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Learning Obstacles of Prospective Madrasah Ibtidaiyah Teachers in Set Theory: A Praxeology Theory Review

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ABSTRACT

The identification of learning barriers is conducted to diagnose various problems encountered in learning so that the learning process becomes optimal. Set theory is one of the essential topics in the Basic Mathematics Concepts course taken by prospective Madrasah Ibtidaiyah teachers in the early semester. This study aims to identify and describe the learning barriers of prospective Madrasah Ibtidaiyah teachers in set theory based on praxeology theory. The approach used in this study is qualitative with a case study method. The participants of this study consisted of 37 prospective Madrasah Ibtidaiyah teacher education students from a teacher education institution in Pekanbaru, Riau, Indonesia. Data collection techniques used triangulation, consisting of tests and interviews. Based on the results of the analysis of students' answers and in-depth interviews, learning barriers in set theory were found, including ontogenic, didactic, and epistemological barriers. These learning barriers can be seen from students' limited knowledge, ranging from understanding set concepts, set operations, to set problem solving. These three types of learning barriers can serve as a reference for lecturers in designing didactic strategies that can minimize the learning barriers of prospective teachers in learning basic mathematics concepts, particularly in set theory.

Keywords: Learning Obstacles, Praxeology, Set Theory, Basic Mathematics Concepts.

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INTRODUCTION

Mathematics cannot be separated from human life because almost all fields of life involve mathematical concepts (Agustiawan, E., & Faradiba, S. S. (2023). Hambatan belajar mahasiswa pada materi himpunan di masa pandemi. *Histogram: Jurnal Pendidikan Matematika, 7*(1), 57–68. https://doi.org/10.31100/histogram.v7i1.2468

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One of the mathematics topics studied at the university level is set theory. This topic is usually included in the Basic Mathematics Concepts course taken by students in the early semesters. Set theory is highly important in mathematics because it is a fundamental concept and serves as the foundation for various higher-level mathematical concepts (Dahlan, J. A., Prabawanto, S., Bariyah, N., & Nti, S. J. (2025). *The mechanism of didactical obstacles in the Pythagorean theorem: From visual rigidity to procedural failure*. Jurnal Pendidikan MIPA, 26(4), 2495–2517. https://doi.org/10.23960/jpmipa.v26i4.pp2495-2517

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Ferreiros, J. (2007). Set theory is frequently encountered in everyday life, for example in grouping certain objects, determining elements of a set that represent intersections or unions of objects, and so forth (

Gueudet, G., Doukhan, C., & Quéré, P.-V. (2022). *Teaching mathematics to non-specialists: A praxeological approach*. In *Proceedings of the Fourth Conference of the International Network for Didactic Research in University Mathematics (INDRUM 2022)*. Leibnitz Universität Hannover. https://hal.science/hal-04027124

Hardman, D., & Hutchinson, P. (2025). *Praxeological analysis: A new qualitative methodology*. *International Journal of Qualitative Methods, 24*, 1–14. https://doi.org/10.1177/16094069251333894

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Jatisunda, M. G., Hoon, T. S., Jamilah, J., & Rohimatunissa, D. (2025). Praxeological analysis of junior secondary students' epistemological obstacles in algebraic operations. *Journal of Research and Advances in Mathematics Education, 10*(4), 218–230. https://doi.org/10.23917/jramathedu.v10i4.13374

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Manurung, M. L. et al. (2023); Sukirwan et al. (2022).

The importance of set theory is inseparable from the various problems encountered in learning it. One of the problems identified is learning barriers. Learning barriers may occur in set theory, including didactic, epistemological, and ontogenic barriers. One theory that can be used to reveal learning barriers is praxeology. Praxeology originates from Ancient Greek, namely praxis and logos. In the praxis component, two praxeology components are used to identify learning barriers, namely the type of task and technique. Furthermore, in the logos component, the other two praxeology components used are technology and theory (Hitier & González-Martín, 2025). Praxeological analysis combines the observation of real-life situations with conceptual clarification through language. This approach is considered capable of helping researchers understand human phenomena more deeply without being trapped in theoretical reductionism or abstract explanations (Hardman & Hutchinson, 2025). Furthermore, praxeology theory views teaching activities not merely as the delivery of content, but as a planned process involving the formulation of objectives, the selection of methods, the implementation of instruction, evaluation, and continuous improvement (Rashidova, 2025).

Several previous studies have examined learning obstacles in set theory. For instance, Nurtini et al. (2019) identified students' errors in understanding basic set concepts and symbols. Lestari et al. (2022) found that students experienced difficulties in determining relationships between sets and performing set operations. Tsara Aulia et al. (2022), Agustiawan & Faradiba (2023); AG, Waliana & Permana (2023) revealed the presence of epistemological obstacles in understanding set notation. Dian Purnama et al. (2023), Kadita, Husaeni, & Arifin (2024) reported that students' errors frequently occurred in representing sets, while Hendriyanto et al. (2024) highlighted didactical obstacles caused by limited variation in teaching strategies. Additionally, Sukirwan et al. (2022) and Manurung et al. (2023) emphasized the importance of real-life contexts in understanding set concepts.

However, these studies have predominantly focused on students at the elementary and secondary school levels. Research that specifically investigates learning obstacles among university students, particularly prospective Madrasah Ibtidaiyah teachers, remains limited. In fact, as future educators, these students are expected to possess strong conceptual understanding in order to effectively teach mathematics. This limitation indicates a clear research gap that needs to be addressed.

This study is important as it aims to identify and analyze the learning obstacles experienced by prospective teachers in set theory using a praxeological approach. The findings of this study are expected to contribute to overcoming difficulties in understanding fundamental mathematical concepts among prospective teachers and to provide a basis for designing more effective and appropriate instructional strategies.

Therefore, the objective of this study is to identify the types of learning obstacles experienced by prospective Madrasah Ibtidaiyah teachers in set theory based on praxeological analysis (*type of task*, *technique*, *technology*, and *theory*). The novelty of this study lies in its focus on prospective teachers at the university level and the comprehensive use of the praxeological framework to analyze learning obstacles, which has not been widely explored in previous studies.

METHOD

The approach used in this research is a qualitative approach, while the method used is a case study. A number of 37 prospective Madrasah Ibtidaiyah teacher students who took the Basic Mathematics Concepts course in the odd semester of the 2025/2026 academic year appointed as a participant in the research. To analyze student learning barriers, two types of instruments were used, namely test and non-test instruments. The test instrument given to students was in the form of test questions on the set material, totaling 12 questions with the type of essay questions. The non-test instrument used was in-depth interviews, which were used to reconfirm the students' answers that had been obtained from the test questions. This was done to further identify the learning obstacles experienced by students. The Miles and Huberman model was chosen as the existing analysis model, in which this model has three stages of data analysis, namely: 1) data reduction, at this stage the researcher recorded all student responses in answering test questions related to the Set material; 2) data presentation, at this stage all responses given by students were classified, to further identify what difficulties they experienced; and 3) drawing conclusions, at this stage the researcher had classified and concluded and analyzed the types of student learning obstacles on the Set material based on theories about learning barriers (Faizti, N. (2023).

RESULT AND DISCUSSION

After obtaining the average score of students who experienced difficulties in each question number, an analysis was then carried out by describing the number of students who experienced difficulties as seen from the previously determined components of the difficulty aspects. This analysis was then followed by determining the percentage of students who experienced difficulties in each aspect. Overall, the researchers observed that difficulties were almost evenly distributed across the aspects of concepts, procedures, and problem solving. The following description provides information on the difficulties experienced by students based on the sources of the problems related to set theory.

Table 1. Recapitulation of Student Difficulties in Each Aspect

N = 30	Concepts of Sets	Procedures of Set Operations	Problem Solving
Number of Items	4	5	3
Mean	71%	74%	90,33%
Median	72	78	92
Standard Deviation	22,32	13,19	5,69

Table 1 shows that problem-solving is the most challenging aspect experienced by students, at 90.33%. This aspect is the application of two other aspects: understanding the concept of sets and arithmetic procedures on sets. Furthermore, set operations procedures are in second place, at 72.92%, and 59% of the difficulties relate to the initial introduction of the concept of sets.

1. Basic Understanding of Set Concepts

Based on the data processing results, it can be seen that 71% of students experienced difficulties in understanding the basic concept of sets. This is evident from the relatively large standard deviation value, namely 22.32. The very significant differences between each indicator are the cause of this condition. This data can be seen in Table IV.2 below.

Table 2. Fulfillment of Indicators in the First Difficulty Aspect

Indicator	Item Number	Amount of Students Meeting the Indicator	Percentage
Unable to represent sets using tabulation	1a	25	68
Unable to represent sets using set builder notation	1b	28	76
Unable to write set elements from various forms of representation	2a	16	43
Unable to identify relationships between sets	2b	38	97

Based on Table 2, it can be stated that many students were still able to write set elements from various forms of representation. The answer to the question that asks students to state the relationship between sets occupies the position with the highest difficulty rating in this aspect (see Figure 1).

Pay attention to the following presentations of sets:

$P = \{x \mid x < 7, x \in A\}$

Q = {odd number less than 10}

R = {the first five letters of the alphabet}

$S = \{x \mid 1 \leq x \leq 6, x \in C\}$

Determine the relationships among these sets.

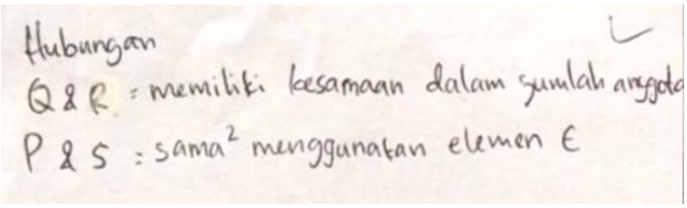


Figure 1. Answer of Subject 1

Subject 1 was able to identify similarities between two sets by observing the number of elements, but was unable to specify the relationship between the sets. The subject also noticed the same symbol used in sets P and S, whereas the question required determining the relationship between two sets, namely subset, intersecting sets, empty sets, equal sets, and equivalent sets. Subject 1 explained their reasoning as follows:

Researcher : "I would like to ask about your answer to question number 2b. What does question 2b ask?"
Subject 1 : "Determine the relationships between the sets."
Researcher : "And what was your answer?"
Subject 1 : "Sets Q and R have the same number of elements, and sets P and S both use the symbol ∈ (element)."
Researcher : "So, what is the relationship between the two sets?"
Subject 1 : "If I am not mistaken, the sets are equal."
Researcher : "Yes, correct. What are the conditions for two sets to be considered equal?"
Subject 1 : "If they have the same number of elements."
Researcher : "Yes, and then?"
Subject 1 : "That is all I know."

The subject assumed that any sets with the same number of elements are equal sets, whereas there is another condition, namely that the elements of the sets must also be the same. If only the number of elements is the same but the elements are different, then the relationship between the two sets is equivalent. This indicates that students still have limited knowledge in comparing and determining relationships between sets. As many as 97% of students experienced difficulties with this item.

The second highest error occurred when students were asked to represent sets using set builder notation (see Figure 2).

Given the following sets:

A is the set of integers between -4 and 4
P is the set of letters forming the word "matematika"

Represent both sets using:
set builder notation

As many as 76% of students answered this question incorrectly, meaning that only 9 out of 37 students answered correctly. In this case, students were still influenced by the previous question, where they were asked to represent sets using tabulation. Students assumed that representing sets could only be done using tabulation.

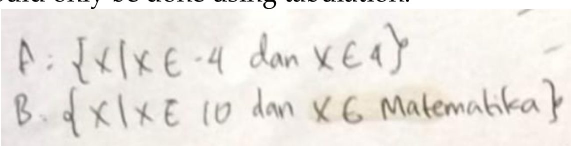
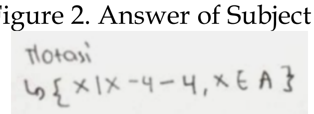


Figure 2. Answer of Subject 2



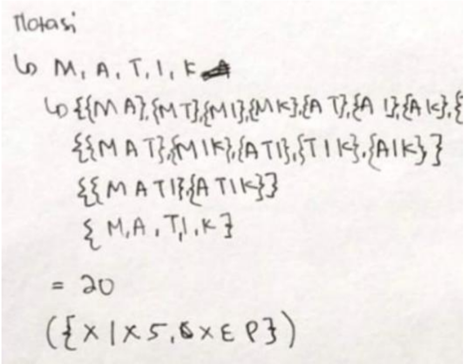


Figure 3. Answer of Subject 3

The answers of Subjects 2 and 3 showed attempts to represent sets using set builder notation, but they were not correct. These students did not understand inequality symbols to express the constraints of set elements. They also did not understand how to represent membership of a set to determine the universal set. Based on the overall analysis of answers, students did not yet understand how to represent sets using set builder notation due to their limited understanding. Furthermore, difficulties in representing sets using tabulation were also experienced by most of the students. This can be seen in Figure 4 below.

Given the following sets:
A is the set of integers between -4 and 4
P is the set of letters forming the word "matematika"

Represent both sets using:
tabulation

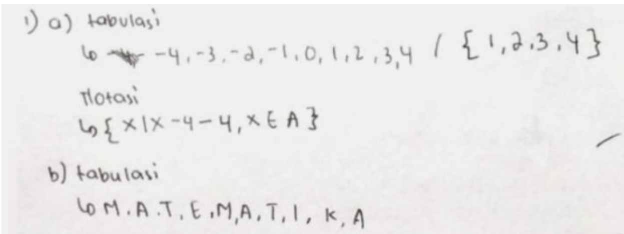


Figure 4. Answer of Subject 4

Subject 4 represented the sets using tabulation but did not use curly brackets and was also incorrect in listing the elements. In the first set, -4 and 4 should not be included as elements because the question stated that the integers are between -4 and 4. Therefore, the set elements should range from -3 to 3. Next, in the second set, Subject 4 listed all letters in the word "matematika" as set elements. In fact, letters that appear more than once in the word should only be listed once. This misunderstanding is also suspected to be due to students' limited understanding of how to represent sets using tabulation.

The results of the study describes that at least there is 71% of students experienced obstacles in understanding set concepts, particularly in representing sets using set builder notation, determining relationships between sets, and writing set elements from various forms of representation. The most dominant error occurred in the indicator of determining relationships between sets, where students were unable to accurately distinguish among the concepts of subsets, equivalent sets, and intersecting sets.

Theoretically, these barriers indicate the presence of epistemological obstacles, namely limitations in students' understanding of the conceptual meaning of a mathematical object rather than merely its procedures. Michèle Artigue (2018) states that epistemological obstacles are learning difficulties that originate from prior knowledge which was once correct, but is no longer appropriate in a new context. Utami et al. (2022) also emphasize that epistemological obstacles may occur due to students' limited knowledge, which is restricted only to what is explained by the teacher. This condition is consistent with the findings of Dahlan, J. A., Prabawanto, S., Bariyah, N., & Nti, S. J. (2025). *The mechanism of didactical obstacles in the Pythagorean theorem: From visual rigidity to procedural failure*. Jurnal Pendidikan MIPA, 26(4), 2495–2517. https://doi.org/10.23960/jpmipa.v26i4.pp2495-2517

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Dian Purnama, S., Fadillah, S., & Jamilah. (2023), which state that students and university students often experience misconceptions in set concepts due to learning that overemphasizes memorization of symbols and definitions without relational meaning. Several errors that commonly occur in problem solving include procedural, interpretative, conceptual, and formulation errors. However, the most dominant type is procedural error (López-Martín et al., 2019). Similar findings were also reported by

Gueudet, G., Doukhan, C., & Quéré, P.-V. (2022). *Teaching mathematics to non-specialists: A praxeological approach*. In *Proceedings of the Fourth Conference of the International Network for Didactic Research in University Mathematics (INDRUM 2022)*. Leibnitz Universität Hannover. https://hal.science/hal-04027124

Hardman, D., & Hutchinson, P. (2025). *Praxeological analysis: A new qualitative methodology*. *International Journal of Qualitative Methods, 24*, 1–14. https://doi.org/10.1177/16094069251333894

Hendriyanto, A., Suryadi, D., Dahlan, J. A., & Juandi, D. (2023). Praxeology review: Comparing Singaporean and Indonesian textbooks in introducing the concept of sets. *EURASIA Journal of Mathematics, Science and Technology Education, 19*(2), em2229. https://doi.org/10.29333/ejmste/12953

Hendriyanto, A. et al. (2024). The didactic phenomenon: Deciphering students' learning obstacles in set theory. Journal on Mathematics Education, 15(2), 517–544. http://doi.org/10.22342/jme.v15i2.pp517-544.

Hitier, M., & González-Martín, A. S. (2025). *Using knowledge from mechanics to solve a calculus task: A study through the lenses of mixed praxeologies*. In *Proceedings of the Fourteenth Congress of the European Society for Research in Mathematics Education (CERME14)*. Free University of Bozen-Bolzano; ERME. https://hal.science/hal-05237842

Jatisunda, M. G., Hoon, T. S., Jamilah, J., & Rohimatunissa, D. (2025). Praxeological analysis of junior secondary students' epistemological obstacles in algebraic operations. *Journal of Research and Advances in Mathematics Education, 10*(4), 218–230. https://doi.org/10.23917/jramathedu.v10i4.13374

Kadita, D., Husaeni, H., & Arifin, F. (2024). Analisis kesulitan belajar dan solusinya terhadap mata pelajaran matematika materi himpunan pada siswa. *Buana Matematika: Jurnal Ilmiah Matematika dan Pendidikan Matematika, 15*(2), 113–130.

Lestari, I., Rosyana, T., & Zhanty, L. S. (2022), who found that conceptual difficulties arise because students are unable to connect different representations of sets, including verbal, symbolic, and visual forms.

In the context of praxeology, students have not yet mastered the logos component, particularly technology and theory, so the techniques they use are not based on solid conceptual understanding. This is based on the Anthropological Theory of the Didactic (ATD), which views learning as a human activity within social and institutional contexts, rather than merely as the transfer of knowledge Yves Chevallard (2019). Therefore, learning about sets at the university level needs to be directed toward strengthening conceptual meaning through multiple representations, conceptual discussions, and exploration of examples and non-examples.

2. Procedures of Set Operations

In this aspect, there are five questions used to diagnose whether students understood the procedures of set operations based on five indicators, with the aim of identifying whether students experienced difficulties in operating procedures on Sets aspect. The results show that, on average, 74% of students experienced difficulties in this aspect, with 86% of students being unable to determine the number of elements in the union of sets based on a diagram, followed by 84% of students who were unable to determine the number of elements in the intersection of sets based on a diagram. This can be seen in Table 3 below.

Table 3. Fulfillment of Indicators in the Second Difficulty Aspect

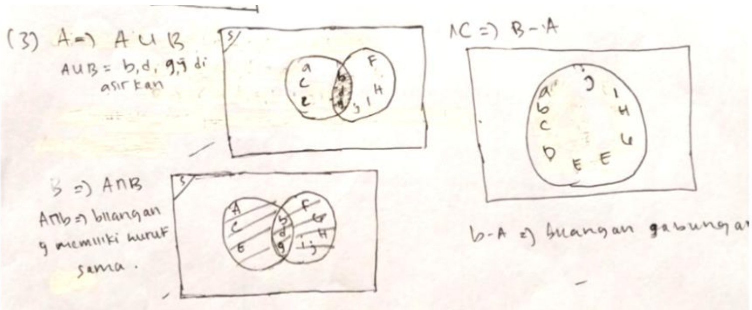
Indicator	Item Number	Amount of Students Meeting the Indicator	Percentage
Unable to perform union operations on sets	3a	20	54
Unable to perform intersection operations on sets	3b	25	68
Unable to perform subtraction operations on sets	3c	27	78
Unable to determine the number of elements in the intersection of sets based on a diagram	4a	31	84
Unable to determine the number of elements in the union of sets based on a diagram	4b	32	86

Based on the analysis of student answers, it can be seen that the majority of students do not yet understand arithmetic operations on sets. The greatest difficulty lies in union operations (84%) and intersection operations (84%). In fact, even for simple intersection and union operations between two sets, some students still provide correct answers. However, when given more complex problems, for example, by providing a combination of images and algebraic operations, students begin to become confused and experience difficulties in solving the problem. Figure 5 below shows some of the students' answers in this aspect.

Given: S={a,b,c,d,e,f,g,h,i,j}
A= {a,b,d,e,g}
B={b,d,g,h,i,j}

Determine the elements and draw the Venn diagram of:

a. $A \cup B$
b. $A \cap B$
c. $B - A$



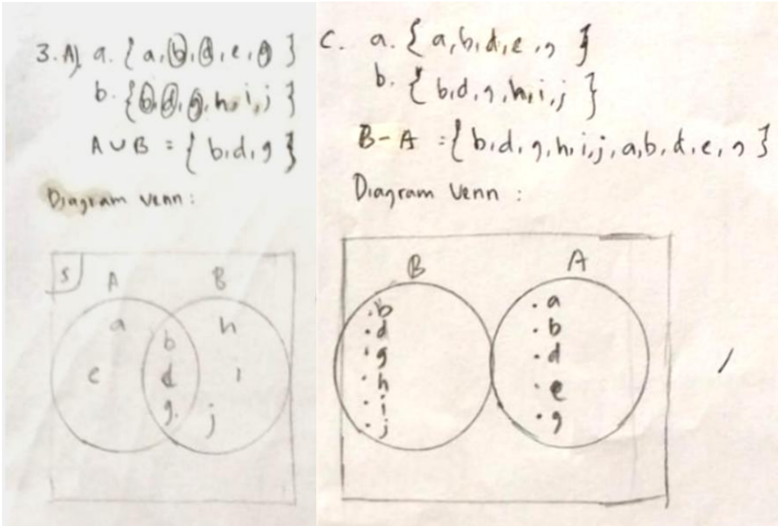


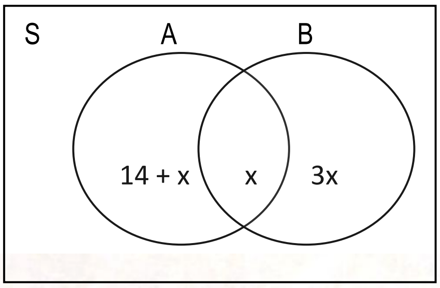
Figure 5. Answers of Subject 5 and Subject 6

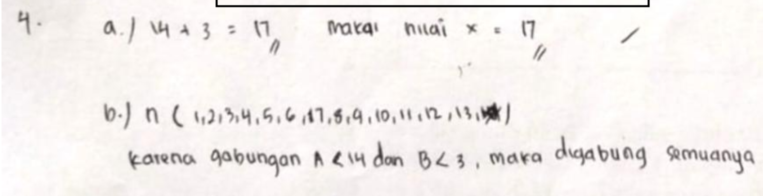
The answers of Subjects 5 and 6 show that they were not yet able to distinguish between intersection and union operations on sets. It can be seen that both subjects reversed the set operations, where the intersection was treated as a union and vice versa. The figure also shows that Subject 6 did not fully understand the subtraction operation on sets. From the answer, the student assumed that subtraction in sets is the same as the union operation. Similar errors were also found when students answered questions about intersection and union operations using the variable x, where the variable was unknown. This can be seen in the following question and figure.

Two sets and the number of elements in each set are shown in the following Venn diagram. If n(A) = n (B), determine:

a. The value of x

b. n(A ∪ B)





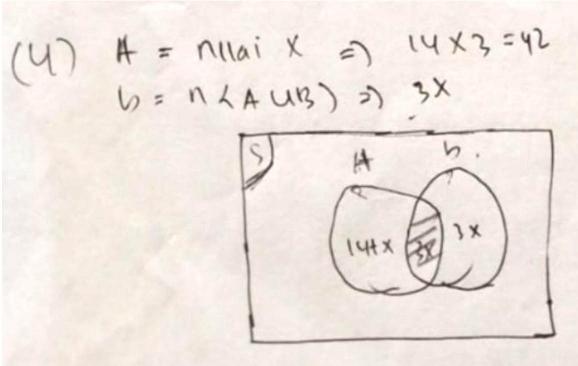


Figure 6. Answers of Subject 7 and Subject 8

Similar to the answer of Subject 7, Subject 8 was also unable to determine the value of x required in the problem. As a result, they were also unable to determine the number of elements in the union of sets A and B. This occurred because the students' understanding of intersection and union operations on sets was incomplete. Therefore, when given modified problems involving set operations, they were unable to solve them.

Most students still experience a lack of understanding of the concept of arithmetic operations on sets. On average, a number of 74% of students had not yet fully understood this concept, although some had partially understood the procedures of set operations.

In the aspect of set operation procedures, more than 70% of students experienced difficulties, particularly in determining the number of elements in unions and intersections of sets based on Venn diagrams. A common error was directly applying numerical operation rules to set operations without understanding the characteristics of sets as mathematical objects.

These findings indicate the presence of didactic obstacles, which are presumed to arise from prior learning experiences that emphasized mechanistic procedures without sufficient visual and contextual understanding. Didactical obstacles may also occur due to the unsystematic sequencing of material presentation and tasks, which can hinder students' learning processes (Yunianta et al., 2023). Furthermore, Dahlan et al. (2025) state that didactical obstacles can arise from monotonous and unsystematic material presentation, causing students to become accustomed to memorizing procedures explained by lecturers or presented in textbooks. These results are consistent with the findings of

Gueudet, G., Doukhan, C., & Quéré, P.-V. (2022). *Teaching mathematics to non-specialists: A praxeological approach*. In *Proceedings of the Fourth Conference of the International Network for Didactic Research in University Mathematics (INDRUM 2022)*. Leibnitz Universität Hannover. https://hal.science/hal-04027124

Hardman, D., & Hutchinson, P. (2025). *Praxeological analysis: A new qualitative methodology*. *International Journal of Qualitative Methods, 24*, 1–14. https://doi.org/10.1177/16094069251333894

Hendriyanto, A., Suryadi, D., Dahlan, J. A., & Juandi, D. (2023). Praxeology review: Comparing Singaporean and Indonesian textbooks in introducing the concept of sets. *EURASIA Journal of Mathematics, Science and Technology Education, 19*(2), em2229. https://doi.org/10.29333/ejmste/12953

Hendriyanto, A. et al. (2024), who reported that learning about sets with minimal use of Venn diagram representations and contextual problems tends to produce recurring procedural errors.

Research by Dahlan, J. A., Prabawanto, S., Bariyah, N., & Nti, S. J. (2025). *The mechanism of didactical obstacles in the Pythagorean theorem: From visual rigidity to procedural failure*. Jurnal Pendidikan MIPA, 26(4), 2495–2517. https://doi.org/10.23960/jpmipa.v26i4.pp2495-2517

Daswarman, D. (2020) also shows that prospective teacher students often make errors in set operations due to weak understanding of relationships between sets, which should form the basis for determining intersections, unions, and complements. Therefore, strengthening the procedures of set operations needs to be developed through visual approaches, concrete modeling, and problem-posing activities so that students construct procedures based on understanding rather than memorization. Students are often able to solve problems procedurally correctly, but are unable to explain the underlying mathematical reasoning (Jatisunda et al., 2025).

3. Problem Solving

In this aspect, three common problems related to sets are presented to identify student difficulties. The questions require students to model everyday problems using appropriate concepts and procedures for operating on sets. Analysis revealed that 90.33% of students still experienced difficulties, as shown in Table 4 below.

Table 4. Fulfillment of Indicators in the Third Difficulty Aspect

Indicator	Item Number	Amount of Students Meeting the Indicator	Percentage
Unable to represent an everyday life problem into a Venn diagram	5a	31	84
Unable to solve an everyday life problem related to set intersection operations	5b	34	92
Unable to solve an everyday life problem related to set union operations	5c	35	95

Based on the three problems presented, it was found that the majority of students experienced difficulties in each indicator. The greatest difficulty was found in the third indicator, at 95%, where students were unable to solve everyday problems related to combined operations on sets. For the other two indicators, students also experienced difficulties with percentages almost as large as the third indicator. This is confirmed by the student responses in Figure 7 below.

Out of 60 students, 20 like meatballs, 46 like siomay, and 5 like neither. Then determine:

a. Draw the Venn diagram!

b. How many students like both?

c. How many students like only meatballs and only siomay?

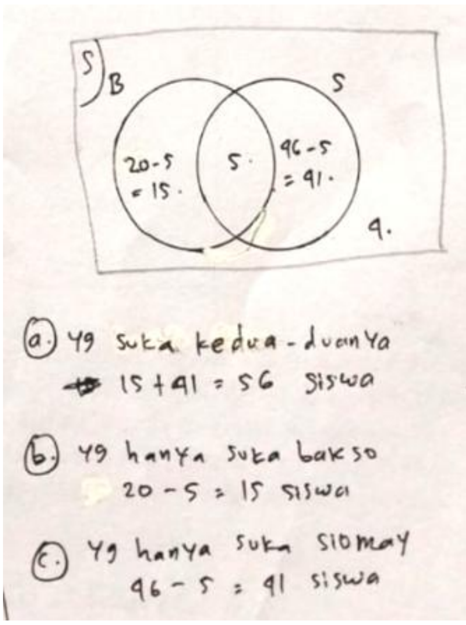


Figure 7. Answer of Subject 9

Subject 9 attempted to solve the problem by representing it in a Venn diagram and then determining the number of students as requested. However, when placing the numbers in the Venn diagram, the student made an error by putting a number in the wrong region. In the problem, the number 5 represents students who like neither option, so it should have been written outside the circles rather than in the intersection. This mistake led to a chain of errors in the subsequent solution steps. Subject 9, along with almost all students, experienced confusion when confronted with this type of problem-solving task. Based on the findings, 33 students (90.33%) still did not understand this type of problem and had difficulty finding solutions. Of the total students, only a small percentage did not experience any difficulties. Meanwhile, the majority of students were unable to grasp the basic concepts of sets, perform operations on sets, or represent solutions to problems related to sets.

The main objective of this research is to identify learning obstacles experienced by prospective Madrasah Ibtidaiyah teachers in set theory, viewed from aspects of conceptual understanding, procedures of set operations, and problem solving. The results show that learning obstacles are still experienced by most students across all three aspects, with the highest level of difficulty found in problem solving, followed by procedures of set operations and understanding of basic set concepts. These findings emphasize that although the respondents are prospective teachers, mastery of basic mathematical concepts still requires serious reinforcement.

The problem-solving aspect represents the greatest obstacle, with more than 90% of students experiencing difficulties in representing contextual problems into Venn diagrams and solving word problems involving set operations.

This condition indicates the presence of ontogenetic obstacles, namely limitations in students' cognitive readiness to integrate concepts and procedures into new situations. Chandra et al. (2025) argue that ontogenic obstacles may occur due to the unsystematic sequencing of material or its incompatibility with students' cognitive development. Students tend to be able to solve routine problems but fail when faced with contextual problems that require mathematical modeling. This finding is consistent with the study by Tsara Aulia, N., Ariyanto, L., & Hery Murtianto, Y. (2022), which states that difficulties in problem solving on set topics are closely related to low levels of mathematical representation and reasoning skills.

A recent study by Nursanty, N et al., (2025) also confirms that the problem-solving ability of prospective teacher students is strongly influenced by the quality of problem-based learning they receive. When lectures are dominated by expository teaching and routine exercises, students are less trained to model real-life situations into mathematical forms. This is in line with the view of Manalo (2025), who argues that mathematics educators also need to incorporate real-life contexts into learning. The praxeological approach helps explain how lecturers design learning strategies that are appropriate to students' contexts (Gueudet, Doukhan, & Quéré, 2022). In mathematics learning, reflective discussions should be developed and students should be involved in the instructional design process (Mensah, 2025). Furthermore, a mathematics educator must be able to make decisions based on theory, experience, context, and students' needs (Pansell, 2023).

Therefore, the results of this study reinforce the urgency of implementing problem-based learning, representation-based learning, and conceptual scaffolding so that prospective teacher students not only master concepts but are also able to teach them meaningfully at the Madrasah Ibtidaiyah and elementary school levels.

The novelty of this study lies in its focus on prospective Madrasah Ibtidaiyah teachers and the use of a praxeological framework to analyze learning obstacles comprehensively. Unlike previous studies that primarily examined students at the school level, this research reveals that similar learning obstacles persist at the university level.

This study contributes theoretically by enriching the application of praxeology in mathematics education, particularly in identifying the interplay between *praxis* (task and technique) and *logos* (technology and theory). Practically, the findings provide insights for lecturers to design instructional strategies that emphasize conceptual understanding, multiple representations, and problem-based learning.

The findings of this study have several important implications. From a practical perspective, lecturers need to implement instructional approaches such as problem-based learning, the use of visual representations (e.g., Venn diagrams), and conceptual scaffolding to enhance students' understanding. Academically, this study contributes to strengthening the theoretical framework of praxeology, particularly in analyzing learning obstacles in higher education contexts. In terms of policy, the results suggest that curriculum developers should place greater emphasis on developing conceptual understanding and problem-solving competencies within teacher education programs.

This study has several limitations. First, the sample size was relatively small (N = 30), which may limit the generalizability of the findings. Second, the study focused only on one mathematical topic (set theory), so the results may not represent learning obstacles in other mathematical domains. Third, the data were primarily based on written tests and interviews, which may not fully capture students' cognitive processes.

Future studies are recommended to expand the sample size and involve multiple universities in order to enhance the generalizability of the findings. In addition, further research should investigate learning obstacles across various mathematical topics to obtain a more comprehensive understanding. It is also important to develop and test instructional interventions based on the praxeological approach to effectively reduce learning obstacles. Moreover, future studies are encouraged to explore the integration of technology-based learning tools to support students' conceptual understanding and improve their problem-solving skills.

CONCLUSION

The conclusion that can be given based on the results of the research and discussion carried out is that it was found that students experienced obstacles with the type of epistemological, didactical, and ontogenetic learning obstacles in set theory. These obstacles manifest as limitations in students' knowledge, ranging from understanding set concepts, performing set operations, to solving set-related problems. In the aspect of conceptual understanding, most students have not yet fully mastered basic set concepts, particularly in expressing sets using various representations and determining relationships among sets. This obstacle indicates the presence of epistemological barriers, where students have not developed a complete conceptual understanding and still rely on memorization of definitions and symbols.

Furthermore, in the aspect of set operation procedures, many students experience difficulties in performing union, intersection, and difference operations, as well as in determining the number of elements in sets based on Venn diagrams. These obstacles indicate the presence of didactical barriers related to previous learning experiences that did not emphasize the interconnection between concepts, visual representations, and procedures. In the problem-solving aspect, obstacles appear most dominantly. Students are not yet able to appropriately represent contextual problems into mathematical models in the form of Venn diagrams and set operations. This condition indicates the presence of ontogenetic obstacles, namely limitations in students' cognitive readiness to integrate concepts and procedures to solve non-routine problems.

Insights into students' learning obstacles in set theory are very important for lecturers teaching in the PGMI study program, particularly in the Basic Mathematics Concepts course. These findings indicate that lecturers must be able to design appropriate learning designs using didactic situations that can minimize the possibility of learning obstacles in sets in subsequent lessons. This study's limitations lie in its focus on basic concepts and set operations alone. Therefore, further research on other materials is strongly recommended not only at the higher education level but also at the elementary school level. This study can also serve as a reference for further research, such as studies on appropriate didactical design for set theory, both with qualitative and quantitative approaches related to set theory in higher education and elementary schools.

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