fluent in speaking and preferring discussions. It is proven that auditory students are able to explain written answers to questions, even though they don't write them down. This means that auditory students understand and solve problems even though they don't write them down. The characteristics of someone with an auditory learning style tend to listen to something rather than write it down. Auditory students also explain the understanding gained when listening to the teacher's explanation in class (Ernawati, Surima Sahirun, 2020). Auditory students do not re-correct their answers. This is caused by a lack of motivation and being too used to being confident in the answers you are working on (Setiana & Purwoko, 2020). Apart from that, auditory students are not careful with the answers they get so they often make solving errors (Firdaus & Rustina, 2019).

Kinesthetic learning style students have good critical thinking skills, below the abilities of visual students and above auditory students (Amalia & Hadi, 2021). First kinesthetic and second kinesthetic students with a kinesthetic learning style fulfill the five aspects of focus, reason, inference, situation, clarity in numbers 1 and 2. Interview results reveal that first kinesthetic and second kinesthetic fulfill the focus aspect because they can explain the problems and reasons for the emergence of problems in question number 1 and 2. Both students write down the things they know in the questions. In line with research by (Ishartono et al., 2021)explained that kinesthetic students are able to write the information in the questions in sketch form, even though they do not write it in detail. First kinesthetic and second kinesthetic students fulfil the reason aspect because students are able to identify and assess the acceptability of reasons. this was revealed through interviews.

First kinesthetic and second kinesthetic students consistently provide relevant reasons for each subsequent part of the problem along with written solution steps. First kinesthetic and second kinesthetic students fulfil the inference aspect because students assess the quality of conclusions by assuming the reasons are acceptable. This can be seen in the students' answers who wrote conclusions at the end. Both students write conclusions in the form of sentences that answer the question in the problem and begin with the word "so". In addition, first kinesthetic and second kinesthetic students can explain through interviews the things that are concluded, how to conclude them and verify the truth of the conclusions made. First kinesthetic and second kinesthetic students fulfil the situation aspect because they can pay close attention to the situation. This was revealed through interviews where the first kinesthetic student stated that he only wrote down the information needed to answer, while what was not important was not written because it was too long. The second kinesthetic student also stated that he wrote down only the necessary information in a known form, and sometimes sorted the information. Both students also emphasized that they were confident in their conclusions. The first and second kinesthetic students fulfill the clarity aspect because they can check the use of language clearly from the answers they work on. The first and second kinesthetic students did not fulfill the overview aspect because they did not make overall corrections to the answers they worked on. This was revealed from interviews that the two students stated that they did not recheck their answers because they were used to collecting answers straight away. Research by Afnia & Setyawan (2021) and Imamuddin et al. (2019) explained that kinesthetic students tend to only use the solution method after finding the answer without correcting it again, even though students believe that correcting it is important. In accordance with Deporter & Hernacki (1992), the characteristics of kinesthetic students are that they cannot sit still for too long, so students will tend to immediately collect the answers they get without making corrections again.

The results showed that the two visual students met all the FRISCO and FRISC critical thinking indicators. Auditory students do not meet the FRISCO critical thinking indicators with differences in the aspects met by the two students and the two kinesthetic students fulfil the FRISC aspects. The findings from two visual and two kinesthetic students met the same indicators. However, auditory students with two students do not meet the same indicators. The first auditory student meets RIC and the second auditory student meets RO. This is because students' abilities to absorb and process information vary. Even with the same learning style, there are other factors that influence students' critical thinking abilities. Research by Afnia & Setyawan (2021) explains that there are other factors besides learning style that influence students' critical thinking

abilities, namely students' lack of habits in working on questions and the tendency to only rely on explanations from the teacher.

There are two research articles that have different results from this research. Research by Rokhimah and Rejeki (2018) explains that auditory students have better abilities than other learning styles. However, this research does not provide sufficient evidence and exposure to show that auditory students meet critical thinking indicators. Furthermore, Amir's (2015) research explained that auditory students could write questions and complete answers. Meanwhile, referring to Deporter and Hernacki (1992), the characteristics of the auditory learning style have a tendency to write down and listen more to things. Apart from that, Amir's (2015) research explains that students with an auditory learning style read questions and answers to state the problem's focus, things they know and ask, and analyze problems. However, based on the characteristics of someone with an auditory learning style, they don't like reading and tend to listen (Deporter & Hernacki (1992). This shows that Amir's (2015) research has a mismatch between research results and learning style characteristics.

CONCLUSION

To conclude, students with a visual learning style have the characteristics of writing completely and systematically. Therefore, visual students can identify the focus of the problem from the questions given in a structured manner. When interviewed, visual students were less able to explain their answers because of the characteristics of visual students who were less able to sort words. Visual students can conclude and explain the situation in the questions because visual students read the questions carefully. Visual students have meticulous characteristics, so they tend to check back on the answers they have worked on. Students with a visual learning style meet five to six indicators of critical thinking abilities. Students with an auditory learning style have difficulty writing things down systematically. Therefore, auditory students are less able to write complete and structured answers. Auditory students have the ability to tell stories, this can be seen from interviews with auditory students who explain written answers even though they don't write them down. Auditory students have less detailed characteristics, so they tend not to check written answers. Students with an auditory learning style fulfil two to four indicators of critical thinking. Students with a kinesthetic learning style can write the information in the questions in sketch form, even though they don't write it in detail. This means that students only write a few steps to answer the questions they are working on. The characteristics of kinesthetic students are that they cannot sit still for too long so students will tend to immediately collect the answers they get without making corrections again. Students with a kinesthetic learning style meet five indicators of critical thinking abilities. Differences in critical thinking abilities are caused by differences in the process of receiving and processing information during learning. Each learning style has advantages and disadvantages that support students' critical thinking abilities.

It is hoped that future research can focus on gender, not just learning styles. Future research is expected to explore the critical thinking abilities of male and female students according to their respective learning styles. In addition, it is hoped that further research can develop a complete HOTS question instrument from C4 to C6 and develop learning strategies to optimize students' critical thinking potential from various learning styles. This step can include using learning methods that are more adapted to each student's learning preferences, as well as teaching techniques that facilitate the formation of critical thinking patterns through visual, auditory, and kinesthetic learning styles.

Educators should tailor their teaching strategies to accommodate different learning styles, enhancing students' critical thinking abilities. Visual learners benefit from structured tasks and systematic problem analysis, while auditory learners excel in discussions and storytelling activities that leverage their verbal strengths. Kinesthetic learners thrive with hands-on, interactive approaches but may need guidance in reviewing their work. By integrating visual, auditory, and kinesthetic methods into classroom activities, educators can create an inclusive learning environment that supports critical thinking development for all students. Additionally, designing HOTS-based questions and exploring gender differences can further refine these strategies.

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