JOELI: Journal of Educational and Learning Innovation
Vol. 1, No. 2, November 2024 pp. 147 – 160
ISSN: 3063-3966 *(online)*

Analysis of Class X MAN Surabaya Students' Mistakes in Solving Function Questions Quadratics Based on Learning Styles and Newman Procedures

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Article Info

Artikel History
Received : 8 January 2025
Reviewed : 18 January 2025
Accepted : 15 February 2025

Keywords:
Teacher Competency
Differentiated Learning
Merdeka Curriculum

ABSTRACT

This qualitative descriptive research aims to examine the errors students make when solving quadratic function problems, focusing on their learning styles and the Newman procedure. The study targeted grade X-H students of MAN Surabaya, selected through purposive sampling. The research employed learning style questionnaires, math tests, and interview guidelines as instruments. The findings revealed five stages of errors in solving the test based on Newman's procedural error analysis, with the following contributing factors: (a) Reading errors: Students often rush and are careless when reading questions, a tendency seen in those with auditory and kinesthetics learning styles; (b) Misunderstanding: Students fail to accurately identify what is given and what is asked due to prior mistakes, commonly observed in auditory and kinesthetics learners; (c) Transformation errors: Students struggle to understand the material and misuse formulas, frequently occurring among kinesthetics learners; (d) Process skill errors: Mistakes in applying steps to use formulas correctly, often stemming from earlier errors, observed across auditory, visual, and kinesthetics learners; and (e) Final answer errors: Mistakes in writing results, influenced by prior errors, also affecting auditory, visual, and kinesthetics learners.

Please cite this article APA style as:
Pramesti, C. A., Shoffa, S., & Soemantri, S. (2025). Analysis of Class X MAN Surabaya Students' Mistakes in Solving Function Questions Quadratics Based on Learning Styles and Newman Procedures. *JOELI: Journal of Educational and Learning Innovation*, *1*(2), pp. 147-160.

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DOI: https://doi.org/10.72204/3e8ha171

1. Introduction

According to James, mathematics is a science that discusses logic, where things learned in mathematics include arrangements, concepts, shapes and quantities that are interrelated, by. When the learning process takes place in every class, not all students are able to follow the learning process either quickly or in a similar method. Various factors that may affect student participation in learning such as: differences in learning styles, the level of initial understanding conveyed, and so on (Rohmah, 2021).

The term learning is widely known in the community, according to Laila, (2023) learning is a change in behavior. Basically, learning is not only about acquiring new knowledge but about changing behavior, attitudes, or skills because of learning experiences. Meanwhile, Festiawan, (2020) defines the teaching and learning process as a way that is deliberately carried out by teachers with the aim of being able to provide delivery related to science, coordinate, and produce a learning environment system with various teaching methods, based on this students can experience teaching and learning activities in the classroom effectively and efficiently so as to obtain optimal results. Learning and learning outcomes are inseparable, because the basis for creating an effective learning process requires a well-organized learning process.

Mathematics is a logical science that involves interrelated arrangements, concepts, forms, and quantities (James, 2020). In the learning process, not all students can follow lessons in the same way. According to Kamarullah (2019), difficulty in understanding concepts is the main cause of errors in solving math problems, which shows the need for in-depth analysis of these types of errors. According to Lipianto (in Rahma & Khabibah, 2022), it can be concluded that difficulties in understanding concepts are the cause of errors.

According to Rosyidi (in Fazzilah et al., 2020), error refers to a form of deviation or inconsistency to what has been determined or agreed beforehand. Thus, error analysis can be understood as a general method used to investigate, identify, and categorize errors or deviations that occur based on their causes. This serves to provide an understanding of the root cause of the error and improve the process in the future. To understand the form and cause of mistakes made by students, it is necessary to conduct an analysis of errors in solving math problems. According to Holisin & Shoffa, (2023) that by understanding the topics discussed, we can identify the types of errors that may occur. This knowledge allows us to plan appropriate precautions. Thus, we can reduce the potential for future errors.

There are several theories that are applied in analyzing the mistakes that have been made by students in solving problems that are closely related to mathematics, one of which is using the Newman procedure. NEA is short for Newman's Error Analysis; this procedure is a method that can be used to analyze errors in the form of description questions or story questions. Abdullah (in Rahma & Khabibah, 2022) stated that many types of student errors are detected in error analysis using the Newman procedure. The purpose of this procedure is to understand and provide analysis of how students solve problems through the identification of mistakes made. According to (in Syafitri Z et al., 2021), there are five stages of errors in the newman procedure, namely: errors in reading, comprehension, transformation, mathematical process skills, and coding or writing conclusions.

Mistakes made by students when solving problems can be influenced by several factors, such as students' lack of thoroughness in calculating, lack of understanding of the mathematical concepts taught, lack of focus when working, and so on.

The indicators used to analyze students' errors in solving math problems based on the Newman procedure are as follows:

1. Stages of Reading Errors: Students make mistakes in interpreting or identifying words, symbols or numbers in the given questions, or Students make mistakes in determining or rewriting the information that has been read completely and accurately.
2. Stages of Misunderstanding: Students are unable to write down correctly both or one of what is known, and asked, or Students can write down what they know and ask but do not match what is in the question.
3. Stages of Transformation Errors: Students make mistakes in converting the information in the problem into mathematical form and students cannot determine the right formula to solve the problem, or Students are not able to carry out procedures to solve problems even though they can determine the formula used correctly.
4. Stages of Process Skill Errors; The student makes a mistake in carrying out the completion process, or Students are wrong in determining the solution step and which step comes first in solving the problem.
5. Stages of Final Answer Writing Errors: Students make mistakes in writing the final answer, either in determining the conclusion, unit, or not being able to determine the final answer, or Students in writing the final answer are not correct and not in accordance with the question

The factor that causes the error is the case that triggers students to make mistakes when solving problems. Overcoming the mistakes that have been made by students when working on the questions presented is to implement the learning style that each student has. Each student has different preferences in receiving, managing, and understanding new information (Rizayana Afifa et al., 2024). According to Faiz, (2021) some of the most popular and often referred to learning styles until now are the VAK learning style, namely Visual, Auditory, and Kinesthetic learning styles. According to Kristanti et al., (2020) the right learning style is the key to success, so it is important for students to be assisted in recognizing their learning style so that learning goals, especially in mathematics, can be achieved effectively. Learning style is a method used to receive, remember, and apply information effectively, which plays a role in improving learning performance. Identifying the learning style that each student has allows teachers to help that suits their learning preferences, so that student learning outcomes can get good results through learning that suits each student's learning style.

The results of the observation showed that students had difficulty understanding the material, so they did other activities during class, such as discussing with friends, moving, or reading books. This leads to a loss of focus. In addition, teachers' teaching methods that are less varied and lack of tools also affect students' understanding. According to the findings revealed in the study by Wibawa et al., (2023) with the research title "Error Analysis Based on Newman Procedures in Solving SPLDV Story Problems Reviewed from Learning Styles" it

was found that students who have a visual learning style can make mistakes at the comprehension stage and the final answer writing stage. Based on the background that has been presented, the researcher chose to research with the title "Analysis of Errors of Class X Man Surabaya Students in Solving Quadratic Function Problems Based on Newman's Learning Style and Procedure".

2. Method

This research is descriptive qualitative research. The subjects used in this study are students of MA Negeri Surabaya class X-H which totals 28 students of the 2023/2024 academic year who were selected by purposive sampling (purposeful sample). The researcher selects a sample of research subjects by considering suggestions from teachers in the field of mathematics and based on the results of observations that have been carried out with the hope that class X students who are selected as research subjects have enough experience so that they can solve the problems given in the quadratic function material. The instruments used in this study are learning style questionnaires, math question tests, and interview guidelines.

The steps to collect data are as follows:

1. Observe the learning process in class X of MA Negeri Surabaya, then consult with the teaching teacher to get initial information about students' mistakes in solving story problems, especially in quadratic function material.
2. Identify common mistakes made by students in solving story problems on quadratic function material, then determine the purpose of the research to find out the stages of mistakes made by students.
3. Prepare a learning style questionnaire based on VAK learning styles (Visual, Auditory, and Kinesthetic), prepare a description question test related to quadratic function material to find out the stages of mistakes made by students, and prepare interview guidelines that will be used in research.
4. Carry out research by providing learning style questionnaires, and math question tests. Then correct the results of the description test and group students based on the test results with high, medium, and low score categories.
5. Conducting interviews, subjects selected based on the provisions of each learning style (Visual, Auditory, and Kinesthetic) are represented by students with high, medium, and low score categories. The interview stage was carried out to identify the stages of mistakes made by students in solving story problems and influencing factors based on the Newman procedure.
6. Conducting data analysis conducted in this study by analyzing the results of learning style questionnaires, description tests, and interviews were reviewed with the Newman procedure with triangulation to find out the stages of mistakes made by students.

The data analysis technique used is qualitative descriptive to analyze student errors in solving quadratic function problems reviewed from the learning style and Newman procedure in class X students of MAN Surabaya.

3. Results and Discussion

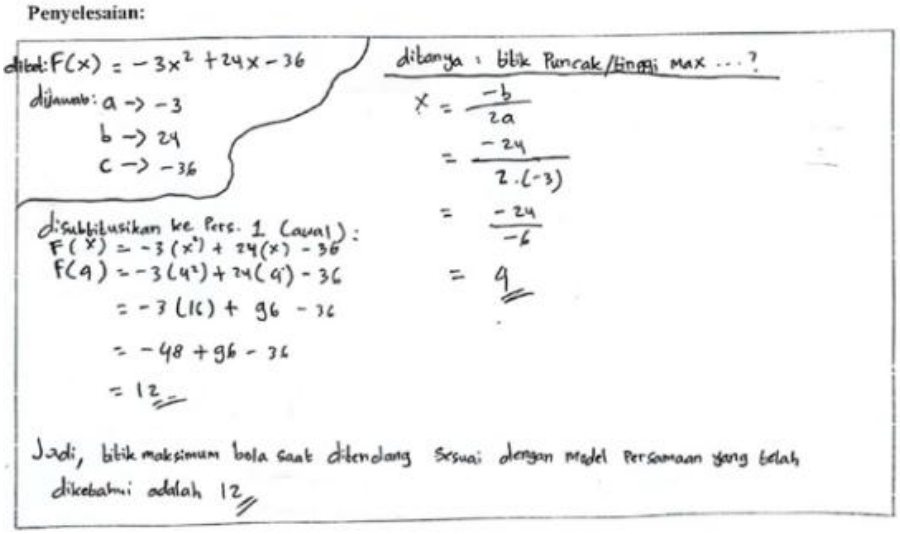
Based on the results of data analysis obtained from the triangulation of questionnaire results, written tests, and interview results, it can be concluded that the data obtained is valid as presented in the following table 1:

Table 1. Data Analysis Results

Subject Code	Stages of Error					Total
	T1	T2	T3	T4	T5	
S-1	✓	✓	×	×	✓	3
S-2	✓	✓	×	✓	✓	4
S-3	×	×	✓	✓	✓	3
S-4	×	×	×	×	✓	1
S-5	×	×	×	✓	✓	2
S-2	✓	✓	✓	✓	✓	5
S-7	✓	✓	×	✓	✓	4
S-1	×	×	✓	✓	✓	3
S-3	✓	✓	✓	✓	✓	5
Total	**5**	**5**	**4**	**7**	**9**	**30**

The description of the data analysis based on the table above is as follows:

a. Subject S-1 (High grade category auditory)

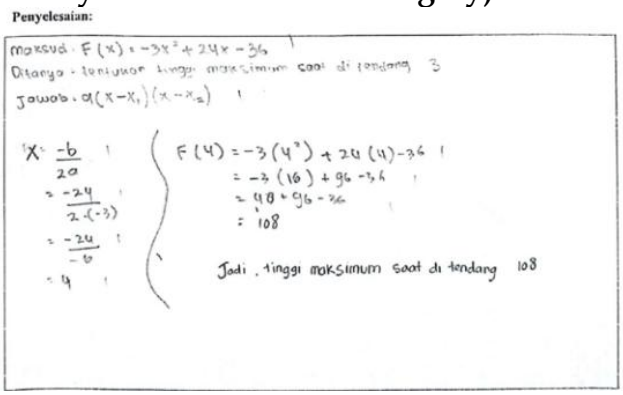


Picture 1. S-1 Subject Answer Results

Based on the written results, and then triangulation of data from the three instruments used can be obtained:

1) Reading Stages: It is not appropriate to rewrite the information that has been read, because students are not careful in reading the questions completely.
2) Stages of Understanding: Inaccurate in interpreting what is known and asked this is due to previous mistakes.
3) Transformation Stage: Make no mistakes.
4) Process Skills Stages: No mistakes.
5) Stage of Writing the Final Answer: Not checking the answer again, so that it is wrong in writing the correct unit and resulting from the previous mistake.

b. Subject S-2 (Auditory of medium value category)

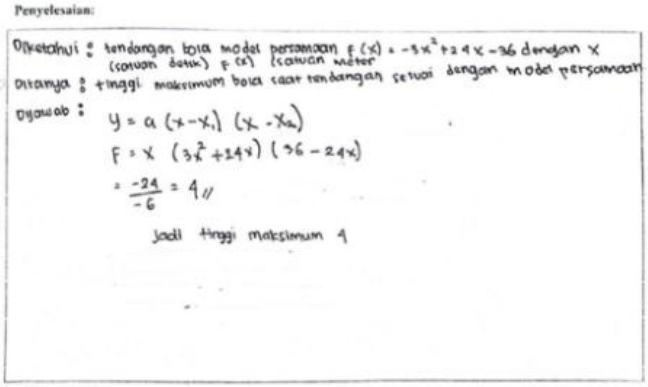


Picture 2. S-2 Subject Answer Results

Based on the written results, and then triangulation of data from the three instruments used can be obtained:

1) Reading Stages: It is not appropriate to rewrite the information that has been read, because students are not careful and wrong in re-reading the information contained.
2) Understanding Stage: Lack of understanding of concepts regarding mathematical concepts in problems so that in determining what is known and asked this is due to previous mistakes.
3) Transformation Stage: Make no mistakes.
4) Process Skill Stage: Not precise in calculation when completing.
5) Stage of Writing the Final Answer: Not checking the answer again so that it cannot write the correct conclusion and unit, and is caused by previous mistakes.

c. Subject S-3 (Auditory low score category)



Picture 3. S-3 Subject Answer Results

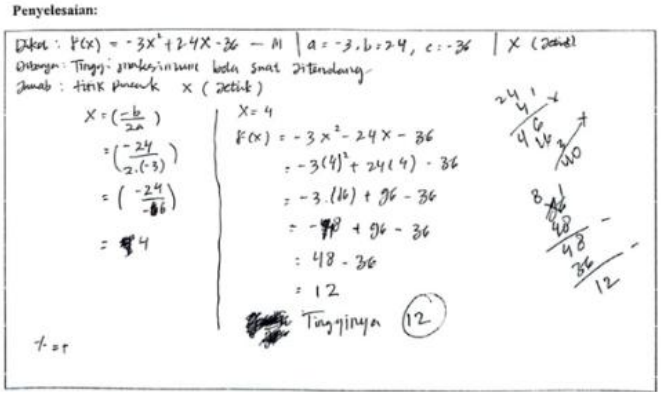
Based on the written results, and then triangulation of data from the three instruments used can be obtained:

1) Reading Stage: Do not make mistakes.
2) Stages of Understanding: Not making mistakes.
3) Transformation Stage: Errors in identifying when understanding the material being tested so that it is not accurate in identifying important information that needs to be converted into mathematical form, so that

students are unable to carry out the formulas and procedures of the formulas used.

4) Process Skills Stages: Inappropriateness in executing completed completion steps, and the consequences of previous mistakes.
5) Stage of Writing the Final Answer: Not checking the answer again, so that students cannot write down the correct conclusion and unit, and is caused by previous mistakes.

d. Subject S-4 (Visual high value category)

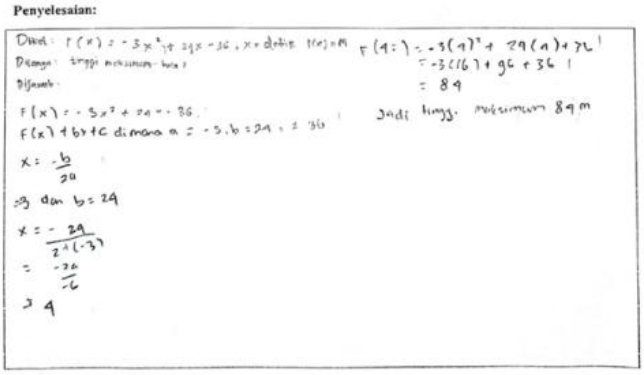


Picture 4. S-4 Subject Answer Results

Based on the written results, and then triangulation of data from the three instruments used can be obtained:

1) Reading Stage: Do not make mistakes.
2) Stages of Understanding: Not making mistakes.
3) Transformation Stage: Make no mistakes.
4) Process Skills Stages: No mistakes.
5) Stage of Writing the Final Answer: Not checking the answer again to ensure the accuracy of the answer, so it does not write down the result with the right conclusion and unit.

e. Subject S-5 (Visual medium value category)



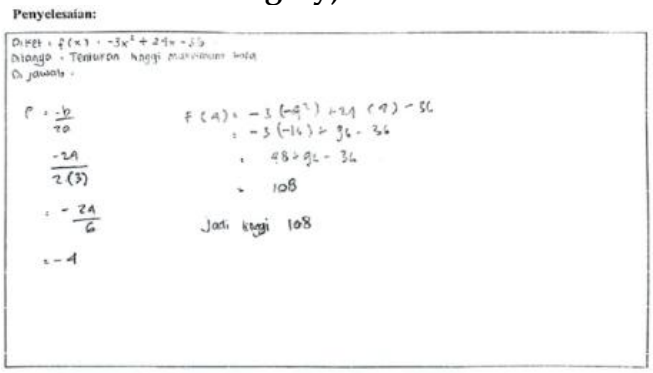
Picture 5. S-5 Subject Answer Results

Based on the written results, and then triangulation of data from the three instruments used can be obtained:

1) Reading Stage: Do not make mistakes.
2) Stages of Understanding: Not making mistakes.
3) Transformation Stage: Make no mistakes.

4) Process Skills Stages: Not accurate in the calculations made, so that the results of the calculations written are not appropriate.
5) Stage of Writing the Final Answer: Not checking the answer again to ensure the accuracy of the answer, so it does not write down the result with the right conclusion and unit.

f. Subject S-6 (Visual low value category)

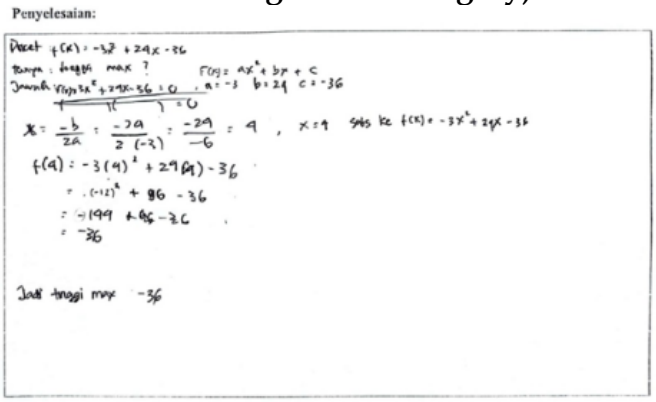


Picture 6. S-6 Subject Answer Results

Based on the written results, and then triangulation of data from the three instruments used can be obtained:

1) Reading Stage: Not being careful in reading the questions again so that students miss important information contained.
2) Stages of Understanding: Not being precise in interpreting what the question requires, so that it does not understand the main purpose of the question, and making mistakes in determining what is known and asked this is due to previous mistakes.
3) Transformation Stage: Unable to convert the information in the problem into mathematical form, because they do not understand the formula to be used
4) Process Skills Stages: Not precise in calculations, because students are not careful in doing calculations so that the grades produced are not accurate.
5) Stage of Writing the Final Answer: Not checking the answer again to ensure the accuracy of the answer and the consequences of previous mistakes.

g. Subject S-7 (Kinesthetics of the high value category)

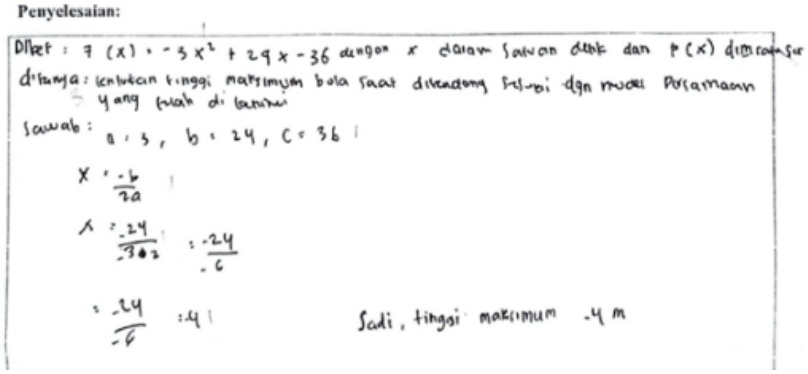


Picture 7. S-7 Subject Answer Results

Based on the written results, and then triangulation of data from the three instruments used can be obtained:

1) Reading Stages: Not being careful in reading the given questions, so that students miss important information in the questions.
2) Stages of Understanding: Not being precise in interpreting what the question requires, so that it does not understand the main purpose of the question, and making mistakes in determining what is known and asked this is due to previous mistakes.
3) Transformation Stage: Make no mistakes.
4) Process Skills Stages: Not precise in calculations, because students are not careful in doing calculations so that the grades produced are not accurate.
5) Stage of Writing the Final Answer: Not checking the answer again to ensure the accuracy of the answer and the consequences of previous mistakes.

h. Subject S-8 (Kinesthetics of medium value category)

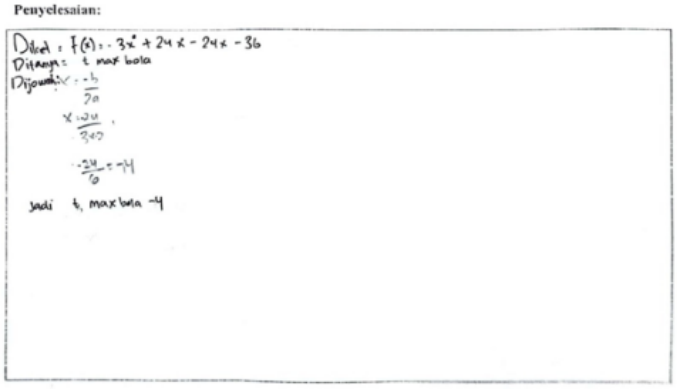


Picture 8. S-8 Subject Answer Results

Based on the written results, and then triangulation of data from the three instruments used can be obtained:

1) Reading Stage: Do not make mistakes.
2) Stages of Understanding: Not making mistakes.
3) Transformation Stage: Errors in identifying the procedure of the formula to be used, because of a lack of understanding of the material being tested.
4) Process Skills Stages: Errors in the process of calculating and completing steps, due to lack of understanding of the formulas used and the consequences of previous errors.
5) Stages of Writing the Final Answer: Unable to write the correct conclusion and unit, because it is the result of a previous mistake.

i. Subject S-9 (Kinesthetics of the low value category)



Picture 9. S-9 Subject Answer Results

Based on the written results, and then triangulation of data from the three instruments used can be obtained:

1) Reading Stage: It is not appropriate to rewrite the information that has been read, because students are not careful in completing.
2) Understanding Stage: Not accurate in determining what is needed by the question, so making a mistake in determining what is known and asked is due to previous mistakes.
3) Transformation Stage: Unable to convert the information in the problem into mathematical form, and unable to determine the procedure of the formula used correctly because it does not understand the formula to be used.
4) Process Skill Stages: Not being precise in doing calculations and not being able to determine the completion steps correctly, because they do not understand the use of the formula this is due to previous mistakes.

Stage of Writing the Final Answer: Not checking the answer again, so that it cannot write the correct conclusion and unit and is the result of previous mistakes. Learning style-based approaches have been proven effective in improving students' understanding of the material being taught, especially in exact subjects such as mathematics (Kolb, 1984). Therefore, it is important for teachers to recognize students' learning styles to apply appropriate teaching methods.

4. Conclusions

Based on the results and discussion in chapter IV, it can be concluded as follows:

a. The types of mistakes made by students in class X-H MA Negeri Surabaya in completing the math problem test given based on the analysis of Newman procedural errors consist of five stages, including: reading errors, comprehension errors, transformation errors, process skills errors, and errors in writing the final answer. The biggest mistake made by students occurs at the stage of writing the final answer, while the smallest mistake made by students occurs at the stage of reading and comprehension. The stages of errors made by the research subjects are reviewed from the learning style and newman procedures as follows:
   1) Students with auditory learning styles with high score categories make three stages of errors, namely at the stage of reading, comprehension, and writing the final answer.
   2) Students with auditory learning styles with moderate grade categories make four stages of errors, namely at the stage of reading, comprehension, process skills, and writing the final answer.
   3) Students with auditory learning styles with low score categories make three stages of errors, namely at the transformation stage, process skills, and writing down the result.
   4) Students with visual learning styles with high score categories make one stage of mistakes, namely at the stage of writing the final answer.
   5) Students with visual learning styles with moderate grade categories make two stages of errors, namely at the process skill stage, and writing down the result.

6) Students with visual learning styles with low grade categories perform five stages of mistakes in the stages of reading, comprehension, transformation, process skills, and writing the final answer.
7) Students with kinesthetic learning styles with high value categories make four stages of errors, namely at the stage of reading, comprehension, process skills, and writing the final answer.
8) Students with a category learning style with a moderate value category make three stages of errors, namely at the transformation stage, process skills, and writing the final answer.
9) Students with a kinesthetic learning style with a low score category make five stages of errors, namely at the stage of reading, comprehension, transformation, process skills, and writing the final answer.

b. The factors that cause errors made by research subjects in solving problems on the quadratic function material are reviewed from the learning style and Newman procedure as follows.

1) Auditory learning style

a) High-value category auditory learning style
   (1) Reading Stages: It is not appropriate to rewrite the information that has been read, because students are not careful in reading the questions completely
   (2) Stages of Understanding: Inaccurate in interpreting what is known and asked this is due to previous mistakes
   (3) Transformation Stage: Make no mistakes
   (4) Process Skills Stages: No mistakes
   (5) Stage of Writing the Final Answer: Not checking the answer again, so that it is wrong in writing the correct unit and resulting from the previous mistake

b) Auditory learning style in the medium value category
   (1) Reading Stages: It is not appropriate to rewrite the information that has been read, because students are not careful and wrong in re-reading the information contained
   (2) Understanding Stage: Lack of understanding of concepts regarding mathematical concepts in problems so that in determining what is known and asked this is due to previous mistakes
   (3) Transformation Stage: Make no mistakes
   (4) Process Skill Stage: Not precise in calculation when completing
   (5) Stage of Writing the Final Answer: Not checking the answer again so that it cannot write the correct conclusion and unit, and is caused by previous mistakes

c) Low-value category auditory learning styles
   (1) Reading Stage: Do not make mistakes
   (2) Stages of Understanding: Not making mistakes
   (3) Transformation Stage: Errors in identifying when understanding the material being tested so that it is not accurate in identifying important information that needs to be converted into mathematical form, so that students are unable to carry out the formulas and procedures of the formulas used

(4) Process Skills Stages: Inappropriateness in executing completed completion steps, and the consequences of previous mistakes
(5) Stage of Writing the Final Answer: Not checking the answer again, so that students cannot write down the correct conclusion and unit, and is caused by previous mistakes

2) Visual learning style

a) High-value category visual learning style
(1) Reading Stage: Do not make mistakes
(2) Stages of Understanding: Not making mistakes
(3) Transformation Stage: Make no mistakes
(4) Process Skills Stages: No mistakes
(5) Stage of Writing the Final Answer: Not checking the answer again to ensure the accuracy of the answer, so it does not write down the result with the right conclusion and unit

b) Visual learning style of medium value category
(1) Reading Stage: Do not make mistakes
(2) Stages of Understanding: Not making mistakes
(3) Transformation Stage: Make no mistakes
(4) Process Skills Stages: Not accurate in the calculations made, so that the results of the calculations written are not appropriate
(5) Stage of Writing the Final Answer: Not checking the answer again to ensure the accuracy of the answer, so it does not write down the result with the right conclusion and unit

c) Low-value category visual learning style
(1) Reading Stage: Not being careful in reading the questions again so that students miss important information contained
(2) Stages of Understanding: Not being precise in interpreting what the question requires, so that it does not understand the main purpose of the question, and making mistakes in determining what is known and asked this is due to previous mistakes
(3) Transformation Stage: Unable to convert the information in the problem into mathematical form, because they do not understand the formula to be used
(4) Process Skills Stages: Not precise in calculations, because students are not careful in doing calculations so that the grades produced are not accurate
(5) Stage of Writing the Final Answer: Not checking the answer again to ensure the accuracy of the answer and the consequences of previous mistakes

3) Kinesthetic learning styles

a) Kinesthetic learning style of the high-value category
(1) Reading Stages: Not being careful in reading the given questions, so that students miss important information in the questions
(2) Stages of Understanding: Not being precise in interpreting what the question requires, so that it does not understand the main purpose of

the question, and making mistakes in determining what is known and asked this is due to previous mistakes
(3) Transformation Stage: Make no mistakes
(4) Process Skills Stages: Not precise in calculations, because students are not careful in doing calculations so that the grades produced are not accurate
(5) Stage of Writing the Final Answer: Not checking the answer again to ensure the accuracy of the answer and the consequences of previous mistakes

b) Kinesthetic learning style of medium value category
(1) Reading Stage: Do not make mistakes
(2) Stages of Understanding: Not making mistakes
(3) Transformation Stage: Errors in identifying the procedure of the formula to be used, because of a lack of understanding of the material being tested
(4) Process Skills Stages: Errors in the process of calculating and completing steps, due to lack of understanding of the formulas used and the consequences of previous errors
(5) Stages of Writing the Final Answer: Unable to write the correct conclusion and unit, because it is the result of a previous mistake

c) Kinesthetic learning styles in the low-value category
(1) Reading Stage: It is not appropriate to rewrite the information that has been read, because students are not careful in completing
(2) Understanding Stage: Not accurate in determining what is needed by the question, so making a mistake in determining what is known and asked is due to previous mistakes
(3) Transformation Stage: Unable to convert the information in the problem into mathematical form, and unable to determine the procedure of the formula used correctly because it does not understand the formula to be used
(4) Process Skill Stages: Not being precise in doing calculations, and not being able to determine the completion steps correctly, because they do not understand the use of the formula this is due to previous mistakes
(5) Stage of Writing the Final Answer: Not checking the answer again, so that it cannot write the correct conclusion and unit, and is the result of previous mistakes

5. Acknowledgment

The author would like to thank the Muhammadiyah University of Surabaya for research support and the teachers and lecturers who have guided this research journey and do not forget the school where the research took place.

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