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Mathematical Reflective Thinking Ability Of Senior High School Students In Solving Hots-Type Problems Reviewed Learning Style

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Abstract

One of the higher order thinking skills is reflective thinking which students can do when they feel confused in dealing with a math problem. One of them is when dealing with HOTS type questions. Efforts to maximize the ability to think reflectively by knowing the type of learning style of each student. This form of qualitative descriptive research was conducted to determine the ability to think reflectively mathematically in solving HOTS questions in students with visual learning styles, auditory learning styles, and kinesthetic learning styles. The subjects of this study were students of class X SMA with a purposive sampling technique of quadratic equation material. The research instrument was in the form of HOTS test questions by paying attention to indicators of reflective thinking and interviews. The results of this study are that students with a visual learning style can meet the indicators of reacting, comparing, pondering. Students with an auditory learning style can meet the indicators of reacting and comparing. Meanwhile, students with kinesthetic learning styles can fulfill the reacting indicators. Suggestions from this study teachers need to apply a more varied and individualized learning approach according to students' learning styles (auditorial, kinesthetic, visual) so that the material is easily understood.

Keywords: *reflective thinking, HOTS, learning styles*

1. Introduction

Thinking is a human person's personal mental activity that generates targeted insights to address a problem or task in a logical way for logical justification (Rasyid et al., 2017). Students' thinking skills can be used as one of the criteria to measure the achievement of learning goals, especially high-level thinking, including critical, creative, and reflective thinking (Kartika Dian et al., 2018). An individual's capacity for reflective thinking is strongly correlated with the congruence between their learning style and the instructional approach. Given that learning styles reveal how learners process information, a match between the two facilitates deeper contemplation and appraisal of one's cognitive processes.

eflective thinking will arise when facing problems so that it involves reinvestigation to overcome confusion in solving the problem (Sa'dijah et al., 2021). In overcoming confusion, it can also solve with several methods (Iksanti & Sari, 2023) According to Jaenudin et al (2017) reflective thinking is the ability to realize what is known, and what is needed in dealing with situations that are different from usual in order to achieve a goal and produce a working approach. According to Suhaji et al (2020) reflective thinking skills are needed by students in solving math problems as the ability of students to remember, identify problems, and capture information when connecting problems with solutions. By

implementing reflective thinking skills, students can find solutions or can solve mathematical concepts that are more directed between one concept to another (Syamsuddin, 2020). Nindiasari, et al (2016) explained that reflective thinking is very related to critical thinking, if students do reflective thinking, it means that they are also doing critical thinking. The factor of low students' thinking ability is due to lack of practice in solving types of questions that demand, analyze, evaluate, and require high creativity (Firdaus et al., 2021). The questions of this type are Higher Order Thinking Skills questions.

HOTS is an ability that is closely related to reasoning, not only remembering or restating, but which focuses on analyzing, making the right choices, and solving problems (Sari et al., 2019). In line with the opinion of Wahyuningtyas & Ratnawati (2018) to measure the ability to not just recall, restate, or refer without processing (recite) can use instruments from HOTS questions.

HOTS-type math problems are problems that when solving students are required to think at a high level so that they can hone their skills. In addition, Widadah (2021) explained that when solving HOTS questions, students need reflective thinking in addition to creativity, critical thinking, and logical reasoning. By solving HOTS-type questions, it can measure students' high-level thinking skills. Krathwohl (2002) in his research, there are three indicators to measure students' higher-order thinking skills: (1) Analytical, including breaking down the subject into parts and finding out how one relationship relates to another; (2) Evaluate, using applicable standards when making decisions, such as criticizing and examining; and (3) Creation, which requires the combination of components to produce a logical work.

Fanani (2018) explained the characteristics of HOTS questions, namely: (1) Measuring high-level thinking skills (2) Using context-based problems (3) Non-routine questions or not used many times in a test, and (4) Using various forms of questions. The level of understanding and ability of students to solve HOTS questions varies because it takes time to process. In the research Maimunah (2020) showed that the level of HOTS differed from one student to another after being analyzed based on their learning style.

According to Rambe & Yarni (2019), learning styles are techniques used by students in organizing, processing, and conveying information. According to some experts, there are many types of learning styles, including those based on personality, contextual factors, learning preferences, and learning modalities (Haryati et al., 2017). According to Deporter & Henacky (2010), learning styles can be distinguished into three types, namely, visual learning styles, auditory learning styles, and kinesthetic learning styles. Of the three, they can be distinguished based on the tendency to understand and capture information more easily using sight, hearing, or doing it yourself (Ernawati et al., 2019).

Each student has a different learning style, the tendency of each student to have a more dominant learning style than other learning styles (Wibowo, 2016). Although knowing one's own learning style does not always remind intelligence, it can help students choose a more effective and efficient learning method (Wahyuni, 2017). Students will get to know themselves better and their needs when they know their learning styles. On the other hand, teachers can apply various learning methods if they can know the learning styles of their students. As Jaenuddin (2017) asserts, educators can facilitate students' reflective thinking by understanding their learning styles. In light of the various explanations regarding students' learning styles in solving HOTS problems, there is a clear correlation with the objective of improving reflective thinking skills. The objective of the research is to investigate the relationship between students' mathematical reflective thinking abilities and their learning styles in solving HOTS-type problems.

Based on various presentations about students' learning styles in solving HOTS questions, there is a correlation to improve reflective thinking skills. The researcher wants to conduct research related to students' mathematical reflexive thinking skills in solving HOTS-type problems reviewed from learning styles.

2. Method

The method applied in this research is qualitative descriptive. This research was conducted to describe students' mathematical reflective thinking skills in solving HOTS-type problems in terms of their learning styles. The design of this research is a case study, where the research subjects are 36 tenth-grade students at a high school.

However, not all student answers are analyzed in detail. Only representatives from each type of learning style were selected through purposive sampling for further analysis. The selection of

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representatives is based on the previously distributed learning style questionnaire, with the aim of exploring students' mathematical reflective thinking skills more deeply based on different learning styles. A more in-depth analysis is conducted on the representatives' answers, while the overall results from all students are used to support the general research findings.

The learning style questionnaire is used as the primary instrument in this research, which contains statements to categorize the most prominent learning styles of each student. This questionnaire has been discussed and validated by previous supervisors. This instrument has been tested for its validity through content validity, involving experts in the field of education to ensure that the statements formulated align with the concept being measured, namely students' learning styles. As for its reliability, the questionnaire was tested using the internal consistency test method (such as Cronbach's Alpha) to ensure that this instrument provides consistent results when used again under the same conditions. The test results indicate that this instrument is valid and reliable for use in this research. Indicators of visual, auditory, and kinesthetic learning styles refer to the theory of Deporter and Heracki in Sundayana (2018), which is listed in Table 1.

Table 1. Indicators of student learning styles

Aspects of Learning Style	Indicator
Visual	Neat and organized
	Attention to detail
	Focus on what is seen rather than what is heard
Auditory	Finding it difficult to write, but easy when telling a story
	Enjoys talking, discussing, and even explaining something long
	Talk to yourself when doing something
Kinesthetics	Using a finger as a pointer
	Lots of use of body cues
	Likes to experiment and is not neat

After the distribution of the learning style questionnaire, representatives from each type of learning style were selected using purposive sampling technique to test reflective thinking skills. The purposive technique was chosen because it allows researchers to specifically select subjects deemed most relevant and aligned with the research objectives, which is to evaluate reflective thinking skills based on different learning styles. In this context, representatives were selected based on specific criteria, such as the dominance of learning styles identified through the previous questionnaire. The selection of this subject is considered effective because each learning style may exhibit different reflective thinking patterns, which are important for in-depth analysis.

The written test provided contains HOTS questions on quadratic equations material according to the reflective thinking indicators. The final step of this research is an interview, which aims to reinforce the answers and information from the subjects regarding the solutions they have written on the answer sheets. This interview provides deeper insights into the subject's thought process when solving problems, as well as how their learning style affects the way they approach problem-solving.

By using purposive sampling techniques, researchers can ensure that the selected subjects truly represent different learning style categories and possess reflective thinking abilities relevant to the objectives of this study.

Table 2. Below are the reflective thinking indicators of the reacting, comparing, and contemplating phases according to Surbeck, E., Han, E. P., & Moyer (1991).

Table 2. Reflective Thinking Ability Indicators

It	Phase	Things to do
1	Thinking for action (*Reacting*)	Fully / partially understand the problems given. Mention what is known. Mention what is asked.

2	Thinking for evaluation (*Comparing*)	Mention the correlation between what is known and what is asked. Mention methods that are considered effective to solve problems. Implement problem-solving methods appropriately and consistently. Write down the final solution of the problem solving
3	Thinking for critical inquiry (*Contemplating*)	Check for errors in each answer. Correct and explain if there are errors. Make conclusions correctly and correctly.

Source: Dian et al., (2018)

The data was analyzed using qualitative descriptive data analysis techniques, namely data reduction, data presentation, and drawing conclusions.

3. Results and Discussion

The research began with the provision of a scale of grouping of student learning styles carried out in one class, namely class X. This is to know the types of visual, auditorial, and kinesthetic learning styles in students in that class. Based on the scale calculation, the conclusion of the results of the grouping of learning styles in the table below is obtained.

Table 3. Results of Student Learning Style Grouping

Learning Style	Number of students
Visual	17
Auditory	8
Kinesthetic	11
Total Students	**36**

Based on Table 3. It was seen that visual students and students with the most prominent learning styles in class X amounted to 17 students. These 17 students tend to understand information more easily through images, graphs, diagrams, or text. They prefer to see the material directly and usually absorb information better when it is presented in an engaging visual format. These students are often seen to be more visually focused and tend to remember what they see rather than what they hear. Meanwhile, there are 8 students with an auditory learning style. These 8 students find it easier to understand information conveyed orally, such as through the teacher's explanation or discussions. They tend to be more sensitive to sounds and often remember material through listening rather than seeing. They like to learn by listening and may be more engaged in learning through discussions, lectures, or audio recordings. And there are 11 students with a kinesthetic learning style. This means these 11 students prefer to learn through direct experiences or physical activities. They understand concepts better through actions, practice, or simulations, such as working with their hands or participating in experiments. This student often needs movement or physical interaction to support their learning process.Thus, the total number of students in class X is 36 students.

Then from the grouping of learning styles, purposive sampling of each representative of the types of visual, auditorial, and kinesthetic learning styles was selected. This selection is also according to the consideration of the subject teacher who teaches by paying attention to several criteria: 1) having a visual, auditorial, or kinesthetic learning style from the distribution of the questionnaire carried out; 2) have relatively high mathematical skills; and 3) be able to express their opinions clearly and completely. The following is presented as the code of the research subject in Table 4.

Table 4. List of Research Subject Codes

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No	Student Initials	Learning Style	Code
1	KADM	Visual	SV
2	AAW	Auditory	SA
3	BMR	Kinesthetics	SK

The codes in table 4 have represented the students who are respondents. The selected subjects were given a reflective thinking ability test consisting of five questions designed with HOTS (Higher Order Thinking Skills) indicators and reflective thinking elements. These questions aimed to assess students' reflective thinking abilities in solving HOTS-type problems related to quadratic equations. The following section presents the analysis of student data regarding their reflective thinking skills during the test. The process of developing this test involved designing questions that not only evaluated students' understanding of quadratic equations but also their ability to reflect on their reasoning and approach to problem-solving.

Analysis of Students' Reflective Thinking Skills with Visual Learning Style

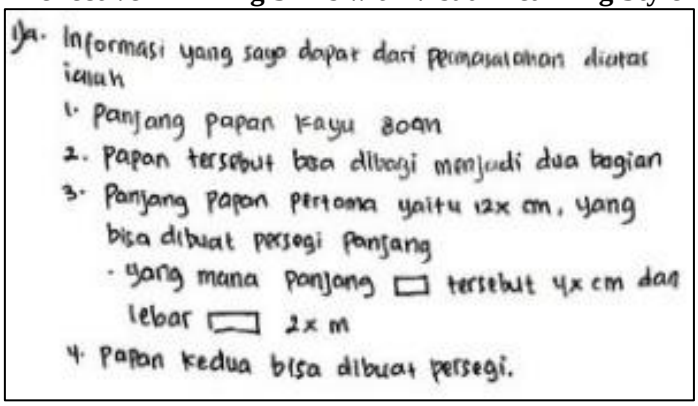

Figure 1. SV Answer Reacting Phase

Based on Figure 1.SV demonstrates an aptitude for comprehending and analyzing the issues presented in the problem. SV's written output is characterized by clarity and completeness. Additionally, SV is capable of articulating both the known aspects of the problem and the specific inquiries being posed. This assertion was corroborated during the interview process, wherein SV demonstrated a high degree of assurance and conviction in responding to questions pertaining to the information gleaned from the problem at hand, exhibiting a notable absence of doubt or reservation. As evidenced in the preceding explanation, SV is capable of fulfilling the criteria associated with reflective thinking during the reacting phase. In accordance with Nabilah (2023), SV is capable of analyzing the problems presented and describing them in terms of the known and the requested.

From the previous explanation, it can be concluded that SV fulfills all phases of reflective thinking which is strengthened from the following interview results.

(Reacting)

P : "From the problem, what information did you get?"

SV : "I got information related to the length of the wooden board, which is 80 cm, the wooden board will be cut into two parts to form a square frame and a rectangular frame, the length of the first wooden board is 12x cm which will be made a rectangular frame with a rectangular length of 4x cm and a rectangular width of 2x cm."

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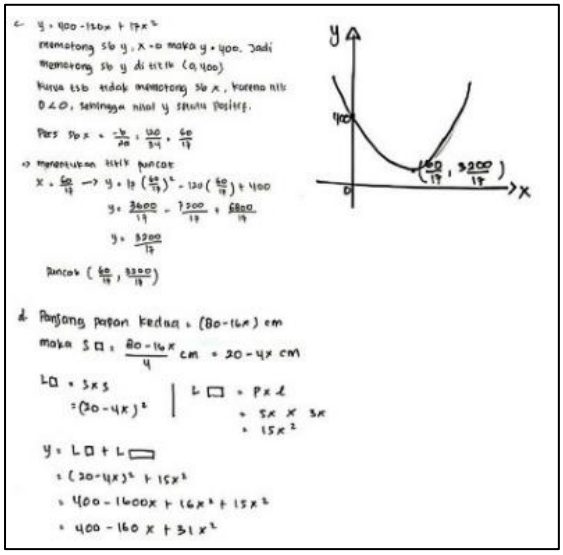

Figure 2. SV Answer Comparing Phase

Based on Figure 2.SV is capable of evaluating the problem and determining the relationship between the given information. Furthermore, it is able to relate problems that have been obtained to solve to previously solved problems. SV is capable of identifying the most efficacious methodology for problem-solving. SV is aware of the formula for calculating the area of a square or rectangle, which was previously learned at the preceding grade level. In implementing the method, SV is able to solve the problem with precision and detail, in accordance with the strategy that has been formulated and the guidelines pertaining to number operations. During the interview, SV was able to articulate the steps involved in problem-solving with clarity and precision. Therefore, SV is capable of fulfilling the comparing phase. In accordance with the views of Arifin et al. (2023) and Inastuti et al. (2021), SV demonstrates consistent characteristics in both problem-solving and planning, as well as in determining the most appropriate solution method.

(*Comparing*)
P : "Have you ever had a problem like this before?"
SV : "Once"
P : "Do you still remember that problem? try to explain."
SV : "The previous problem was also the same, looking for square equations and drawing curves. But the problems that have been solved in the past are easier than this problem."
P : "Alright, is there anything to do with the previous problem you are facing now?"
SV : "There is, both find the square equation and draw the curve but in the present problem it is associated with finding the square and rectangular area"

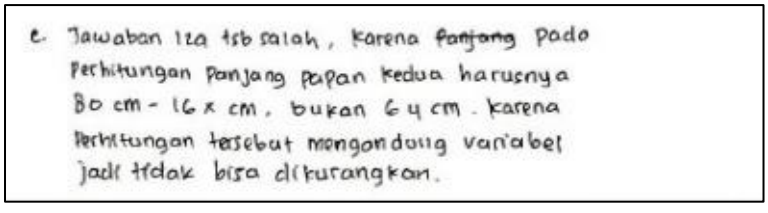

Figure 3. Jawaban SV Fase Contemplating

Before rechecking the truth, SV first checked the final result of the solution by checking the answer by equating the result to the answer in the previous problem. Furthermore, SV reviewed each step as a whole. SV fully believed that there were no mistakes in the answers he wrote as he said during the interview. In addition, SV is also able to determine the final result of problem solving and can draw conclusions from the solution. From this explanation, it can be said that SV can also fulfill the *contemplating* phase . Agreeing with Jaenudin et al (2017), SV can write the conclusion obtained by solving the problem.

(*Contemplating*)
P : "Are you already convinced of the solution that has been written on the answer sheet?"
SV : " Already "
P : "Have you researched every solution you wrote?"
SV : "Already, I've researched it and I'm confident in the answer I wrote."
P : "What conclusion did you get regarding the question at point e?"
SV : "The conclusion on point e is that Isa's answer is wrong, because in the calculation of the length of the second wooden board should be 80 cm-16 x cm instead of 64 cm, because the calculation contains variables that cannot be deducted."

Students with a visual learning style were able to fulfill all the indicators of reflective thinking in the phases of *reacting*, *comparing*, and *contemplating*. They demonstrated accuracy in identifying and analyzing data, as well as the ability to solve problems completely and draw sound conclusions.

Analysis of Reflective Thinking Skills of Auditory Learning Style Students

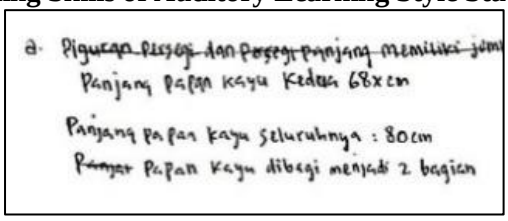

Figure 4. SA Answer

Based on Figure 4. SA can understand and analyze The problem is that the SA can write down the information in the information provided even though only part of it is incomplete. And SA did not write what was known and asked. This is also seen when SA writes information that SA feels difficult. However, when an interview is conducted, the SA can mention the information in detail, even though it is not complete. From the explanation above, SA can meet the reacting phase. This is in line with Nabilah (2023) SA can describe the problem but does not provide some things that are known and questioned first, but, during the interview, SA can explain the problem.

The presentation of SA that can meet reflective thinking indicators in the reacting and comparing phases is only strengthened by the following interview results.
(Reacting)
Q : "From the problems I gave, what information did you get?"
SA : "The information I got from the problem is that there is a wooden board that is 80 cm long which will be divided into 2 parts. The first wooden board with a cm length will be made into a rectangular frame and the second board will be made into a square frame."$12x$

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Figure 5. SA Answer Comparing Phase

In evaluating the problem, SA is able to ascertain the relationship between the provided information and to relate the problems obtained to the solution of the problem. SA is capable of identifying the most efficacious method for solving the problem. SA is aware of the formula for calculating square and rectangular areas that were previously learned in earlier grade levels. In applying the method, SA is able to solve the problem in an appropriate and correct manner. However, when constructing the curve of the quadratic equation, SA is unable to do so. Instead, he or she records the steps or additional information that will be employed to construct the curve. This was corroborated during the interview. SA was able to provide a comprehensive account of his responses and stated that he felt constrained by time when attempting to construct the curve. The aforementioned explanation can be considered an illustration of SA's fulfillment of the comparing phase. In accordance with Nabilah's research (2023), SA demonstrates the capacity to identify the complexity of a problem and to elucidate the rationale behind the solution. This is reinforced by the following interview results.

(*Comparing*)

Q : "Have you ever had this kind of problem before?"

SA : "Once, yesterday it was time to study with the teacher in class"

Q : "Do you still remember that problem? try to explain."

SA : "What I remember, the previous problem I got was also solving quadratic equations and drawing curves, but the problem

which used to be just a matter of ordinary stories if this is HOTS."

Q : "Then, why in question 1c in making a graph, don't you draw the graph?"

SA : "I forgot how to describe the curve and also I felt I didn't have enough time to work on it."

Q : "Well, is there anything to do with the problems you faced now?"

SA: "This problem is also related to the previous problem, the only difference is that the problem given is now related again to square and rectangular matter."

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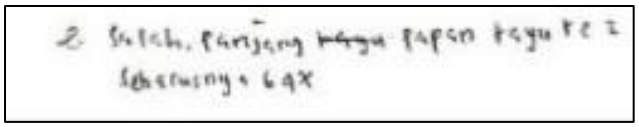

Figure 6. SA Answer Contemplating Phase

In evaluating the problem, the SA is limited to referencing the location of the error as indicated in the problem statement. The SA does not provide explicit rationale for the identified errors in the problem. Therefore, the SA is unable to present the conclusions derived from the aforementioned issues. During the interview, the SA did not provide a logical explanation for the results of the answers he had written. Accordingly, the aforementioned explanation precludes SA from fulfilling the contemplating phase. In alignment with Haryati's research (2017), it can be concluded that SA is unable to draw conclusions due to the persisting deficiencies in clarifying and analyzing questions and answers, as well as in checking arguments. The results of the interview serve to reinforce this conclusion.

(*Contemplating*)

Q : "Are you sure of the solution that has been written on the answer sheet?"
SA: "I'm sure."
Q : "Have you researched every solution you wrote?"
SA : "I have researched the answers I wrote."
Q : "If your answer is wrong, are you willing to justify it?"
SA : "I don't want to justify my wrong answer."
Q : "What is the conclusion you got regarding the question at point e?"
SA : "All I know is that Isa's answer is wrong."

Students with an auditory learning style were able to fulfill the indicators of reflective thinking in the *reacting* and *comparing* phases. Nevertheless, they encountered difficulties in evaluating each solution and consequently were unable to formulate definitive conclusions.

Analysis of Students' Mathematical Reflective Thinking Skills with Kinesthetic Learning Styles

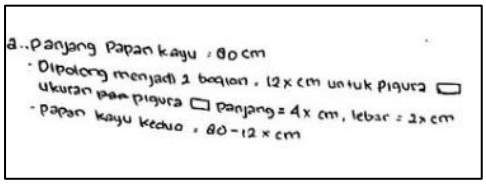

Figure 7. SK Answer Reacting Phase

In Figure 7. it is SK's answer which can mention the information in the problem even though it does not write it completely. Seen when SK wrote down the information, SK always checked what was written down with the problem. SK also did not write what was known and asked. As during the interview, SK explained the information that was written simply not the whole thing. From the explanation above, it can be stated that SK fulfills the reacting phase . SK reads the problem only briefly, but if it is not understood SK just repeats it by reading the whole problem (Jaenudin et al., 2017). The results are strengthened by the following interview with SK.

(*Reacting*)

Q : "From the problems I gave, what information did you get?"
SK : "The information obtained is that the length of the wooden board is 80 cm, it will be cut into two parts, a rectangular frame with length and width is made while the second wooden board $.12x\ cm4x\ cm2x\ cm80 - 12x\ cm$

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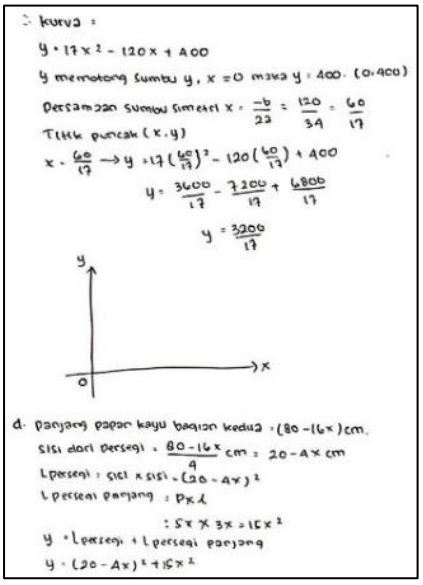

Figure 8. SK Answer Comparing Phase

In evaluating the problem, SK is able to identify the mathematical formulas that are involved in the given problem. Moreover, SK is capable of determining the most efficacious method for solving the problem. SK could express the formulas for the areas of squares and rectangles in order to determine the result of the quadratic function. However, SK was unable to provide a complete answer, instead only writing the formula. SK was able to successfully determine the area of the square and rectangle. However, when attempting to find the quadratic function of the sum of the areas of the square and rectangle, SK was unable to do so. SK was unable to factor the rectangle area. Moreover, when attempting to solve the problem by creating a curve, SK merely recorded some of the requisite data, thus rendering the curve unconstructible. As during the interview, SK was unable to elucidate the methodology employed until the ultimate outcome was reached. From the aforementioned description, it can be posited that SK does not engage in the comparing phase, but rather determines the most efficacious methodology. In accordance with the findings of Nurdalillah's (2021) investigation into the conceptual elements involved, SK demonstrated a notable challenge in responding to the presented inquiries, ultimately leading to an absence of a comprehensive answer. The results of the interview with SK are presented below.

(*Comparing*)

Q : "Have you ever had this kind of problem before?"
SK: "Ever got."
Q : "Do you still remember that problem? try to explain."
SK : "Still, we both learn about quadratic equations."
Q : "Then, why don't you solve every question to the end?"
SK : "I know how to factor so I can only do that."
Q : "Is there anything to do with the problems you faced now?"
SK: "Yes, both solve the quadratic equation but this is through the step of finding the area of a square or a rectangle and is associated with factoring."

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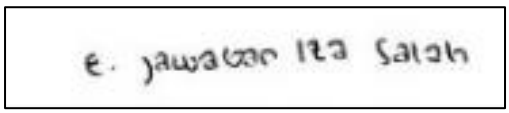

Figure 9. SK Answer Contemplating Phase

From the evidence presented in the above image, it can be concluded that SK made an error in judgement by not completing the task to its conclusion. This resulted in SK being unable to evaluate the overall response and draw conclusions from each individual problem. Additionally, SK was unable to evaluate each answer in a manner that would allow him to take responsibility for the content of his written responses during the subsequent interview. Thus, SK is unable to complete the contemplating phase. In alignment with Jaenudin (2017), SK tends to approach problem-solving with haste and a lack of thoroughness. This is evident in instances where SK identifies an error in a calculation but chooses not to rectify it upon subsequent review. The results of the interview with SK are as follows:

(*Contemplating*)

Q : "Are you sure of the solution that has been written on the answer sheet?"
SK : "I don't know about my results."
Q : "Have you researched every solution you wrote?"
SK : "I haven't researched it with the previous answer."
Q : "If your answer is wrong, are you willing to justify it?"
SK : "I can't justify it if there is a mistake yet."
Q : "What is the conclusion you got regarding the question at point e?"
SK : "All I know is that Iza's answer is wrong."

Kinesthetic learners demonstrated reflective thinking only in the *reacting* phase. During the *comparing* phase, they were limited to recording formulas they considered effective. Moreover, their abilities were restricted to identifying and analyzing the provided information, without progressing to solving or evaluating the given problems. Kinesthetic learners can mention the information presented in the problem and can communicate it using mathematical symbols (Hidayah et al., 2020).

CONCLUSIONS AND SUGGESTIONS

1. Conclusion

Learning styles are techniques used by students in organizing, processing, and conveying information. Reflective thinking is the ability to realize what is known, and what is needed in dealing with situations that are different from usual in order to achieve a goal and produce a functional approach. An analysis of students' mathematical reflective thinking abilities at the reacting, comparing, and contemplating phases shows significant differences based on learning styles. Visual learners demonstrated the most comprehensive abilities, meeting all indicators in all three phases. They were not only able to identify and analyze information but also solve problems to the end and draw accurate conclusions. Auditory learners performed fairly well in the initial phase but struggled with evaluation and conclusion-drawing. Meanwhile, kinesthetic learners were only able to perform at the reacting phase, had difficulty with comparing, and were unable to reach the contemplating phase.

2. Suggestion

Teachers are expected to be able to familiarize students to repeat the solution of the problem so that students can determine the conclusions obtained from the problems given, especially students with

auditorial and kinesthetic learning styles. In addition, students are expected to be able to master every learning material taught at that time because the upcoming math material is always related to the previous material. So that when getting material that is associated with previous material students can solve it, especially for students with kinesthetic learning styles.

Teachers also need to know the type of learning style of each student so that teachers can vary learning that can be accepted by all students.Teachers can use teaching materials with attractive learning media displays for visual students to learn. Teachers can also use image illustrations and interesting animations during learning to facilitate learning for auditorial students. In addition, teachers can also provide group work activities to express each of their opinions to accelerate the learning process of kinesthetic students.

It is expected that teachers will facilitate the development of students' reflective thinking skills through the implementation of questioning techniques. These techniques may include prompting students to respond to taught material or to explain the material according to their abilities. Moreover, educators can facilitate the development of reflective thinking skills in students through the provision of practice questions. One such approach is the incorporation of Higher-Order Thinking Skills (HOTS) type questions.

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