

Analisis Hambatan Belajar Mahasiswa dalam Perkalian Pecahan: Sebuah Studi Hermeneutics Phenomenology di Perguruan Tinggi

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Abstrak

Perkalian pecahan merupakan salah satu operasi pecahan yang cenderung mudah, tetapi justru menjadi masalah bagi mahasiswa. Tidak banyak penelitian sebelumnya yang mengkaji perkalian pecahan dan faktor penyebab terjadinya masalah tersebut pada jenjang perguruan tinggi. Penelitian ini bertujuan untuk mendeskripsikan faktor penyebab terjadinya masalah ditinjau dari jenis hambatan belajar yang mahasiswa alami. Desain penelitian ini adalah *hermeneutics phenomenology*. Partisipan dalam penelitian ini adalah 15 mahasiswa usia 18-25 tahun, 7 laki-laki, 8 perempuan, 9 mahasiswa berasal dari jurusan IPA ketika SMA, dan 6 mahasiswa berasal dari jurusan IPS. Peneliti adalah instrumen utama dengan tes perkalian pecahan yang terdiri atas 2 buah soal yang dikembangkan NCTM dan pedoman wawancara yang bersifat *semi-structured* sebagai instrumen tambahan. Data diolah menggunakan analisis tematik berbantuan NVivo-12 untuk mempermudah proses pengkodean. Hasil penelitian mengungkapkan bahwa mahasiswa mengalami lebih banyak hambatan belajar pada saat mengerjakan masalah perkalian pecahan yang bersifat non-rutin. Untuk masalah rutin, mahasiswa mengalami hambatan belajar dengan jenis *ontogenic obstacle* yang bersifat psikologis (tidak hati-hati). Untuk masalah non-rutin, mahasiswa mengalami hambatan belajar dengan jenis *epistemological* karena jarang mengerjakan soal cerita, serta *ontogenic obstacle* yang bersifat konseptual dan psikologis.

Kata Kunci: epistemological obstacle, hermeneutics phenomenology, ontogenic obstacle, perkalian pecahan

Analysis of Student Learning Barriers in Fractional Multiplication: A Hermeneutics Phenomenology Study in Higher Education

Abstract

Multiplication of fractions is one of the operations on fractions that tends to be easy, but it becomes a problem for students. Only a little previous research has examined the multiplication of fractions and the factors that cause this problem at the tertiary level. This study aims to describe the factors that cause problems in terms of the types of learning barriers that students experience. The research design is hermeneutics phenomenology. The participants in this study were 15 students aged 18-25 years, 7 boys and 8 girls, 9 students majoring in natural sciences during high school, and 6 students from social studies majors. The researcher is the main instrument, with a fraction multiplication test consisting of 2 questions developed by NCTM and a semi-structured interview guide as an additional instrument. Data is processed using NVivo-12-assisted thematic analysis to simplify the coding process. The study revealed that students experienced more learning difficulties when working on non-routine fraction multiplication problems. For routine problems, students experience learning difficulties with the type of ontogenic obstacle that is psychological (not careful). For non-routine problems, students experience learning barriers with epistemological types because they rarely work on word problems, as well as ontogenic obstacles that are conceptual and psychological.

Keywords: epistemological obstacle; hermeneutics phenomenology; multiplication of fractions; ontogenic obstacle

INTRODUCTION

Fraction multiplication is one of the procedures in the learning of fractions that is relatively easy (Purwanti, 2015; Shanty et al., 2011). However, several previous studies revealed that non-routine problems involving fractional multiplication were a problem in learning, including in lectures (Chen et al., 2013; Julie, 2017; Rifandi, 2017). Fraction multiplication is often used during lessons (Isnawan et al., 2022; Zhang et al., 2014). Quite a lot of lecture material, both related to advanced mathematics, as well as those related to the world of agriculture that require operations in fractional multiplication (Fehr, 1968; Iulia & Gugoiu, 2006; Singh et al., 2021). Based on the existing problems and the importance of the expansion of fractions for students, conducting research on fractional multiplication studies is essential. It must immediately get attention when the problem is found in the multiplication of the fraction itself. Some previous studies reviewed the multiplication of fractions. However, only a few made universities objects of research studies. Only a few researchers use the hermeneutics phenomenology design to study fractions' multiplication (Chen et al., 2013; Rifandi, 2017; Shanty et al., 2011).

In research conducted by Son and Lee (2016), despite using students as participants, the research design could be more precise. The study results revealed that some participants experienced problems in terms of being unable to change daily life problems involving fractions into mathematical statements and appropriate visual representations. Research conducted by Ekawati et al. (2022) uses students in schools as participants and uses case study designs as research designs. The study revealed that some participants needed to change the form of non-routine problems that involved the multiplication of fractions into an appropriate mathematical model. Likewise, Bharaj et al. (2021) research uses grade 5 elementary school students as participants and uses research designs that still need to be clarified in the study. One of the conclusions of the research activity is that some participants use strategies or understanding of integers when multiplying fractions and directly use addition and subtraction operations when finding non-routine problems that should involve fractional multiplication operations.

The hermeneutics phenomenology design is preferred because it tends to be relevant to be used in studying a group of people (students) about the phenomenon (fraction) (Isnawan et al., 2022; Ramezanzadeh et al., 2016). The results of this study are expected to provide an overview of external factors that cause students to experience problems in fractional multiplication. By knowing these factors, the lecturer is expected to provide alternative solutions or lecture designs under these causative factors so that learning carried out in class can minimize the learning barriers that students experience. Therefore, this study aims to describe the types of learning barriers experienced by students in fractional multiplication using the hermeneutics phenomenology design.

METHOD

The approach in this study is qualitative, with the type of research being hermeneutics phenomenology. Hermeneutics Phenomenology was chosen because this study seeks to study students' experiences in solving problems related to the multiplication of fractions (Isnawan et al., 2022; Keshavarz, 2020; Ramezanzadeh et al., 2016; Stephenson et al., 2018; Tan et al., 2009). This research was conducted from September 2022 to February 2023 at a private university in West Nusa Tenggara Province, Indonesia. Participants in this study were fifteen students from three study programs. Five students came from the Mathematics Education Study Program, seven from the Agrotechnology Study Program, and three from the Food Technology Study Program. The three study programs were chosen because the three study programs studied mathematics as a compulsory course during lectures. The description of the participant biodata is as follows: The age range of 18 to 25 years; 7 people are male, the rest are female; 9 people majored in science during high school, and the rest majored in social studies. The technique of determining the participants used purposive sampling. The technique was chosen because it was adapted to the purpose of this study, which was to determine the types of learning barriers students experienced. These students were chosen because there were indications of experiencing learning difficulties in multiplying fractions.

The procedure in this study is the determination of research instruments, granting test instruments to participants, analysis of student answer sheets, student interviews, and analysis of research data. The main instruments in this study are researchers with fractional multiplication test instruments and interview guidelines as additional instruments. The test instrument was taken from the questions developed by NCTM (NCTM, 2014). Figure 1 provides examples of test questions classified as routine problems, and Figure 2 presents examples of questions classified as non-routine problems.

$$\frac{5}{6} \times \frac{7}{8}$$

Figure 1. Problem Number 1 (Routine Problems in Fractions) (NCTM, 2014, p. 19)

For lunch Mom gave me three-fourths of a pizza that we ordered. I could only finish two-thirds of what she gave me. How much of the whole pizza did I eat?

Figure 2. Problem Number 2 (Non-Routine Problems in Fraction Multiplication) (NCTM, 2014, p. 19)

The data in this study were then analyzed using Nvivo-12 thematic analysis. Thematic analysis is used because it is more systematic with the following steps: familiarizing with data (repeatedly reading data), determining the initial code, forming themes, reviewing themes, and naming or defining themes (Alhojailan & Ibrahim, 2012; Finkelstein et al., 2019; Nowell et al., 2017). NVIVO-12 facilitates the coding process when determining the initial code and forming an appropriate theme (Dalkin et al., 2020; Paulus et al., 2015; Wilk et al., 2019). This study uses triangulation of data sources (confirming students' answers with other students) and triangulation of methods (test results are confirmed by conducting in-depth interviews) to strengthen trustworthiness findings in research (Heale & Forbes, 2013; Olsen, 2004). This study also prioritizes research ethics by ensuring that all participants have agreed to provide the required data, do not include the original identity of the participants, and display data only for scientific purposes (Dooly et al., 2017; Esposito, 2012).

RESULTS

The initial code of learning obstacles that students experience in fraction multiplication

After analyzing the student answer sheet, information related to the description of the Initial Code (IC) formed for problem number 1 can be seen in Table 1.

Table 1. Description of the IC of Student Learning Barriers for Problem Number 1

IC	Descriptions	References
IC1_1	No obstacles.	11
IC1_2	Mistaken in carrying out multiplication procedures (using the distribution procedure).	3
IC1_3	Mistaken in simplifying fractions.	1
IC1_4	Mistaken in the multiplication of the denominator.	1
IC1_5	There is no sign of "per" during the process of working.	1

Table 1 shows that IC1_1 is the initial code that dominates for problem number 1. In other words, students are indicated not to experience learning barriers when working on routine problems on mathematical multiplication. The initial code description of learning obstacles for problem number 2 can be seen in Table 2.

Table 2. Description of the IC of Student Learning Barriers for Problem Number 2

IC	Descriptions	References
IC2_1	Wrong in making mathematical modeling (reduction model).	7
IC2_2	Mistaken in making mathematical modeling (division model).	4
IC2_3	Mistaken in converting fractions into decimal form.	3
IC2_4	Mistaken in working on the procedure for reducing fractions (using multiplication procedures).	2
IC2_5	Doubt.	1
IC2_6	Equates the distribution and multiplication procedure.	1
IC2_7	Cannot make mathematical modeling (just writing what is known).	1
IC2_8	Mistaken in quoting fractions.	1
IC2_9	Cannot make mathematical modeling (percentage method).	1
IC2_10	Wrong in making mathematical modeling (addition model).	1
IC2_11	Added the number "2" for the first fraction and denominator, adding the number "4" for the second fraction and denominator.	1
IC2_12	Wrong in carrying out the procedure for the addition of fractions (adding up the Peling with the Peling and Minkering with the denominator).	1
IC2_13	Cannot Make Math Modeling (Recognizing the two known fractions).	1

Wrong in making mathematical modeling (reduction model) becomes the most dominant IC on problem number 2. Snipped One of the results of student work that forms IC2_1 can be seen in Figure 1.

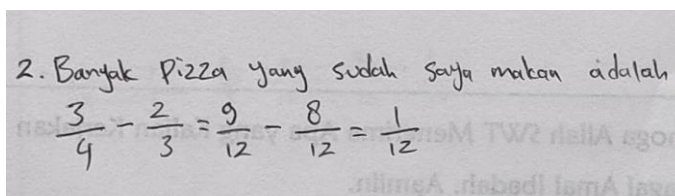


Figure 1. Footage of One of the Student Jobs on IC2_1

The description of the learning barriers students experience in the multiplication of fractions.

After determining the IC, the next step is to determine the theme, review the theme, and name or define the theme. The description of the name or definition of themes for problem number 1 can be seen in Table 3.

Table 3. Description of the Theme of Student Learning Resistance for Problem Number 1

Theme	Descriptions	References
T1_1	No Obstacles.	11
T1_2	Mistaken in carrying out multiplication procedures for fractions.	3
T1_3	Obstacles related to prerequisite material.	2
T1_4	Not Be careful.	1

T1_1 in table 3 formed from IC1_1, T1_2 comes from IC1_2, T1_3 formed from IC1_3 and IC1_4, and T1_4 comes from IC1_5. The themes formed in problem number 1 then concluded that some students did not experience obstacles when solving routine problems in fraction multiplication. When several students were interviewed and asked to redo problem number 1, students were able to do the problem correctly. A snippet of one student’s answer to T1_1 can be seen in Figure 2.

$$\frac{5}{6} \times \frac{7}{8}$$

$$= \frac{35}{48}$$

$$= 0,79$$

Figure 2. Snippet of Student Answers Without Experiencing Obstacles

When some students who were wrong in carrying out multiplication procedures were interviewed more in-depth, information was obtained that the student was able to carry out fractional multiplication procedures. After confirming the results with the answer sheet, some students revealed that they tend to rush in working so that the written results do not match what they should. The excerpt of the results of the interview of researchers with several students can be seen in Table 4.

Table 4. Examples of Researchers' Interviews with Students for Problem Number 1

Researcher	Students
Are you aware of the mistake in your answer sheet for problem number 1?	S1: Now I just realized, sir. S2: Gosh, wrong, sir.
In which part are you wrong?	S1: I should multiply the remake with the removal and the denominator with the denominator. S2: That is, sir, I use the distribution method, sir. The multiplication should be multiplied by the top and the bottom with the bottom.

The results of interviews of several students in table 4 are the same as those of several other students who experienced obstacles with the initial code IC1_4 and IC1_5. The results of interviews with the two students revealed that students tend to need to be more careful when working on problem 1. Based on the results of this interview, it can be concluded that for problem number 1, students are indicated to experience one type of learning obstacle, namely t1_4 (not careful). This conclusion is based on the results of interviews that confirm that T1_4 is also formed by T1_2 and T1_3.

Table 5 then shows the description of the theme for problem number 2. The theme in Table 5 is the theme formed from the initial code that is in Table 2.

Table 5. Description of the Theme of Student Resistance for Problem Number 2

Theme	Descriptions	References
T2_1	Mistaken in making mathematical modeling.	12
T2_2	Cannot Procedure in Operating Fractions.	5
T2_3	Obstacles related to prerequisite material.	4
T2_4	Cannot make mathematical modeling.	3
T2_5	Doubt.	1

The T2_1 in problem number 2 comes from IC2_1, IC2_2, and IC2_3. T2_2 is formed from IC2_4, IC2_6, IC2_11, and IC2_12. T2_3 comes from IC2_3 and IC2_8. While T2_4 comes from IC2_7, IC2_9, and IC2_13.

Furthermore, interviews with several students were conducted to confirm the themes formed in Table 5. Based on the interviews with several students who formed the T2_1 and T2_4 themes, information was obtained that students needed help understanding the meaning of the questions. It is

because students rarely answer problems that contain story questions. Table 6 shows excerpts of interviews between researchers and students regarding these two themes.

Table 6. Snippets of Interviews by Researchers with Students for T2_1 and T2_4

Researcher	Students
<i>Do you understand the meaning of question number 2?</i>	<i>S3: Anu sir, we are asked to share a pizza.</i>
<i>Then how do you do it?</i>	<i>S4: I do not understand, sir.</i>
	<i>S3: I will share the fractions that you know, sir.</i>
	<i>S4: I am just going to equate the fractions, sir.</i>
<i>Do you often work on word problems in math?</i>	<i>S3: Rarely, sir. What I remember is only answering questions about numbers.</i>
	<i>S4: Often, sir, but not too often either. The teacher usually gives questions about the numbers, sir.</i>

After analyzing the results of the interviews, information was obtained that students were indicated to be unable and wrong in making mathematical modeling because students rarely worked on word problems in mathematics. As for the themes T2_2 and T2_3, the students needed to remember some prerequisite procedures and materials in operating fractions (information was obtained during the interviews). As for the T2_5 theme, students revealed that students were unsure about the correct answer, so they wrote down two alternative answers on the answer sheet. Based on the results of the interviews, it was indicated that they experienced several learning barriers, such as rarely working on word problems in mathematics, really could not understand the prerequisite material for operating fractions, and needed clarification on their answers (problem 2).

DISCUSSION

Based on the description of the results of previous research, information was obtained that students were indicated to experience learning obstacles in the form of being careless when working on problem number 1. If it is associated with a theory related to the type of learning obstacles (Brousseau, 2002; Suryadi, 2019b, 2019a), it is concluded that the types of learning barriers students experience for problem number 1 are ontogenic obstacles that are psychological. It is because the mistakes students experience when working on problem number 1 are that they tend to be more careful when working on it so that the process and results are correct. Students can do the problem well when asked to do it more calmly. These results are then in line with the theory which reveals that psychological or emotional calm is one of the determinants of success in a lesson, including caution when studying and working on problems (Baylor et al., 1999; Cohen & Sherman, 2014; Critcher & Dunning, 2015; Gulevska & Atanasoska, 2015; Ioannidou & Konstantikaki, 2008; Purnamayanthi et al., 2022; Reskina & Kartini, 2022; Yulika et al., 2019). The results of this study then strengthen previous research (Fauzi & Suryadi, 2020; Isnawan, 2022; S. K. Rohmah, 2019; Ulfa et al., 2021), which revealed that students tend to experience learning barriers with ontogenic obstacles which are psychological types. In other words, learning barriers with the psychological ontogenic obstacle type are experienced by students at the elementary and secondary school levels and the tertiary level.

In connection with problem number 2, if it is associated with theories related to types of learning barriers, students in this study are indicated to experience several types of learning barriers:

1. Students are indicated to experience learning barriers with the type of epistemological obstacle because students have limited ways of learning fractions at school. Students know they rarely work on or get word problems when learning fractions or mathematics (Table 6).
2. Students are indicated to experience learning difficulties with conceptual ontogenic obstacles. It is because students need a greater understanding of the concepts or prerequisite material needed to learn multiplication of fractions (Table 5).
3. Students are indicated to experience learning barriers with ontogenic obstacles, which are psychological because students tend to have doubts in making decisions regarding the procedures or results that are selected and used when answering questions or learning (Table 5).

Furthermore, the results of this study reinforce several previous studies. These researchers reveal that conceptual and psychological barriers to learning are epistemological and ontogenic obstacles. Not only experienced by students at the elementary and secondary school levels but also at the tertiary level (Aksoy & Yazlik, 2017; Maelasari & Jupri, 2017; Makonye & Khanyile, 2015; Malone & Fuchs, 2016; M. Rohmah & Sutiarsa, 2018; Safriani et al., 2019; Singh et al., 2020). Epistemological obstacles, if left unchecked, will result in other learning barriers (Aebi & Linde, 2015; Daut Siagian et al., 2022; Moru, 2007). Therefore, educators, both teachers and lecturers, must be able to provide learning to students in order to be able to minimize these obstacles. Some examples of what lecturers can do are compiling didactic designs or teaching materials in lectures with various contexts, familiarizing students with solving everyday life problems in learning, and providing an epistemic learning flow by utilizing the steps of didactic situations in learning. These steps include are: action-formulation situations (students solve problems in their way), validation (students discuss to determine what solutions, concepts, or procedures are found from problems), and institutionalization (students use solutions, concepts, or procedures obtained in situations or contexts that are different from previous learning activities) (Brousseau, 2002; Suryadi, 2019b, 2019a).

There are several things that lecturers can do to minimize learning barriers with ontogenic obstacles that are psychological, namely: integrating ICT in lecture activities, such as using the *quizizz* platform to attract students' interest in learning; providing problems that challenge students' logical thinking; provide several learning videos that can illustrate the benefits of the material being studied; as well as asking students to re-check the process and work results in learning. Meanwhile, one of the things that lecturers can do to strengthen student prerequisite material is to give *quizizz* to students, which contains some prerequisite material and reinforcement at the beginning of learning activities (Isnawan, 2022).

Finally, when comparing the learning barriers experienced by students in problem number 1 and problem number 2, it is obtained that information indicates that students experience more learning difficulties in problem 2. In other words, students tend to have more difficulty solving non-routine problems (stories or everyday life) rather than routine matters. It is because students need to understand the intent of the problems given (according to the results of the interviews in Table 6). The results of this study are then in line with the theory which reveals that the ability to understand questions, including literacy skills, is an ability that supports one's success in solving problems in mathematics (Bolstad, 2019; Genc & Erbas, 2019; Umbara & Suryadi, 2019). The results of this study are then in line with the previous, which revealed that non-routine problems are more complex problems for students or students than routine problems in learning mathematics (Johar & Lubis, 2018; Powell et al., 2020; Saygili, 2017; Shin & Bryant, 2017; Upu et al., 2022). Getting students used to interacting with non-routine problems in lectures is an alternative so that students get used to solving these non-routine problems.

CONCLUSION

Based on previous research and discussion results, students experience more learning difficulties when solving non-routine fraction multiplication problems than routine fraction multiplication problems. It is because it is indicated that students need help understanding the meaning of non-routine problems correctly, so they are constrained when solving them. Students in this study indicated that they experienced learning difficulties with an ontogenic psychological obstacle type for problem number 1 (a routine problem in multiplying fractions). These obstacles form students need to be more careful. In addition, this study indicates that students have experienced epistemological, conceptual, and psychological ontogenic obstacles (a non-routine problem in multiplying fractions). The epistemological obstacle students experienced in this study in the form of students rarely getting or working on word problems while studying mathematics at school. Students experienced conceptual ontogenic obstacles in multiplying fractions, like needing to be corrected in equivalent fractions and corrected in converting fractions into decimal form. While the learning barriers that are classified as ontogenic and psychological obstacles are students who hesitate when using specific procedures in solving non-routine problems in multiplying fractions.

This study then recommends using various forms of lecture design in order to be able to minimize the learning barriers that have been described previously. Some recommended lecture design characteristics are: integrating ICT (*quizizz* and learning videos); familiarizing students with answering or solving non-routine problems in lectures; using epistemic learning steps; and providing practice questions that challenge students' mindsets during lectures. As for subsequent research, this research recommends that the results be used as a basis for lecturers in compiling didactic designs or teaching materials in mathematics lectures, especially those related to rational numbers. It is intended so that the learning design created by the lecturer can be more in line with the characteristics of the types of student learning barriers and be able to be a solution in minimizing these learning barriers.

ACKNOWLEDGMENTS

Researchers would like to thank the Universitas Nahdlatul Wathan Mataram for providing support during the implementation of this research, including support for research funds and publications. In addition, the researcher also thanked all students who were willing to participate in this research activity.

BIBLIOGRAPHY

- Aebi, M. F., & Linde, A. (2015). The Epistemological Obstacles in Comparative Criminology: A Special Issue Introduction. *European Journal of Criminology*, 12(4), 381–385. <https://doi.org/10.1177/1477370815595311>
- Aksoy, N. C., & Yazlik, D. O. (2017). Student Errors in Fractions and Possible Causes of These Errors. *Journal of Education and Training Studies*, 5(11), 219–233. <https://doi.org/10.11114/jets.v5i11.2679>
- Alhojailan, M. I., & Ibrahim, M. (2012). Thematic Analysis: A Critical Review of Its Process and Evaluation. *West East Journal of Social Sciences*, 1(2011), 8–21. https://faculty.ksu.edu.sa/sites/default/files/ta_thematic_analysis_dr_mohammed_alhojailan.pdf
- Baylor, A. L., Shen, E., & Warren, D. (1999). Supporting Learners with Hating Mathematics: The Impact of System Pedagogical Agent of Emotional and Motivational Support. *Pedagogical Agent*, 1997.
- Bharaj, P. K., Jacobson, E., Liu, J., & Ahmad, F. (2021). Assessing Students' Understanding of Fraction Multiplication. *Mathematics Education Across Cultures: Proceedings of the 42nd Meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education*, 265–269. <https://doi.org/10.51272/pmena.42.2020-27>
- Bolstad, O. H. (2019). Teaching for Mathematical Literacy: School Leaders' and Teachers' Rationales. *European Journal of Science and Mathematics Education*, 7(3), 93–108. <https://doi.org/10.30935/scimath/9537>
- Brousseau, G. (2002). *Theory of Didactical Situations in Mathematics*. Kluwer Academic Publishers. <https://id1lib.org/book/979725/fd6fae>
- Chen, C.-H., Chiu, C.-H., Lin, C.-P., & Wu, S.-T. (2013). Presenting Solution Strategies of Fraction Multiplication and Division on Mathematics Instructional Websites. *World Journal on Educational Technology*, 5(53), 431–444. https://doi.org/https://www.academia.edu/35535476/Presenting_solution_strategies_of_fraction_multiplication_and_division_on_mathematics_instructional_websites

- Cohen, G. L., & Sherman, D. K. (2014). The Psychology of Change: Self-affirmation and Social Psychological Intervention. In *Annual Review of Psychology* (Vol. 65, pp. 333–371). Annual Reviews Inc. <https://doi.org/10.1146/annurev-psych-010213-115137>
- Critcher, C. R., & Dunning, D. (2015). Self-affirmations Provide a Broader Perspective on Self-threat. *Personality and Social Psychology Bulletin*, 41(1), 3–18. <https://doi.org/10.1177/0146167214554956>
- Dalkin, S., Forster, N., Hodgson, P., Lhussier, M., & Car, S. M. (2020). Using Computer Assisted Qualitative Data Analysis Software (CAQDAS; NVivo) to Assist in the Complex Process of Realist Theory Generation, Refinement and Testing. *International Journal of Social Research Methodology*, 24(1), 123–134. <https://doi.org/10.1080/13645579.2020.1803528>
- Daut Siagian, M., Suryadi, D., Nurlaelah, E., & Prabawanto, S. (2022). Investigation of Secondary Students' Epistemological Obstacles in the Inequality Concept. *Mathematics Teaching Research Journal*, 14(4), 106–128. <https://commons.hostos.cuny.edu/mtrj/wp-content/uploads/sites/30/2022/12/06-Siagian.pdf>
- Dooly, M., Moore, E., & Vallejo, C. (2017). Research Ethics. In E. Moore & M. Dooly (Eds.), *Qualitative Approach to Research on Plurilingual Education* (pp. 351–362). Research-publishing.net.
- Ekawati, R., Imah, E. M., Amin, S. M., Kohar, A. W., Nisa', K., & Prahmana, R. C. I. (2022). Error Analysis of Dyslexic Student's Solution on Fraction Operation Tasks. *Mathematics Teaching Research Journal*, 14(1), 67–79. <https://files.eric.ed.gov/fulltext/EJ1361650.pdf>
- Esposito, A. (2012). Research Ethics in Emerging Forms of Online Learning: Issues Arising from a Hypothetical Study on a MOOC. *Electric Journal of E-Learning*, 10(3), 315–325. <https://files.eric.ed.gov/fulltext/EJ985433.pdf>
- Fauzi, I., & Suryadi, D. (2020). The Analysis of Students' Learning Obstacles on the Fraction Addition Material for Five Graders of Elementary Schools. *Al Ibtida: Jurnal Pendidikan Guru MI*, 7(1), 33–45. <https://doi.org/10.24235/al.ibtida.snj.v7i1.6020>
- Fehr, H. F. (1968). Fractions as operators. *The Arithmetic Teacher*, 15(3), 228–232. <http://www.jstor.org/stable/41163165>
- Finkelstein, S., Sharma, U., & Furlonger, B. (2019). The Inclusive Practices of Classroom Teachers: A Scoping Review and Thematic Analysis. *International Journal of Inclusive Education*, 1–28. <https://doi.org/10.1080/13603116.2019.1572232>
- Genc, M., & Erbas, A. K. (2019). Secondary Mathematics Teachers' Conceptions of Mathematical Literacy. *International Journal of Education in Mathematics, Science and Technology (IJEMST)*, 7(3), 222–237. <https://www.ijemst.com/index.php/ijemst/article/view/611>
- Gulevska, V., & Atanasoska, T. (2015). Enhancing Teacher Competencies with Emotional and Ethical Capacity. *International Journal of Cognitive Research in Science, Engineering and Education*, 3(2), 85–90.
- Heale, R., & Forbes, D. (2013). Understanding Triangulation in Research Understanding Triangulation in Research. *Evid Based Nurs*, 16(4), 98. <https://doi.org/10.1136/eb-2013-101494>
- Ioannidou, F., & Konstantikaki, V. (2008). Empathy and Emotional Intelligence: What is It Really About? *International Journal of Caring Sciences*, 1(3), 118–123.

- Isnawan, M. G. (2022). *Desain Didaktis Pembelajaran Pecahan di SMP Negeri 1 Narmada Kabupaten Lombok Barat* [Dissertation]. Universitas Pendidikan Indonesia.
- Isnawan, M. G., Suryadi, D., & Turmudi, T. (2022). How Do Secondary Students Develop the Meaning of Fractions? A Hermeneutic Phenomenological Study. *Beta: Jurnal*, 15(1), 1–19. <https://doi.org/10.20414/betajtm.v15i1.496>
- Iulia, & Gugoiu, T. (2006). *The Book of Fractions*. La Citadelle. https://la-citadelle.com/mathematics/the_book_of_fractions.pdf
- Johar, R., & Lubis, K. R. (2018). The Analysis of Students' Mathematical Representation Errors in Solving Word Problem Related to Graph. *Jurnal Riset Pendidikan Matematika*, 5(1), 96. <https://doi.org/10.21831/jrpm.v5i1.17277>
- Julie, H. (2017). The Elementary School Teachers' Ability in Adding and Subtracting Fraction, and Interpreting and Computing Multiplication and Division Fraction. *International Journal of Science and Applied Science: Conference Series*, 1(1), 55–63. <https://doi.org/10.20961/ijscasc.v1i1.5114>
- Keshavarz, H. (2020). Hermeneutic Phenomenology in Supporting Research and Information Services: Contributions to Information Science. *Journal of Information Science Theory and Practice*, 8(4), 29–39. <https://doi.org/https://doi.org/10.1633/JISTaP.2020.8.4.3>
- Maelasari, E., & Jupri, A. (2017). Analysis of Students Errors on Division of Fractions. *Journal of Physics: Conference Series*, 812, 1–5. <https://doi.org/10.1088/1742-6596/755/1/011001>
- Makonye, J. P., & Khanyile, D. W. (2015). Probing grade 10 students about their mathematical errors on simplifying algebraic fractions. *Research in Education*, 94(1), 55–70. <https://doi.org/10.7227/RIE.0022>
- Malone, A. S., & Fuchs, L. S. (2016). Error Patterns in Ordering Fractions Among At-Risk Fourth-Grade Students. *Journal of Learning Disabilities*, 1–16. <https://doi.org/10.1177/0022219416629647>
- Moru, E. K. (2007). Talking with the Literature on Epistemological Obstacles. *For the Learning Mathematics*, 27(3), 34–37. <https://flm-journal.org/Articles/7968B5B6DC68EB311866308086F062.pdf>
- NCTM. (2014). *Principles to Actions: Ensuring Mathematical Success for All*. NCTM. <http://areaiihsmmap.pbworks.com/w/file/109255672/Principles.To.Actions.ebook.pdf>
- Nowell, L. S., Norris, J. M., White, D. E., & Moules, N. J. (2017). Thematic Analysis: Striving to Meet the Trustworthiness Criteria. *International Journal of Qualitative Methods*, 16, 1–13. <https://doi.org/10.1177/1609406917733847>
- Olsen, W. (2004). Triangulation in Social Research: Qualitative and Quantitative Methods Can Really Be Mixed. In M. Holborn (Ed.), *Developments in Sociology* (pp. 1–334). Causeway Press. <https://doi.org/10.4324/9781315838120>
- Paulus, T., Woods, M., Atkins, D. P., & Macklin, R. (2015). The Discourse of QDAS: Reporting Practices of ATLAS.ti and NVivo Users with Implications for Best Practices. *International Journal of Science Research Methodology*, 20(1), 35–47. <https://doi.org/10.1080/13645579.2015.1102454>

- Powell, S. R., Berry, K. A., & Benz, S. A. (2020). Analyzing the Word-Problem Performance and Strategies of Students Experiencing Mathematics Difficulty. *Journal of Mathematical Behavior*, 58, 1–16. <https://doi.org/10.1016/j.jmathb.2020.100759>
- Purnamayanthi, K. T., Suparta, I. N., & Suweken, G. (2022). Analisis Tipe Kesalahan Siswa dalam Menyelesaikan Soal Matematika Berdasarkan Taksonomi Anderson. *Edumatica: Jurnal Pendidikan Matematika*, 12(1), 63–75. <https://online-journal.unja.ac.id/edumatica/article/download/14747/13262>
- Purwanti, K. L. (2015). Pembelajaran Perkalian Pecahan Biasa Berbantu Media Benda Konkret: Studi Kasus Perbedaan Gender terhadap Kemampuan Matematika Siswa Kelas V SDN Sambiroto 3 Semarang. *SAWWA*, 10(2), 193–207. <https://journal.walisongo.ac.id/index.php/sawwa/article/download/1431/1050>
- Ramezanzadeh, A., Adel, S. M. R., & Zareian, G. (2016). Teaching in Higher Education Authenticity in Teaching and Teachers' Emotions: A Hermeneutic Phenomenological Study of the Classroom Reality. *Teaching in Higher Education*, 21(7), 807–824. <https://doi.org/10.1080/13562517.2016.1183616>
- Reskina, & Kartini. (2022). Analisis Kesalahan Siswa dalam Menyelesaikan Soal Aritmetika Sosial Berdasarkan Teori Newman. *Edumatica: Jurnal Pendidikan Matematika*, 12(3), 238–248. <https://online-journal.unja.ac.id/edumatica/article/view/19589/14974>
- Rifandi, R. (2017). Supporting Students' Reasoning About Multiplication of Fractions by Constructing an Array Model. *JRAMathEdu (Journal of Research and Advances in Mathematics Education)*, 1(2), 99–110. <https://doi.org/10.23917/jramathedu.v1i2.3385>
- Rohmah, M., & Sutiarsa, S. (2018). Analysis Problem Solving in Mathematical Using Theory Newman. *Eurasia Journal of Mathematics, Science and Technology Education*, 14(2), 671–681. <https://doi.org/10.12973/ejmste/80630>
- Rohmah, S. K. (2019). Analisis Learning Obstacles Siswa pada Materi Pecahan Kelas IV Sekolah Dasar. *Al-Aulad: Journal of Islamic Primary Education*, 2(1), 13–24. <https://doi.org/10.15575/al-aulad.v2i1.4428>
- Safriani, W., Munzir, S., Duskri, M., & Maulidi, I. (2019). Analysis of Students' Errors on the Fraction Calculation Operations Problem. *Al-Jabar: Jurnal Pendidikan Matematika*, 10(2), 307–318. <https://doi.org/10.24042/ajpm.v10i2.5224>
- Saygili, S. (2017). Examining the Problem Solving Skills and the Strategies Used by High School Students in Solving Non-Routine Problems. *E-Uluslararası Eğitim Araştırmaları Dergisi*, 8(2), 91–114. <https://doi.org/10.19160/ijer.321075>
- Shanty, N. O., Hartono, Y., Putri, R. I. I., & De Haan, D. (2011). Design Research on Mathematics Education: Investigating the Progress of Indonesian Fifth Grade Students' Learning on Multiplication of Fractions with Natural Numbers. *Journal on Mathematics Education*, 2(2), 147–162. <https://doi.org/10.22342/jme.2.2.749.147-162>
- Shin, M., & Bryant, D. P. (2017). Improving the Fraction Word Problem Solving of Students with Mathematics Learning Disabilities: Interactive Computer Application. *Remedial and Special Education*, 38(2), 76–86. <https://doi.org/10.1177/0741932516669052>
- Singh, P., Hoon, T. S., Nasir, N. A. M., Han, C. T., Rasid, S. M., & Hoong, J. B. Z. (2021). Obstacles Faced by Students in Making Sense of Fractions. *The European Journal of Social & Behavioural Sciences*, 30(1), 34–51. <https://doi.org/10.15405/ejsbs.287>

- Son, J.-W., & Lee, J.-E. (2016). Pre-service Teachers' Understanding of Fraction Multiplication, Representational Knowledge, and Computational Skills. *Mathematics Teacher Education and Development*, 18(2), 5–28. <https://eric.ed.gov/?id=EJ1113959>
- Stephenson, H., Giles, D., & Bissaker, K. (2018). The Power of Hermeneutic Phenomenology in Restoring the Centrality of Experiences in Work-integrated Learning. *International Journal of Work-Integrated Learning*, 19(3), 261–271. <https://files.eric.ed.gov/fulltext/EJ1196747.pdf>
- Suryadi, D. (2019a). *Landasan Filosofis Penelitian Desain Didaktis (DDR)*. Pusat Pengembangan DDR Indonesia.
- Suryadi, D. (2019b). *Penelitian Desain Didaktis (DDR) dan Implementasinya*. Gapura Press.
- Tan, H., Wilson, A., & Olver, I. (2009). Ricoeur's Theory of Interpretation: An Instrument for Data Interpretation in Hermeneutic Phenomenology. *International Journal of Qualitative Methods*, 8(4), 1–15. <https://doi.org/10.1177%2F160940690900800401>
- Ulfa, N., Jupri, A., & Turmudi, T. (2021). Analisis Hambatan Belajar pada Materi Pecahan. *Research and Development Journal of Education*, 7(2), 226. <https://doi.org/10.30998/rdje.v7i2.8509>
- Umbara, U., & Suryadi, D. (2019). Re-interpretation of Mathematical Literacy Based on the Teacher's Perspective. *International Journal of Instruction*, 12(4), 789–806. <https://doi.org/10.29333/iji.2019.12450a>
- Upu, A., Taneo, P. N. L., & Daniel, F. (2022). Analisis Kesalahan Siswa dalam Menyelesaikan Soal Cerita Berdasarkan Tahapan Newman dan Upaya Pemberian Scaffolding. *Edumatica: Jurnal Pendidikan Matematika*, 12(1), 52–62. <https://online-journal.unja.ac.id/edumatica/article/view/16593/13261>
- Wilk, V., Soutar, G. N., & Harrigan, P. (2019). Tackling Social Media Data Analysis: Comparing and Contrasting QSR NVivo and Leximancer. *Qualitative Market Research: An International Journal*, 22(2), 94–113. <https://doi.org/http://dx.doi.org/10.1108/QMR-01-2017-0021>
- Yulika, R., Rahman, U., & Sewang, A. M. (2019). The Effect of Emotional Intelligence and Learning Motivation on Student Achievement. *South African Journal of Education*, 39(1), 1–8. <https://doi.org/10.2991/icamr-18.2019.94>
- Zhang, X., Clements, M. A. K., & Ellerton, N. F. (2014). Conceptual Mis(understandings) of Fractions: From Area Models to Multiple Embodiments. *Mathematics Education Research Journal*, 27(2), 233–261. <https://doi.org/10.1007/s13394-014-0133-8>