Proceeding International Conference on Islamic Education
"Strengthening Educational Institutions in Advancing The Moderate, Inclusive, and Disability-Friendly Islamic Education"
Faculty of Tarbiyah and Teaching Training
Universitas Islam Negeri (UIN) Maulana Malik Ibrahim Malang
November 10th, 2023
P-ISSN 2477-3638 / E-ISSN 2613-9804
Volume: 8 Year 2023

ERROR ANALYSIS OF ELEMENTRAY SCHOOL PRE-SERVICE TEACHER STUDENTS ON GEOMETRY LECTURES BASED NEWMAN THEORY

Muhammad Islahul Mukmin
Universitas Islam Negeri Maulana Malik Ibrahim Malang; Indonesia
E-mail: muhammadislahulmukmin@uin-malang.ac.id

Abstract. This study aims to describe the errors of elementary school pre-service teacher students in geometry lectures with the topic of triangles and congruence. This research used qualitative methode involving 33 PGMI students of State Islamic University of Malauna Malik Ibrahim Malang semester 3 in the 2023-2024 academic year. Researchers used Newman error analysis to explore the types of errors made by students in solving geometry problems. The results showed that most students experienced errors at the stage of understanding the problem, process transformation, process skills, and the stage of writing the final answer. Some subjects also still have errors in writing symbols. This error is caused by the low conceptual understanding of students. Therefore, conceptual learning in geometrical concepts must be strengthened.

Keywords: Error Analysis; Geometry; Newman

A. INTRODUCTION

The basic concepts of geometry course is a compulsory course in the PGMI Study Program at State Islamic University of Maulana Malik Ibrahim Malang. This course contains geometry concepts that include lines, angles, triangles, quadrilaterals, circles, area, alignment, and position. Pre-service teacher students have to master the conceptual understanding including the ability to prove the concept of geometry because in teacher must transform knowledges and concepts of geometry to their students (Hunte, 2018), (Agustina, 2023),(Cirillo & Hummer, 2021).

In lectures on basic concepts of geometry, the process of exploring the types of errors made by students in proving or constructing proofs is important to do because the material studied is closely related to the theorems that must be proven (Reflina, 2019), (Urhan & Bülbül, 2022). The exploration process aims to measure the extend of learning success so that follow-up can be done for further learning (Nutov, 2021). Newman in (Yazidah, 2017) suggests that there are five types of errors, namely: reading the problem (reading), understanding the problem (comprehension), transforming the problem (transformation), solving the process (process skills), writing conclusions (encoding).

The results showed that the learning process about proof for students in higher education has not achieved optimal results. (Reflina, 2019). (Zhao et al., 2019) revealed that students still experience limitations in proof. (Badriani et al., 2022) mentioned that one of the limitations of students is the difficulty in sketching diagrams with appropriate geometry labels and difficulty in constructing conjectures in writing formal proofs. (Zazkis & Marmur, 2021), (Cirillo & Hummer, 2021). Based on this research, this research is important to do in order to improve the ability of prospective teachers in proving the basic concepts of geometry lecture.

B. METHODS

The type of research used is qualitative research. Researchers collected data on error analysis of Islamic Elementary School pre-service teacher students based on Midterm Exam questions. The subjects of this study were PGMI students of UIN Maulana Malik Ibrahim Malang in the third semester of the 2023-2024 academic year, with 33 students. The instrument used in this research is a geometry problem solving description test. The test was conducted after students get basic geometry material. The data obtained were reduced, presented, analysed, and concluded (Sugiyono, 2018). The data analysed in this study is the data of subjects who contain errors as Newman's error indicators from 33 students. The Newman error indicators in each problem solving process can be seen in the following Table 1.

Table. 1 Newman's Error Indicator

No	Error Type	Indicator
1	Reading error	Students do not write the terms, symbols, or important information contained in the problem correctly
2	Comprehension error	a. Students do not write what is known in the problem b. Students write what is known but not exactly c. Students do not write what is asked in the question d. Students write down what is asked but not exactly
3	Transformation error	a. Students do not write the mathematical model of the problem b. Students write a mathematical model but it is not correct c. Students incorrectly present other images of the same object
4	Process skill error	a. Students gets a mistake in calculations or computations b. Students do not continue the completion procedure completely
5	Encoding error	a. Students do not write the final answer b. Students write the final answer but not correctly

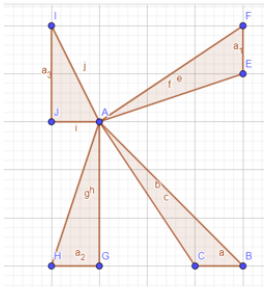
C. RESULT & DISCUSSION

The following are the errors of 33 pre-service teacher students in solving the geometrical problems which presented below.

Perhatikan Gambar di bawah ini.

a. Manakah yang lebih besar, luas daerah ABC atau AEF ? Berikan penjelasan !

b. Apakah kamu setuju bahwa luas AGH lebih besar dari luas AEF ? Berikan alasannya !



Based on observations of student answers, the following data were obtained.

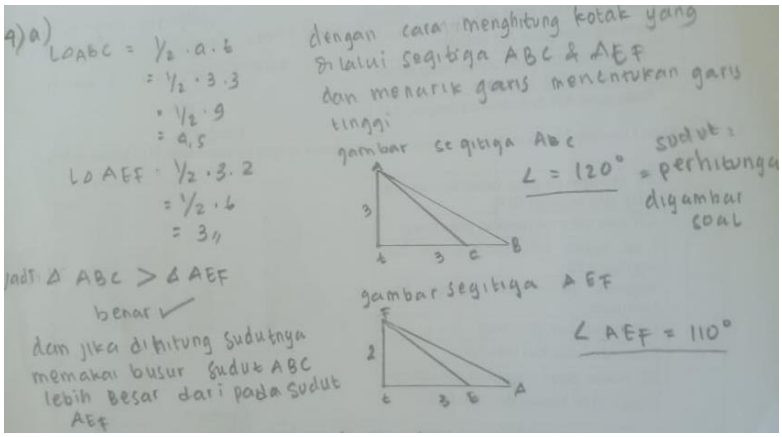


Figure 1. S1 Subject's Answer

Based on the answers of subject S1 in solving math problems, it is found that S1 is able to read terms and write symbols, words, or important information in the problem. However, subject S1 still made a mistake writing the angle symbol. In Figure 1, subject S1 wrote the angle magnitude with the symbol "∠", when it should be written $\mu(\angle ACB) = 120^{\circ}$. Subject S1 was unable to distinguish the writing of symbols for angles and angle magnitudes. At the stage of understanding the problem, subject S1 also knows what is actually asked in the problem and is able to capture the information in the problem. However, at the process transformation stage, the student failed to change the image of the rotation result triangle AEF. This error resulted in subject S1's error in identifying the height of a triangle. As a result, subject S1 stated that the height of triangle AEF is 2 units long. The error at this stage affected subject S1's error in writing the final answer. At this stage subject S1 can write the final answer but it is not correct. At the process skill stage, subject S1 did not experience errors in using the formula to calculate the area and perform computation. This shows that S1 is skilled in utilizing the triangle area formula and performing mathematical calculations.

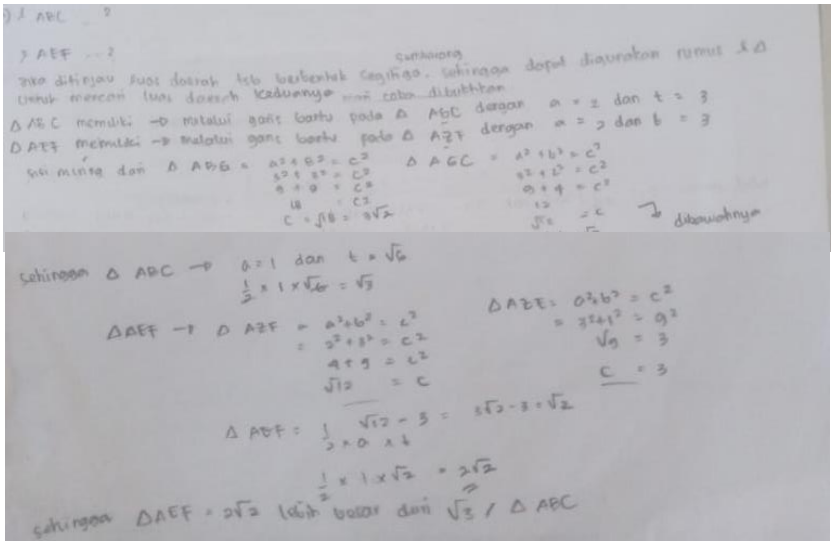


Figure 2. S2 Subject's Answer

Based on the answer of subject S2 in Figure 2, it can be seen that subject S2 is able to understand what is asked in the problem, but subject S2 is unable to identify the information provided in the problem. This is shown in S2's error in writing the height of the triangle. Subject S2 used the area formula of each triangle to determine which triangle has a larger area. Subject S2 was

correct in utilizing the triangle area formula, but was inconsistent in using the height information used. Subject S2 utilized the hypotenuse of the triangle as the height.

Based on the answers of S2 subjects who use the Pythagoras formula, it appears that the mini students do not understand the concept of area conceptually, but they tend to memorize mathematical formulas only without being accompanied by a deep understanding of the concept and the application of the concept (Bisson et al., 2016a). This was shown when they used the Pythagoras formula which was not necessary. They associate triangles with the Pythagoras formula. This condition is because learning so far has only prioritized procedural understanding which is marked by memorizing formulas without the process of deriving and using formulas appropriately (Bisson et al., 2016b), (Crooks & Alibali, 2014). The next mistake is that S2 subjects write the calculation of multiplication of base and height without including the purpose of calculating these numbers. They should have written it completely, namely $L = \frac{1}{2} \times a \times t$.

In Figure 2, it can be seen that subject S2 used the Pythagoras formula to determine the hypotenuse. But at the calculation stage, subject S2 made a mistake. This can be seen from the calculation of the triangle area. In detail, this can be seen in Figure 3.

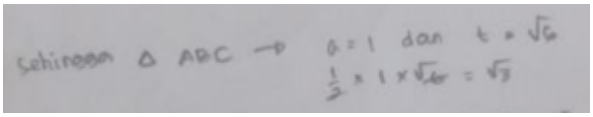


Figure 3. Subject S2's Error in Computation

Subject S2 made a mistake in calculating $\frac{1}{2}.1.\sqrt{6}.$. This error was not only made once, but also for the same calculation on the triangle area AEF as shown in Figure 4.

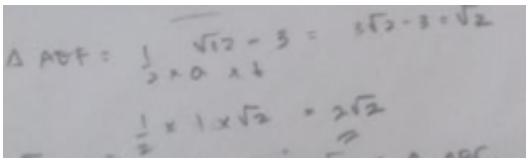


Figure 4. Subject S2's Error in Computation

The misunderstanding is shown when the subject answers the triangle area in the problem which is an arbitrary triangle, not a right triangle. The subject's answer shows that the concept of area used is limited to finding the area of a right triangle that requires the length of the base and height of the triangle (Badriani et al., 2022). This is because students fail to understand and analyse important information from the problem. This understanding error is caused by learning that does not emphasize in-depth understanding of concepts (B Rittle-Johnson, 2001), (Rittle-Johnson & Schneider, 2014). Thus, conceptual learning needs to be emphasized to anticipate similar errors. This misunderstanding can be anticipated by emphasizing the understanding of the concept of area as presented in Figure 5.

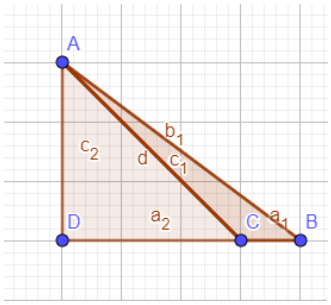


Figure 5. Concept of triangle area

To calculate the area of a triangle ABC is the same as calculating the difference in the areas of triangles ABD and area ACD. Thus

$$L\Delta ABC = L\Delta ABD - LABC = \frac{1}{2}(CD + BC) \times AD - \frac{1}{2}CD \times AD$$
$$= \frac{1}{2}CD \times AD + \frac{1}{2}BC \times AD - \frac{1}{2}CD \times AD = \frac{1}{2}BC \times AD$$

Transformation errors are shown when the subject is wrong in rotating the triangle, causing errors in identifying the height of the triangle. At the stage of writing the final answer (encoding), subject S2 also made an error, namely writing the conclusion of the final answer but it was not correct. The error is in the writing of the symbols used. The subject wrote $\Delta AEF = 2\sqrt{2}$, it should say $L\Delta AEF = 2\sqrt{2}$. This shows that the subject does not understand the real concept of the area of a flat figure including the area of a triangle. (Loeffler et al., 2020), (JP Byrnes, 1991). Because at the stage of transformation and process skills the subject made mistakes, at this stage the subject also made mistakes. (Ilhan et al., 2019),(Verner et al., 2019). Subject S2 managed to write the final answer to the question but subject S2 has not managed to give the correct answer. This can be seen in Figure 6

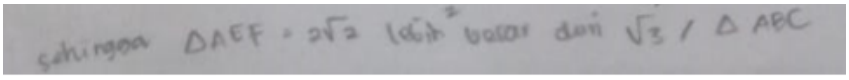


Figure 6. Subject's Encoding Error

D. CONCLUSION

Based on the discussion above, the subjects experienced errors at the stage of understanding the problem, process transformation, process skills, and the stage of writing the final answer. Some subjects also still have errors in writing symbols. This error is caused by low conceptual understanding of students. Thus, learning basic geometry needs to be emphasized with an emphasis on understanding more mature concepts and by integrating conceptual understanding and problem-based learning.

REFERENCES

Agustina, P. (2023). *Pengaruh Model Pembelajaran Conceptual Understanding Procedures (Cups) Terhadap Pemahaman Konsep Matematika Siswa Kelas Iv Sdn 4 Natar Lampung Selatan*.

B Rittle-Johnson, R. S. W. A. (2001). Developing Conceptual Understanding And Procedural Skill In Mathematics: An Iterative Process. *Journal Of Educational Psychology*, *93*(2), 346–362. Https://Doi.Org/10.1037/0022-0663.93.2.346

Badriani, I., Wyrasti, A. F., & Tanujaya, B. (2022). Student Errors In Solving Hots Based-Match Story Problems With Newman's Theory. *Jurnal Elemen*, *8*(1), 77–88. Https://Doi.Org/10.29408/Jel.V8i1.4199

Bisson, M.-J., Gilmore, C., Inglis, M., & Jones, I. (2016a). Measuring Conceptual Understanding Using Comparative Judgement. *International Journal Of Research In Undergraduate Mathematics Education*, *2*(2), 141–164. Https://Doi.Org/10.1007/S40753-016-0024-3/Figures/1

Bisson, M.-J., Gilmore, C., Inglis, M., & Jones, I. (2016b). Measuring Conceptual Understanding Using Comparative Judgement. *International Journal Of Research In Undergraduate Mathematics Education*, *2*(2), 141–164. Https://Doi.Org/10.1007/S40753-016-0024-3/Tables/1

Cirillo, M., & Hummer, J. (2021). Competencies And Behaviors Observed When Students Solve Geometry Proof Problems: An Interview Study With Smartpen Technology. *Zdm Mathematics Education*, *53*(4), 861–875. Https://Doi.Org/10.1007/S11858-021-01221-W

Crooks, N. M., & Alibali, M. W. (2014). Defining And Measuring Conceptual Knowledge In Mathematics. In *Developmental Review* (Vol. 34, Issue 4, Pp. 344–377). Mosby Inc. Https://Doi.Org/10.1016/J.Dr.2014.10.001

Hunte, A. A. (2018). *Opportunities For Reasoning And Proving In Geometry In Secondary School Textbooks From Trinidad And Tobago*. 39–58. Https://Doi.Org/10.1007/978-3-319-77476-3_4

Ilhan, A., Tutak, T., & Celik, H. C. (2019). What Is The Predictive Power Of Visual Mathematics Literacy Perception And Its Sub-Dimensions For Geometry Success? *Eurasian Journal Of Educational Research*, *2019*(80). Https://Doi.Org/10.14689/Ejer.2019.80.1

Jp Byrnes, B. W. (1991). Role Of Conceptual Knowledge In Mathematical Procedural Learning. *Developmental Psychology*, *27*(5), 777–786. Https://Doi.Org/10.1037/0012-1649.27.5.777

Loeffler, C. F., Galimberti, R., & Barcelos, H. De M. (2020). A Self-Regularized Scheme For Solving Helmholtz Problems Using The Boundary Element Direct Integration Technique With Radial Basis Functions. *Engineering Analysis With Boundary Elements*, *118*(May), 11–19. Https://Doi.Org/10.1016/J.Enganabound.2020.05.011

Matematika, J. P., & Yazidah, N. I. (2017). Analisis Kesalahan Menyelesaikan Soal Pembuktian Geometri Euclid Ditinjau Dari Gender Pada Mahasiswa Ikip Budi Utomo Malang. *Kalamatika: Jurnal Pendidikan Matematika*, *2*(1), 71–80. Https://Doi.Org/10.22236/Kalamatika.Vol2no1.2017pp71-80

Nutov, L. (2021). Integrating Visual Arts Into The Mathematics Curriculum: The Case Of Pre-Service Teachers. *Teaching And Teacher Education*, *97*, 103218. Https://Doi.Org/10.1016/J.Tate.2020.103218

Reflina, R. (2019). *Analisis Kesulitan Mahasiswa Pendidikan Matematika Dalam Menyelesaikan Soal Soal Pembuktian Matematis Pada Mata Kuliah Geometri*.

Rittle-Johnson, B., & Schneider, M. (2014). *Developing Conceptual And Procedural Knowledge Of Mathematics*. Oxford University Press.

Sugiyono. (2018). *Metode Penelitian Pendidikan Pendekatan Kuantitatif, Kualitatif, Dan R&D* (27th Ed.). Alfabeta.

Urhan, S., & Bülbül, A. (2022). Analysis Of Mathematical Proving In Geometry Based On Habermas' Construct Of Rationality. *Mathematics Education Research Journal*, 1–31. Https://Doi.Org/10.1007/S13394-022-00420-2/Figures/11

Verner, I., Massarwe, K., & Bshouty, D. (2019). Development Of Competencies For Teaching Geometry Through An Ethnomathematical Approach. *Journal Of Mathematical Behavior*, *56*(1), 1–14. Https://Doi.Org/10.1016/J.Jmathb.2019.05.002

Zazkis, R., & Marmur, O. (2021). *Pedagogical Tasks Toward Extending Mathematical Knowledge: Notes On The Work Of Teacher Educators*. 83–108. Https://Doi.Org/10.1007/978-3-030-62408-8_5

Zhao, N., Teng, X., Li, W., Li, Y., Wang, S., Wen, H., & Yi, M. (2019). A Path Model For Metacognition And Its Relation To Problem-Solving Strategies And Achievement For Different Tasks. *Zdm - Mathematics Education*, *51*(4), 641–653. Https://Doi.Org/10.1007/S11858-019-01067-3