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Analysis of Students' Mathematical Representation Ability in Working on Conical Section Problems

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Abstract

This study aims to analyze students' representational ability in working on conic section problems. This study is included in case study research using a qualitative approach. The subjects of this study were students of Widya Dharma University. This study used the primary instrument (researcher) and auxiliary instruments (tests and interview guidelines). The validity of this research data was supported by triangulation techniques that compared the results of the conic section test work with those of the interview. The data analysis stage of this study consisted of data condensation, data presentation, and conclusion. The results of this study are presented as a profile of students' representational ability when working on geometry problems. In ellipse, parabola, and hyperbola problems, writing important information in the problem, not making analogies, and writing incorrect equations. The profile of students' visual representation ability shows that they are unable to draw sketches of ellipse, parabola, and hyperbola graphs correctly. In ellipse, parabola, and hyperbola questions, the problem is that they do not provide explanatory sentences for each stage of working on the questions

Keywords: analysis; conic section; representation.

INTRODUCTION

One of the branches of algebra in mathematics that plays a role in modeling geometric objects, such as points, straight lines, circles, and other geometric objects, is analytical geometry (Kadry, 2014). Analytical geometry can be used to determine the relationship between these objects using linear and nonlinear formulas (Ižvoltová & Cesnek, 2018). The focus of the study of analytical geometry is on dimensions 2 (especially conic sections) and dimensions 3 (Aljohani, 2016). Geometric objects resulting from conic sections are circles, ellipses, parabolas, and hyperbolas (Siegel, 2022). Conic sections can aid human life. Parabolas, which reflect light parallel to their axis of symmetry and through a focus, are useful in solar power plants, radar, lamp reflectors, and so on (Suyitno, 2016). Elliptical curves represent the orbits of planets, with the sun as one of the focal points (Suyitno, 2016). Hyperbolic curves are used in navigation and in the construction of cooling chimneys to increase cooling efficiency (Suyitno, 2016).

Students still experience misconceptions in the material on conic sections at the basic level, such as determining the equations of parabolas, ellipses and hyperbolas (Sudihartinih & Purniati, 2020). The shape of objects from conic sections is difficult for students to imagine in their minds (Ekayanti, 2017). Students have not been able to make connections between parabolas, ellipses and hyperbolas (Cholily et al., 2024). Students also experience confusion in determining formulas and steps to solve conic section problems (Sugandi et al., 2022). The types of student errors in working on conic section material are language errors, mathematical themes, and procedural errors (Sadidah & Sudihartinih, 2023).

Salsabila et. al. (2019) research revealed the condition of students in working on problems for elliptical and hyperbolic conic section objects as follows. Students only rewrote what was known from the problem without knowing the intent of the question in the ellipse problem. Students were able to understand the intent and questions of the hyperbola problem, but made algorithmic errors in the next stage.

Representation ability is an important thing needed by students to gain an understanding (Hidayati & Wahyuni, 2021) and solve mathematical problems (Abdurahman et al., 2023; Fudin et al., 2022; Sabrina & Effendi, 2022; Supandi et al., 2018; Tupamahu et al., 2023). Representation ability is the ability to convey one's ideas in the form of mathematical symbols or expressions, images or visuals, and the ability to express ideas verbally in an effort to solve mathematical problems (Dihna & Sudihartinih, 2023). The ability to represent the verbal aspect is shown by someone being able to state what they are doing, both verbally and in writing (Tupamahu et al., 2023). The ability to represent the visual aspect is shown by someone being able to make pictures or graphs of what they are thinking (Tupamahu et al., 2023). The ability to represent the symbolic aspect is shown by someone being able to use numbers, symbols, number operations, relations, and those related to them (Tupamahu et al., 2023).

Students tend only to imitate the stages of solving analytical geometry problems presented by the lecturer in the process of working on the questions (Rokhman & Oktaviani, 2015). This can occur due to the low mathematical representation ability of students (Rokhman & Oktaviani, 2015). The representation ability of mathematics education students in the verbal, visual, and symbolic representation aspects tends to be low (Ratumanan et al., 2022). The results of Amir et al.'s (2021) research indicate that difficulties in representational skills persist in understanding the concept of fractions. The results of Novitasari et al.'s (2021) research indicates that students'symbolic representation skills are not as good as their visual and verbal representation skills.

Yanuarto (2018) conducted a study by designing a plane analytical geometry learning that was able to improve students' representational abilities in the material of lines and circles. The study was not aimed at the material of conic sections and did not analyze in depth how the profiles of three types of student representational abilities. Research by Azzahra et. al. (2024), Muzangwa and Ogbonnaya (2022) only analyzed the visual representation ability of geometry. Research by Noto et. al. (2016) analyzed three types of student representational abilities in the plane analytical geometry course, but only in the form of achievements displayed in numerical form. Research by Hidayat and Lestari (2022) analyzed the profile of representational abilities in working on geometric problems based on each level of representational ability. Therefore, it is necessary to conduct a representational ability analysis study that aims to obtain a description of the profile of three types of student representational abilities (verbal, visual, and symbolic) in working on ellipse problems consisting of ellipses, parabolas, and hyperbolas.

METHOD

This research is a case study research using a qualitative approach to reveal the profile of students' representational abilities in working on conic section problems based on symbolic aspects, visual aspects, and verbal aspects (Agusven et al., 2023).

This research stage includes the preparation stage, implementation stage, and data analysis stage. The preparation stage includes activities such as (1) literature study on representational capabilities (symbolic, visual, and verbal), the concepts of ellipses, parabolas, and hyperbolas; and (2) instrument design in the form of compiling question indicators, question items, and interview guidelines. In the implementation stage, data collection was carried out in the form of conic section tests and interviews. The data analysis stage was conducted to process the test and interview data, enabling the identification of research conclusions.

The subjects of this study were students of Widya Dharma University, who had taken the Plane Analytical Geometry course in semester II. This study used the main instrument and auxiliary instruments in collecting research data. The main instrument of this study was the researcher himself, while the auxiliary instruments of this study were tests and interview guidelines. The test instrument used conic section material consisting of an ellipse, a parabola, and a hyperbola. The interview guideline instrument was used to conduct interviews and gather in-depth information about students' representational abilities, based on students' work with ellipse, parabola, and hyperbola materials, across symbolic, visual, and verbal aspects. Interview subjects were selected using purposive sampling, taking into account the adequacy of data obtained from the conic section test results. The instrument has been declared valid by expert validators. Table 1 presents the design of the conic section test instrument.

Table 1. Design of the Conical Section Test Instrument

No	Sub-Material	Equation Indicator	Representation Indicator
1	Ellipse	Determine the equation of an ellipse and sketch its graph if the center point, one of the vertices, and one of the focus points are known. Determine the equation of an ellipse and sketch its graph if the center point, one of the vertices, and one of the focus points are known.	1. In the symbolic aspect, students are expected to be able to identify the known and the unknown in the problem, create analogies in algebra, and solve problems in the algebraic section. 2. In the visual aspect, students are expected to be able to draw detailed and accurate sketches of the requested graphs. 3. In the verbal aspect, students are expected to be able to convey complete steps, accompanied by supporting sentences that clarify the meaning of each step.
2	Parabola	Determine the equation of a parabola and its sketch if the coordinates of the endpoints of the latus rectum are known.	
3	Hyperbola	Determine the coordinates of the center point, end points, and focus points of the hyperbola and sketch its graph if the general equation of the hyperbola is known.	

To ensure the credibility of the data, validation was conducted using a triangulation technique that compared the results of the conic section test with the interview results (Denzin, 2015). The data analysis stage of this study consisted of the data condensation stage, data presentation, and concluding the profile of students' representational abilities in working on ellipse, parabola, and hyperbola problems based on symbolic, visual, and verbal aspects (Miles et al., 2014).

RESULTS

Based on the results of the conic section test, the results of student work according to the aspects of symbolic, visual, and verbal representation are presented in Table 2.

Table 2. Recapitulation of Conic Section Test Results

No	Material	Not working	Done but Wrong/ Incomplete	Complete and Correct Work	Number of Students
1	Ellipse	1	7	3	11
2	Parabola	7	4	0	11
3	Hyperbola	0	11	0	11

Based on the recapitulation of the conic section test results, the parabola was the most challenging question for most students to answer correctly. Furthermore, for each of the three questions, ellipses, parabolas, and hyperbolas, most students answered incorrectly or incompletely. This group became the focus of the study to explore, in depth, the students' representational abilities as they worked on the questions from the three materials through interview activities. The interview subjects for each question number were selected based on the results of their work with, consideration that the results of their work could be analyzed more deeply during the interview to obtain valid data. Based on the results of observations of the results of students' work, three students were obtained to be used as interview subjects. The researchers assessed that the results of the work of these three students could provide sufficient information to be explored in more depth through interviews compared to the results of the work of other students. The three students selected as interview subjects were given the code M1 for the first subject, M2 for the second subject, and M3 for the third subject.

Subject M1 is focused on exploring representational skills on ellipse material. Figure 1 below presents the results of subject M1's work on ellipse problems.

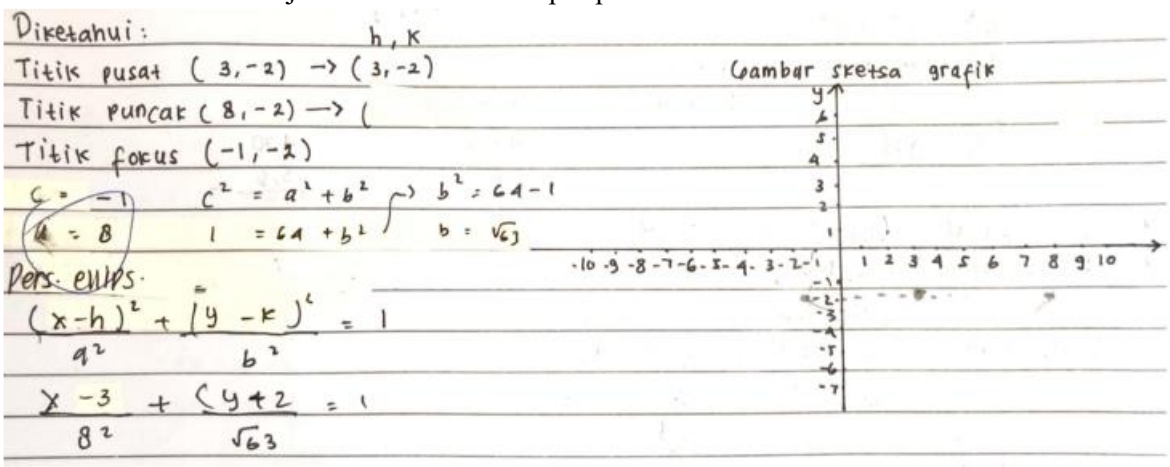

Figure 1. Results of Subject M1's Work for Ellipse Material

Information obtained from Figure 1 is that subject M1 rewrote the coordinates of the center point, vertex, and focal point as stated in the problem. Subject M1 wrote the wrong value of *c*, resulting in an incorrect value of *b* and an incorrect ellipse equation. Subject M1 only drew the Cartesian coordinates without sketching the ellipse graph as asked in the problem.

Based on the symbolic aspect review, Figure 1 provides information that subject M1 wrote important information in the question, did not make an analogy into algebraic form, and wrote an incorrect ellipse equation. This information was cross-checked against an excerpt from an interview with subject M1 regarding the ellipse problem, as follows.

P : Okay, Ms. Firna, let us start with interview number one. You've read the questions. Okay, I want to know first, at the beginning, you wrote three points. Please explain what they mean and why you wrote those points.

M1 : Okay, in the question it's been explained. It is known that there is a center point and a peak point, and a focal point. Well, here the center point has a value of 3, -2. Then the peak point is 8, -2. And the focal point is -1, -2.

P : Okay, there you didn't write an example first, the center point was likened to a letter or something.

M1 : I didn't write it

P : In geometry or algebra, a point is symbolized by a capital letter.

M1 : Yes. Because there is already an explanation here. The center point is like that.

P : Here you wrote, what is that, Ms.? c is equal to negative 1?
M1 : Well, I misunderstood c is -1, and a is 8.
P : a is equal to 8, why?
M1 : I see here because here a,0 is not a,0, what is the point?
P : So, you assume that it can be obtained from the vertex. Okay, then after that c is known and a has been determined, that means finding.

Based on an interview excerpt with subject M1 regarding the ellipse problem, it was obtained that subject M1 wrote three important points in the ellipse as in question number 1. Subject M1 did not write the analogy in algebraic form. Subject M1 made a mistake in giving the value of a which is the measurement of the long axis of the ellipse, causing the equation that was composed not to produce the correct answer. Based on a review of the results of the work and the results of the interview with subject M1 for the ellipse problem on the symbolic aspect, it was concluded that subject M1 wrote important information in the problem, did not make the analogy into algebraic form, and wrote an incorrect ellipse equation.

Based on the visual aspect review, Figure 1 provides information that subject M1 only describes the Cartesian coordinates without describing the ellipse graph. This information is cross-checked with the following interview excerpt with subject M1 about the ellipse problem.

P : What is your strategy in answering this question?
M1 : It is written first, the center point, peak and focus are known, then it should be drawn, right, sir?
P : Yes, it should be drawn first and then searched.
M1 : Find c, a and b to determine the image.

Based on the interview excerpt with subject M1, the information obtained is that subject M1 did not sketch the ellipse graph first before determining the components needed to compile the ellipse equation. Based on a review of the work results and interview results with subject M1 for the ellipse problem on the visual aspect, it was concluded that subject M1 did not draw a sketch of the ellipse graph.

Based on the verbal aspect review, Figure 1 provides information that subject M1 only wrote down the known coordinate points in the question, the components of the ellipse equation, the ellipse equation, and the Cartesian coordinate image. This information was cross-checked with an excerpt from an interview with subject M1 about the ellipse problem as follows.

P : What is your strategy in answering this question?
M1 : It is written first, the center point, peak and focus are known, then it should be drawn, right, sir?
P : Yes, then it should be drawn first and then searched
M1 : Find c, a and b to determine the image
P : Why do we have to find c, a and b?
M1 : To find the focal point. There is a focus, there is also an f'. If here, only the focal point is determined, for example, the focus of both is not yet known, so I have to find it first.

Based on the interview excerpt with subject M1, the information obtained is that subject M1 did not provide complete information about the stages of solving ellipse problems. Based on a review of the work results and interview results with subject M1 for ellipse problems in the verbal aspect, subject M1 did not convey complete stages accompanied by supporting sentences that make clear the meaning of each stage.

Subject M2 is focused on exploring representational skills in parabola material. Figure 2 below presents the results of subject M2's work in working on parabola problems.

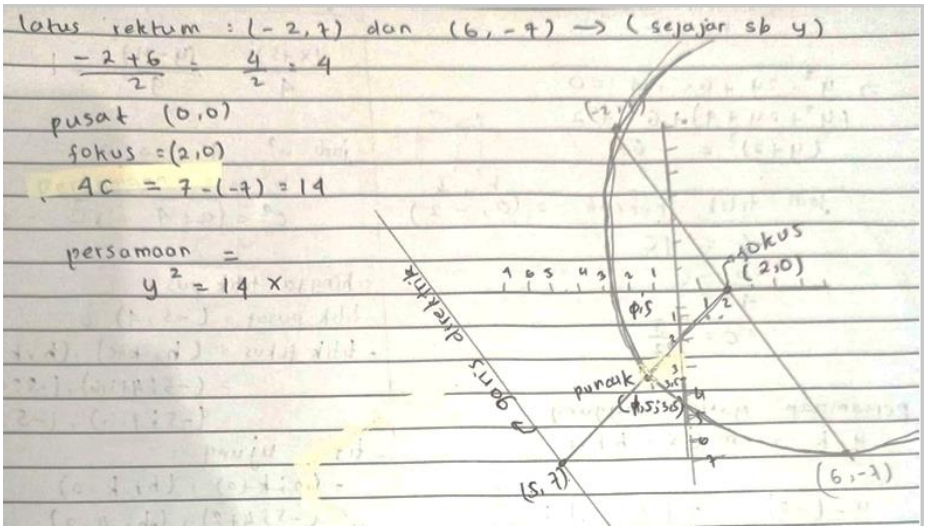

Figure 2. Results of Subject M2's Work for Parabola Material

Information obtained from Figure 2 shows that subject M2 wrote the coordinates of the center point and the focal point without providing a method for finding them. The parabola equation written by M2 without a method for finding them is incorrect. The sketch drawn is incorrect, due to the incorrect location of the coordinates of the latus rectum point.

Based on the symbolic aspect review, Figure 2 provides information that subject M2 wrote important information in the question, did not make an analogy into algebraic form, and wrote an incorrect parabola equation. This information was cross-checked with an excerpt from an interview with subject M2 about the ellipse question as follows.

P : Okay, Miss, let's start with question number two. From question number 2, what is known?
M2 : The coordinates of the ends of the rectum are (- 2, 7) and (6, 7)
P : What is being asked?
M2 : Sketch the parabola graph.
P : Where did you get that 4c from?
M2 : 7 minus negative 7 equals 14. Because this is the end of the rectum. 4c 7 minus negative 7.
P : Sure it's like that.
M2 : I don't really understand either.

Based on an interview excerpt with subject M2 regarding the parabola problem, it was determined that subject M2 wrote the two coordinates of the endpoints of the latus rectum, as in question number 2. Subject M2 did not write the equation in algebraic form. Subject M2 made a mistake in determining the value of c, which is the distance between the vertex and the focus of the parabola, causing the equation that was composed not to produce the correct answer. Based on a review of the results of the work and the results of the interview with subject M2 for the ellipse problem on the symbolic aspect, it was concluded that subject M2 wrote important information in the problem, did not make the equation in algebraic form, and wrote an incorrect parabola equation.

Based on the visual aspect review, Figure 2 provides information that subject M2 drew an incorrect parabola graph sketch. This is because subject M2 placed the coordinates of the endpoint of the latus rectum incorrectly. This information was cross-checked with an excerpt from an interview with subject M2 about the parabola problem as follows.

P : Okay, please explain the general steps.
M2 : Actually I'm confused about this because I don't understand the material about parabolas, the first is I draw a graph from the known latus rectum, which is (-2,7) and (6,7). Then I combine the two points and find the midpoint between the two ends, found (-2,0), originally 2 from 6 minus negative 2 divided by 2, the result is 2 and negative 7 minus 7, 0.
P : That's why the latus rectum can be tilted like that, Miss. Is there something wrong? Try checking the latus rectum point.
M2 : From the latus rectum there is negative 2, 5.

Based on the interview excerpt with subject M2, it appears that subject M2 incorrectly determined the coordinates of the endpoint of the latus rectum, resulting in incorrect coordinates for the parabola's focus. This causes the parabola graph sketch to be incorrect. Based on a review of the work results and interview results with subject M2 for the parabola question on the visual aspect, it was concluded that subject M2 did not draw the parabola graph sketch correctly.

Based on the verbal aspect review, Figure 2 provides information that subject M2 only wrote down the coordinates of the endpoints of the latus rectum known in the question, the components of the parabola equation, the parabola equation, and the parabola graph sketch. This information was cross-checked with an excerpt from an interview with subject M2 about the parabola question as follows.

P : Then where do you find the focal coordinates?
M2 : c multiplied by 2, we get the coordinates of the X axis.
P : Are you still confused about the focal point? Now how do you find the peak point, miss?
M2 : From the distance between the center point and the tip of the parabola, by multiplying by 2c.
P : by multiplying by 2c, in which direction?
M2 : to the left
P : Are you sure? Why to the left?
M2 : Because if my parabola faces to the right, it will be backwards.
P : You are asked to find the general equation of the parabola. How do you find the general equation of the parabola?
M2 : Using the formula
P : What formula?
M2 : y squared is equal to 4 cx, use the formula, x min h squared is equal to c multiplied by y min k. That's why we first find the peak coordinates.

Based on the interview excerpt with subject M2, the information obtained is that subject M2 did not provide complete information about the stages of solving the parabola problem. Subject M2 was unable to provide logical reasons for the answers given. Subject M2 was still confused in determining the focal point and the peak point of the parabola. This resulted in M2 being unable to compose the parabola equation and draw the parabola sketch correctly. Based on a review of the work results and interview results with subject M2 for the parabola problem in the verbal aspect, subject M2 did not convey the complete stages accompanied by supporting sentences that make clear the meaning of each stage.

Subject M3 is focused on exploring representational skills in hyperbola material. Figure 3 below presents the results of subject M3's work in working on hyperbola problems. Subject M3 is focused on exploring representational skills in hyperbola material. Figure 3 below presents the results of subject M3's work in working on hyperbola problem.

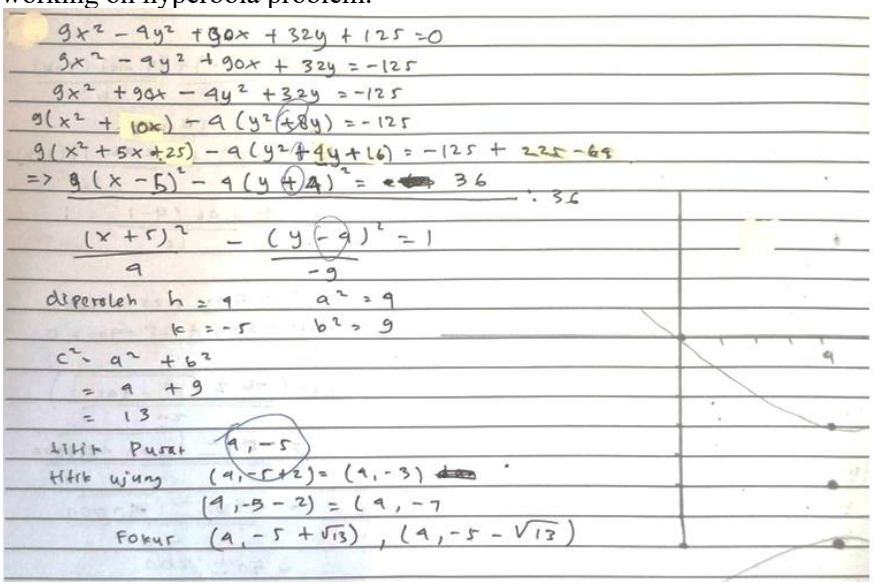

Figure 3. Results of Subject M3's Work for Hyperbola Material

Information obtained from Figure 3 indicates that subject M3 attempted to convert the general equation of the hyperbola to its standard equation using the technique of completing the perfect square. However, subject M3 was not thorough in the process, resulting in an incorrect standard equation. This, of course, resulted in incorrect coordinates for the center point, endpoints, and foci. The resulting hyperbola graph sketch was also inaccurate.

Based on the symbolic aspect review, Figure 3 provides information that subject M3 directly changes the general equation of hyperbola into the standard equation of hyperbola by using algebraic manipulation and does not make an analogy into algebraic form. This information is cross-checked with the following interview excerpt with subject M3 about the hyperbola problem.

P : Okay, after that what was asked?

M3 : I was told to find the endpoints and focus points. The first step I took was to find the equation of the hyperbola whose center is at (h,k). Find the equation of the hyperbola in general or standard form.

P : How do you do it, miss? Can you explain?

M3 : First, I grouped 9x squared with 90x, and the same goes for the variable y. Then I moved 125 to the other side to negative 125. Then I simplified, the first one I divided 9 into x squared plus 10x and this one I simplified negative 4 into 9 squared minus 8, and here I was wrong.

Based on an interview excerpt with subject M3 regarding the hyperbola problem, it was obtained that subject M3 immediately tried to change the general hyperbola equation to the standard hyperbola equation. Subject M3 did not write the analogy in algebraic form for the important components in the standard hyperbola equation. Subject M3 was not careful in the process of changing the equation, resulting in the written standard equation being incorrect. This causes the components derived from the standard hyperbola equation to not have the correct values. Based on a review of the results of the work and the results of the interview with subject M3 for hyperbola problems on the symbolic aspect, it was concluded that directly changing the general hyperbola equation to the standard hyperbola equation and not making analogies into algebraic form.

Based on the visual aspect review, Figure 3 provides information that subject M3 drew an incorrect hyperbola graph sketch. This is because subject M3 was not careful in the process of changing the general hyperbola equation into the standard hyperbola equation. This information was cross-checked with an excerpt from an interview with subject M3 about the hyperbola problem as follows.

P : How do you know the center point is (-5, 4)?

M3 : Because I have learned on YouTube that the center point is obtained from this equation. From this equation x min 5

P : Why is this x plus 5?

M3 : because the factorization result is x min 5 and x min 5, so I made it 1. Min times min becomes plus. So x plus 5 squared.

P : What rule did you use, Miss? How can it be like that?

M3 : eh not that, like this, make x when factoring it is min 5, now I find x min 5 is equal to no x like this so it becomes plus 5.

Based on the interview excerpt with subject M3, the information obtained is that subject M3 was confused when explaining the process of changing the general equation of hyperbola into the standard equation of hyperbola. Subject M3 used the method of completing the perfect square. However, subject M3 was confused when asked about the method which caused his inaccuracy. His inaccuracy caused the hyperbola sketch to be wrong. Based on a review of the results of the work and the results of the interview with subject M3 for the hyperbola question on the visual aspect, it was concluded that subject M3 did not draw the hyperbola graph sketch correctly.

Based on the verbal aspect review, Figure 3 provides information that subject M3 directly changes the general equation of hyperbola into the standard equation of hyperbola using algebraic manipulation without providing a sentence explaining the procedure for working on hyperbola problems. This information is cross-checked with an excerpt from an interview with subject M3 about hyperbola problems as follows.

P : How do you know the center point is (-5, 4)?

M3 : Because I have learned on YouTube that the center point is obtained from this equation. From this equation x min 5
P : Why is this x plus 5?
M3 : Because the factor result is x min 5 and x min 5, so I made it 1. Min times min becomes plus. So x plus 5 squared.
P : What rule did you use, Miss? How can it be like that?
M3 : eh not that, like this, make x when factoring it is min 5, now I find x min 5 is the same as no x like this so it becomes plus 5.
P : x squared plus 5x plus 25 why is it the same as x min 5 squared?
M3 : Oh yeah. I think I was wrong sir. It should be plus 5.

Based on the interview excerpt with subject M3, the information obtained is that subject M3 did not provide complete information about the stages of solving hyperbola problems. Subject M3 was still confused when asked about the center point of the hyperbola. This resulted in M3 being unable to compose the hyperbola equation and draw the hyperbola sketch correctly. Based on a review of the work results and interview results with subject M3 for hyperbola problems in the verbal aspect, subject M3 did not convey the complete stages stated in supporting sentences that make clear the meaning of each stage.

DISCUSSION

There are nine points of research results that are discussed one by one as follows. The first result states that student wrote important information in the problem, did not make the analogy into algebraic form, and wrote an incorrect ellipse equation. Students tend to re-state important information in math problems (Yuwono et al., 2024). The errors experienced by students in the transformation of problems are still high (Ningsi et al., 2022), Students working on ellipse problems tend to be incomplete and make mistakes (Sadidah & Sudihartinih, 2023).

The second results stated that student did not draw a sketch of the ellipse graph. The difficulty in drawing an ellipse graph sketch is due to the difficulty in applying the drawing procedure (Dias et al., 2021).

The third result states that student did not convey complete stages accompanied by supporting sentences that make clear the meaning of each stage. Students have difficulty determining the equation of the conic and difficulty proving the equations contained in the ellipse (Sudihartinih & Purniati, 2020). Verbal representation ability is the lowest representation ability for students in solving analytical geometry problems (Dihna & Sudihartinih, 2023).

The fourth result states that student wrote important information in the problem, did not make the equation in algebraic form, and wrote an incorrect parabola equation. Students can identify the main elements of the problem and there are still students who do not write the equation when working on math problems (Simarmata, 2021). Students still have difficulty in determining the simple equation of the parabola (Sadidah & Sudihartinih, 2023).

The fifth result states that student did not draw the parabola graph sketch correctly. Students have difficulty in determining the direction of the parabola (Sadidah & Sudihartinih, 2023).

The sixth result states that student did not convey the complete stages accompanied by supporting sentences that make clear the meaning of each stage. Many students still have difficulty in conveying or communicating the process of solving mathematical problems (Nadlifah & Putri, 2023). Students still have difficulty in concepts and principles to be conveyed through mathematical problem-solving ideas (Rachmawati et al., 2021). Students' interpretation abilities presented in writing in working on mathematical problems are still relatively low (Wulandari & Astutiningtyas, 2020).

The seventh result states that student directly changing the general hyperbola equation to the standard hyperbola equation and not making analogies into algebraic form. Students tend to have difficulty in making mathematical modeling and writing algebraic symbols in analytical geometry (Arwadi et al., 2024). Students have difficulty manipulating algebraic forms in working on analytical geometry problems so that they fail in the transformation process in problem solving (Hajizah & Salsabila, 2024).

The eighth result states that student did not draw the hyperbola graph sketch correctly. Students' errors in drawing graphs were caused by a lack of understanding of the concepts related to the analytical geometry material they were studying (Inganah et al., 2021).

The ninth result states that student did not convey the complete stages stated in supporting sentences that make clear the meaning of each stage. The verbal representation indicator is still the weakest indicator in students' representation abilities in working on mathematics problems (Erita et al., 2023; Hadiastuti & Soedjoko, 2019; Listyotami & Wahyuni, 2023). Students' ability to communicate mathematical ideas, concepts, and concepts in written, pictorial, or tabular form is still not optimal (Muchlis et al., 2023).

This study has produced a profile of students' representational abilities in solving problems with ellipses, parabolas, and hyperbolas across symbolic, visual, and verbal aspects. This finding is new and differs from previous studies that also examined representational abilities, such as those by Noto et al. (2016), Yanuarto (2018), Hidayat and Lestari (2022), Azzahra et al.(2024), and Muzangwa and Ogbonnaya (2022).

A limitation of this study is that the focus of the material does not cover other topics in analytical geometry courses, such as straight lines and circles. Furthermore, this study did not focus on strategies for addressing the problems identified in the profile. It is recommended that future research conduct similar research on straight lines and circles, as well as research to determine strategies for addressing the problems identified in the profile.

CONCLUSION

The profile of students' symbolic representation ability on ellipse, parabola and hyperbola questions is that students write important information in the questions, do not make analogies into algebraic forms, and write incorrect equations. The profile of students' visual representation ability is that they cannot draw sketches of ellipse, parabola and hyperbola graphs correctly. The profile of students' verbal representation ability on ellipse, parabola and hyperbola questions is that they do not convey complete stages accompanied by supporting sentences that make clear the meaning of each stage.

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DECLARATIONS

Author Contribution	:	Muhammad Ridlo Yuwono: Conceptualization, writing-original draft, implementation, data analysis, and editing; Fery Firmansah: Writing - Review & Editing, and data analysis; M. Wahid Syaifuddin: Validation and data analysis.
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Additional Information	:	-

REFERENCES

Abdurahman, M. R., Haryadi, D. R., Inayah, S., & Lutfi, A. (2023). Analisis kemampuan representasi matematis siswa dalam menyelesaikan soal matematika materi kesebangunan dan kekongruenan. *SIGMA DIDAKTIKA: Jurnal Pendidikan Matematika*, *11*(2), Article 2. https://doi.org/10.17509/sigmadidaktika.v11i2.66158

Agusven, T., Satriadi, S., Hafizni, R., Santoso, N. K., & Hasnarika, H. (2023). *Dasar Metodologi Penelitian Kualitatif*. CV Rey Media Grafika.

Aljohani, S. (2016). Analytic geometry of three dimensions. *International Journal of Scientific & Engineering Research*, *7*(4), 185–186.

Amir, M. F., Wardana, M. D. K., & Usfuriah, D. (2021). Visual and symbolic representation forming: A case of relational understanding on elementary student. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *10*(4), Article 4. https://doi.org/10.24127/ajpm.v10i4.4361

Arwadi, F., Asmaun, A., & Ruslan, R. (2024). Analisis kesalahan mahasiswa dalam menyelesaikan soal geometri analitik ditinjau dari prestasi belajar. *Jurnal Riset Dan Inovasi Pembelajaran*, *4*(3), 1819–1828. https://doi.org/10.51574/jrip.v4i3.2206

Azzahra, A., Rianti, T. D., & Wandani, R. R. (2024). Analisis kemampuan representasi visual matematika pada materi geometri. *Jurnal Pendidikan Tambusai*, *8*(1), 57–61. https://doi.org/10.31004/jptam.v8i1.12340

Cholily, Y. M., Jamil, A. F., & Dintarini, M. (2024). Metacognitive regulation strategies among indonesian undergraduate students during conic sections conceptualization. *AL-ISHLAH: Jurnal Pendidikan*, *16*(2), Article 2. https://doi.org/10.35445/alishlah.v16i2.5252

Denzin, N. K. (2015). Triangulation. In *The Blackwell Encyclopedia of Sociology*. John Wiley & Sons, Ltd. https://doi.org/10.1002/9781405165518.wbeost050.pub2

Dias, G. N., Ferreira, R. D. C., Araújo, M. B. S. de, Araújo, G. M. de, Júnior, J. C. B. de S., Lobato, F. da S., Vogado, G. E. R., Pamplona, V. M. S., Rodrigues, A. E., Reis, C. P. dos, Junior, W. L. P. da S., Barbosa, E. da S., Beirao, A. T. M., & Silva, K. P. da. (2021). A didactic proposal for the construction of the ellipse. *International Journal for Innovation Education and Research*, *9*(6), Article 6. https://doi.org/10.31686/ijier.vol9.iss6.3195

Dihna, E. R., & Sudihartinih, E. (2023). Analisis kemampuan representasi matematis mahasiswa melalui perkuliahan geometri analitik topik garis. *JIPM (Jurnal Ilmiah Pendidikan Matematika)*, *11*(2), Article 2. https://doi.org/10.25273/jipm.v11i2.12443

Ekayanti, A. (2017). Pengembangan modul irisan kerucut berbantuan geogebra. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *6*(3), Article 3. https://doi.org/10.24127/ajpm.v6i3.1151

Erita, S., Mulyani, T., & Putra, A. (2023). Analysis of mathematic representation ability in online learning. *Mathline : Jurnal Matematika Dan Pendidikan Matematika*, *8*(1), Article 1 . https://doi.org/10.31943/mathline.v8i1.259

Fudin, M. I., Cahyono, H., & Putri, O. R. U. (2022). Analysis of the visual to verbal mathematical representation process for junior high school students in solving hots questions in terms of adversity quotient. *Mathematics Education Journal*, *6*(2), Article 2. https://doi.org/10.22219/mej.v6i2.23047

Hadiastuti, D. I., & Soedjoko, E. (2019). Analysis of mathematical representation ability based on students' thinking style in solving open-ended problems. *Unnes Journal of Mathematics Education*, *8*(3), Article 3. https://doi.org/10.15294/ujme.v8i3.34189

Hajizah, M. N., & Salsabila, E. (2024). Analisis kesalahan mahasiswa dalam menyelesaikan masalah geometi analitik berdasarkan newman's error analysis. *Plusminus: Jurnal Pendidikan Matematika*, *4*(1), Article 1. https://doi.org/10.31980/plusminus.v4i1.1749

Hidayat, F., & Lestari, P. (2022). Kemampuan representasi matematis siswa berbantuan aplikasi wingeom pada masa pembelajaran tatap muka terbatas. *Plusminus: Jurnal Pendidikan Matematika*, *2*(3), Article 3. https://doi.org/10.31980/plusminus.v2i3.1124

Hidayati, D. W., & Wahyuni, A. (2021). Analysis of mathematical representation ability based on level of reading interest in geometry course. *Journal of Medives : Journal of Mathematics Education IKIP Veteran Semarang*, *5*(2), Article 2. https://doi.org/10.31331/medivesveteran.v5i2.1671

Inganah, S., Nabila, A. I., & Putri, O. R. U. (2021). Kesalahan konstruksi konsep matematis dalam proses representasi visual mahasiswa. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *10*(3), Article 3. https://doi.org/10.24127/ajpm.v10i3.3993

Ižvoltová, J., & Cesnek, T. (2018). Accuracy analysis of continual geodetic diagnostics of a railway line. In *Advances and Trends in Geodesy, Cartography and Geoinformatics*. CRC Press.

Kadry, S. (2014). *Mathematical formulas for industrial and mechanical engineering*. Elsevier. https://doi.org/10.1016/C2012-0-06165-0

Listyotami, M. K., & Wahyuni, E. (2023). Evaluasi kemampuan representasi matematis mahasiswa terhadap pembelajaran online dalam mata kuliah matematika ekonomi. *Jurnal Cendekia : Jurnal Pendidikan Matematika*, *7*(2), Article 2. https://doi.org/10.31004/cendekia.v7i2.2321

Miles, M. B., Hubermas, A. M., & Saldana, J. (2014). *Qualitative data analysis*. SAGE Publications Ltd. https://books.google.co.id/books?id=3CNrUbTu6CsC&printsec=frontcover&dq=miles+huberman+data+analysis&hl=id&sa=X&ved=0ahUKEwiYvLPz8PrnAhUZfX0KHbEXCywQ6AEIKDAA#v=onepage&q=miles huberman data analysis&f=false

Muchlis, E. E., Priatna, N., Herman, T., & Juandi, D. (2023). Analisis kemampuan komunikasi matematis mahasiswa calon guru matematika pada pembelajaran kalkulus integral. *Jurnal Penelitian Pembelajaran Matematika Sekolah (JP2MS)*, *7*(1), Article 1. https://doi.org/10.33369/jp2ms.7.1.68-82

Muzangwa, J., & Ogbonnaya, U. I. (2022). Undergraduate mathematics education students' visual representations of multivariable functions. *Edumatica : Jurnal Pendidikan Matematika*, *12*(3), Article 3. https://doi.org/10.22437/edumatica.v12i03.15712

Nadlifah, M., & Putri, O. R. U. (2023). Kemampuan komunikasi matematis mahasiswa melalui pembelajaran berbasis masalah berbantuan aplikasi MAPLE. *CERMIN: Jurnal Penelitian*, *7*(1), 84–95. https://doi.org/10.36841/cermin_unars.v7i1.2887

Ningsi, G. P., Nendi, F., Jehadus, E., Sugiarti, L., & Kurnila, V. S. (2022). Analisis kesalahan mahasiswa dalam menyelesaikan soal kalkulus integral berdasarkan newman's error analysis dan upaya pemberian scaffolding. *Jurnal Cendekia : Jurnal Pendidikan Matematika*, *6*(3), Article 3. https://doi.org/10.31004/cendekia.v6i3.1469

Noto, M. S., Hartono, W., & Sundawan, D. (2016). Analysis of students mathematical representation and connection on analytical geometry subject. *Infinity Journal*, *5*(2), 99–108. https://doi.org/10.22460/infinity.v5i2.p99-108

Novitasari, P., Usodo, B., & Fitriana, L. (2021). Visual, symbolic, and verbal mathematics representation abilities in junior high school's students. *Journal of Physics: Conference Series*, 1–8. https://doi.org/10.1088/1742-6596/1808/1/012046

Rachmawati, L. N., Cholily, Y. M., & Zukhrufurrohmah, Z. (2021). Mathematics communication mistakes in solving hots problems. *Infinity Journal*, *10*(1), 69–80. https://doi.org/10.22460/infinity.v10i1.p69-80

Ratumanan, T. G., Ayal, C. S., & Tupamahu, P. Z. (2022). Mathematical representation ability of mathematics education study program students. *Jurnal Pendidikan Matematika (JUPITEK)*, *5*(1), Article 1. https://doi.org/10.30598/jupitekvol5iss1pp50-59

Rokhman, M. S., & Oktaviani, D. N. (2015). Pengembangan modul geometri analitik berbasis konstruktivisme untuk meningkatkan kemampuan representasi matematis mahasiswa Pendidikan Matematika Universitas Pancasakti Tegal. *Cakrawala: Jurnal Pendidikan*, *9*(2), Article 2. https://doi.org/10.24905/cakrawala.v9i2.88

Sabrina, K. A., & Effendi, K. N. S. (2022). Kemampuan representasi matematis siswa pada materi kesebangunan. *Jurnal Educatio FKIP UNMA*, *8*(1), 219–228. https://doi.org/10.31949/educatio.v8i1.1969

Sadidah, Y. A., & Sudihartinih, E. (2023). Analisis kesalahan mahasiswa menurut skema fong pada materi irisan kerucut dalam pembelajaran geometri analitik. *Mathematics Education And Application Journal (META)*, *5*(1), Article 1. https://doi.org/10.35334/meta.v5i1.3751

Salsabila, E., Rahayu, W., Kharis, S. A., & Putri, A. (2019). Analysis of mathematical literacy on students' metacognition in conic section material. *Journal of Physics: Conference Series*, *1417*(1), 012057. https://doi.org/10.1088/1742-6596/1417/1/012057

Siegel, L. (2022). Crafting conic sections. *Math Horizons*, *29*(2), 29–29. https://doi.org/10.1080/10724117.2021.1978760

Simarmata, R. H. (2021). Kemampuan mahasiswa pendidikan matematika dalam menyelesaikan soal pemecahan masalah materi SPLDV. *Jurnal Pendidikan Matematika Undiksha*, *12*(2), Article 2. https://doi.org/10.23887/jjpm.v12i2.34632

Sudihartinih, E., & Purniati, T. (2020). Students' mistakes and misconceptions on the subject of conics. *International Journal of Education*, *12*(2), Article 2. https://doi.org/10.17509/ije.v12i2.19130

Sugandi, A. I., Sofyan, D., Linda, L., & Ratnasari, D. (2022). Identifikasi kesalahan mahasiswa dalam menyelesaikan soal-soal pada mata kuliah geometri analitik. *JPMI (Jurnal Pembelajaran Matematika Inovatif)*, *5*(4), 1209–1220. https://doi.org/10.22460/JPMI.V5I4.11151

Supandi, S., Waluya, St. B., Rochmad, R., Suyitno, H., & Dewi, K. (2018). Think-Talk-Write model for improving students' abilities in mathematical representation. *International Journal of Instruction*, *11*(3), 77–90. https://doi.org/10.12973/iji.2018.1136a

Suyitno, A. (2016). *Strategi Pembelajaran 1, Geometri, dan Irisan Kerucut.* Kementerian Pendidikan dan Kebudayaan.

Tupamahu, P. Z., Ratumanan, T. G., & Laamena, C. (2023). Students' mathematical representation and communication ability in mathematics problem solving. *Jurnal Didaktik Matematika*, *10*(1), Article 1. https://doi.org/10.24815/jdm.v10i1.29376

Wulandari, A. A., & Astutiningtyas, E. L. (2020). Analisis kemampuan komunikasi matematis mahasiswa dalam pembelajaran relasi rekurensi. *Jurnal Math Educator Nusantara: Wahana Publikasi Karya Tulis Ilmiah di Bidang Pendidikan Matematika*, *6*(1), Article 1. https://doi.org/10.29407/jmen.v6i1.14263

Yanuarto, W. N. (2018). Deskripsi kemampuan representasi matematis dalam pembelajaran geometri. *Indonesian Journal of Mathematics Education*, *1*(1), Article 1. https://doi.org/10.31002/ijome.v1i1.888

Yuwono, M. R., Ferryka, P. Z., Setyandari, A., & Munif, F. A. (2024). Analisis kemampuan literasi numerasi mahasiswa pada implementasi program kampus mengajar. *JPMI (Jurnal Pembelajaran Matematika Inovatif)*, *7*(1), Article 1. https://doi.org/10.22460/jpmi.v7i1.21595

