



## The Most Common Students' Epistemological Obstacles in Relations and Functions

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### Abstract

Epistemological obstacles are obstacles that cannot be avoided by students. There are many epistemological obstacles experienced by students in understanding scientific knowledge. In this case, students experience cognitive constraints in understanding a learning topic, such as Relations and Functions. The topic of Relations and Functions is one of the important topics for learning further topics. However, there are still students who cannot understand this topic perfectly due to various epistemological obstacles they experience. Therefore, this study aims to describe the epistemological obstacles on the topic of relation and function. This study was qualitative research with 22 junior high school students who have studied the topic of relation and function. The results of this study are in the form of epistemological obstacles experienced by students, namely obstacles to understanding the concepts of relations and functions, obstacles to understanding the concepts of relations and functions in different contexts, obstacles to determining the domain, codomain, and range, and obstacles to presenting relations and functions to various representations. This research is expected to be used as a reference by teachers to minimize the occurrence of epistemological obstacles in the learning process. In addition, one of the efforts that can be made by teachers and researchers to minimize epistemological obstacle is by making Didactical Design Research (DDR) that supports the development of student knowledge epistemically.

**Keywords:** *Epistemological obstacle; relations; functions.*

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### Abstrak

*Hambatan epistemologis merupakan suatu hambatan yang tidak dapat dihindari oleh siswa. Terdapat banyak kendala epistemologis yang dialami oleh siswa dalam memahami pengetahuan ilmiah. Dalam hal ini, siswa mengalami kendala kognitif dalam memahami suatu materi pembelajaran, seperti Relasi dan Fungsi. Topic Relasi dan Fungsi merupakan salah satu topic penting untuk mempelajari topic-topic selanjutnya. Namun, masih terdapat siswa yang tidak dapat memahami topic ini dengan sempurna dikarenakan berbagai hambatan epistemologis yang dialaminya. Oleh karena itu, penelitian ini bertujuan untuk mendeskripsikan hambatan epistemologis pada topic relasi dan fungsi. Penelitian ini merupakan penelitian kualitatif dengan subjek berupa 22 siswa sekolah menengah pertama yang telah mempelajari topic relasi dan fungsi. Hasil penelitian ini berupa hambatan-hambatan epistemologis yang dialami oleh siswa yaitu hambatan memahami konsep relasi dan fungsi, hambatan memahami konsep relasi dan fungsi pada konteks yang berbeda, hambatan menentukan domain, kodomain, dan range, serta hambatan menyajikan relasi dan fungsi ke berbagai representasi. Penelitian ini diharapkan dapat digunakan sebagai acuan bagi guru untuk meminimalkan terjadinya hambatan epistemologis dalam proses pembelajaran. Selain itu, salah satu upaya yang dapat dilakukan oleh guru maupun peneliti untuk meminimalkan hambatan epistemologis yaitu dengan membuat Didactical Design Research (DDR) yang mendukung perkembangan pengetahuan siswa secara epistemic.*

## INTRODUCTION

Mathematics is the basic science for studying other sciences (Rahmah, 2013). Mathematics must be well understood by students to obtain other sciences easily. One of the most important topics in mathematics is Relations and Functions. Relations and functions are prerequisite topics for learning further topics, such as straight lines (Ramadan & Arfinanti, 2019). This topic is also very important in everyday life, such as categorizing components that have similarities into one group and calculating the amount of savings in a certain period.

Unfortunately, the topic of relations and Functions have not been able to understand the concepts of relation and function topics well. This imperfect understanding of the concept will result in students experiencing errors in solving problems about relations and functions. For example, students cannot distinguish between relations and functions (Anastasia et al., 2020) and students do not know about the concepts of domain, codomain, and range. This error could be caused by difficulties experienced by students. This difficulty is characterized by student obstacles in achieving learning outcomes (Pramesty, 2020). The condition of stu-

dents in this condition shows that students are not learning properly. Obstacles are difficulties experienced by students caused by didactical aspects, such as books (Suryadi, 2013).

According to Brousseau (2002), obstacles consist of three types, namely ontogenic obstacles, didactic obstacles, and epistemological obstacles. Ontogenic obstacles are obstacles that include student readiness before starting the learning process, didactic obstacles are obstacles caused by didactic factors such as books, and epistemological obstacles are obstacles experienced by students when solving problems from the topics studied.

Obstacles are very important for teachers and students to know. This is to minimize the potential difficulties that students will face. One of the obstacles that is important to know is epistemological obstacles. This obstacle occurs when students do not achieve knowledge because the information is not epistemic. This can be caused by the limited context used to learn the concept for the first time. Usually, this epistemological obstacle tends to rely on intuition. This obstacle can result in a decline in a person's knowledge (Suryadi, 2018).

Epistemological obstacle is also can be caused by the design of books that do not support students' thinking processes.

Thus, the focus of this research is to examine epistemological obstacles. Epistemological obstacles are obstacles that cannot be avoided by students. This is because this obstacle is contained in the concept of knowledge itself (Brousseau, 2002). Hercovics stated that there are many epistemological obstacles experienced by students in the development of scientific knowledge, where conceptual schemes in knowledge experience cognitive constraints (Setiawati, 2011). As in research by (Subroto & Suryadi, 2018) students experience obstacles in recognizing, building, and constructing abstract forms in mathematical material. students cannot use precise intuition to generalize. Epistemological obstacles are related to the nature of mathematical concepts (Dewi *et al.*, 2021). It is also (Cornu, 1991) statement that the occurrence of epistemology obstacles is due to the nature of the mathematical concepts themselves. One of the mathematical concepts that many students still cannot master is the concept of relation and function (Hutagaol *et al.*, 2022). Students are also unable to apply the concepts of relations and functions in solving problems related to these topics (Ilyanah, 2022). Students who cannot understand a topic clearly can have an impact on the next topic. Since mathematics is a continuous science, this will cause students to experience obstacles in the topics to be studied.

Several studies have been conducted to determine learning obstacles, especially epistemological obstacles, including Raudiyah and Suryadi (2023) states that students have limited context for the system of linear equations of two variables and students are unable to use the concept in certain contexts. Utami and Prabawanto (2023) examined that epistemological obstacles in mathematics occur because most students are still ac-

customed to the operational interpretation of mathematics that they learned at the previous level of education. In addition, there is also research by Nopriana *et al.* (2023) that examines epistemological obstacles in combinatorics material, namely students who have difficulty compiling mathematical sentences/models, determining the concepts of permutation and combination, finding solutions to questions that they have encountered before, and students experience misunderstanding of the rules of addition and multiplication. In addition, there is also research on epistemological obstacles on the topic of relations and functions, including (Rahmi & Yulianti, 2022) which presents epistemological obstacles, namely the definition of functions that students understand is not complete. Istiqomah (2015) also stated that students still cannot understand the concept of function well which is an epistemological obstacle. Epistemological obstacles are the most important obstacles in a topic. However, no research has focused on examining these obstacles on the topic of relations and functions, especially on students' understanding of the concepts of relations and functions and the differences between the two. In addition, it will also analyze students' epistemological obstacles in various representations of relations and functions. Therefore, the researcher wants to describe the obstacles experienced by students when learning the topic of relations and functions in the epistemological aspect.

## METHOD

This study was conducted on 22 students in a junior high school in Bandung City. The selection of these subjects was specific to students who had studied the topic of relation and function. In qualitative re-

search, the researcher is the first instrument. In addition, supporting instruments are test instruments in the form of 3 description questions about relation and function topic that have been validated by experts, and non-test instruments, namely interview guidelines.

The data in this study were collected through student ability tests on relation and function material followed by interviews with selected research subjects. The data were analyzed through three stages, namely data reduction, data presentation, and conclusion drawing (Miles et al., 2014). At the data reduction stage, the researcher summarizes the data that has been collected, focusing on important things. This is also to select the subjects to be interviewed. Next, the researcher compiled information in the form of epistemological obstacles experienced by students in relation and function material at the data presentation stage. Meanwhile, in the final stage, the researcher concludes based on the findings by linking the research questions with the data obtained. This research will present the epistemological barriers experienced by students in relation and function material, which can then be a reference for making didactical design research (DDR).

## RESULTS AND DISCUSSION

### Results

Based on the description test given to 22 junior high school students, the epistemological obstacles experienced by students in working on the test were obtained. The following will describe the epistemological obstacles in question number 1, question number 2, and question number 3.

### Question Number 1

1. Diberikan  $A = \{1,2,3,4\}$  dan  $B = \{1,2,3,4,5,6,7,8,9,10\}$ .
  - a. Buatlah suatu relasi yang menyatakan hubungan A dan B!  
Tentukan domain, kodomain, dan range dari relasi yang telah dibuat tersebut!
  - b. Buatlah suatu fungsi yang menyatakan hubungan A dan B!  
Tentukan domain, kodomain, dan range dari fungsi yang telah dibuat tersebut!

Figure 1. Question Number 1

In question number 1, students are unable to know and distinguish the set which is the domain, codomain, and range of a function. In addition, students also cannot distinguish between relations and functions. Students who experience this obstacle are student S8. The following student answers can be seen in Figure 2.

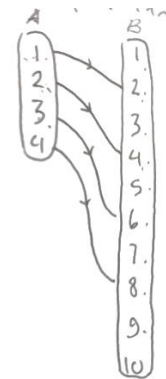


Figure 2. S8's Answer

In problem 1, student S8 was able to draw an arrow diagram showing the relationship from set A to set B. However, he was unable to determine the set that is the domain, codomain, and range of the function. This is by the results of the interview conducted with student S8. He did not understand the terms or names used in functions. In addition, he also could not distinguish between relations and functions. So, he could not determine whether the answer was a relation or a function.

Another student who experienced something like student S8 was student S10. The following is student S10's answer which can be seen in Figure 3.

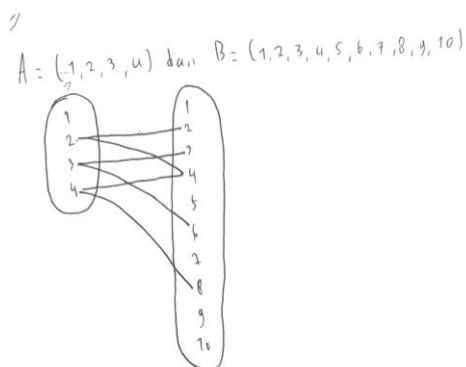


Figure 3. S10's Answer

From Figure 3, students cannot answer this question perfectly. The researcher interviewed student S10. From the interview, it was found that student S10 did not remember to write the direction of the arrow connecting the members of set A to set B. According to him, the arrow could not connect the members of set B to set A. According to him, the arrow could not connect the members of set B to set A. Student S10 could determine the domain, and codomain according to the arrow diagram he had drawn. However, he could not distinguish between relation and function. According to him, the answer he wrote was a relation answer. The student could not answer when he was asked about the possibility of a relation that could be a function. This is because students cannot distinguish the concepts of relation and function correctly.

Another student who experienced the same thing was student S22. The following answer can be seen in Figure 4.

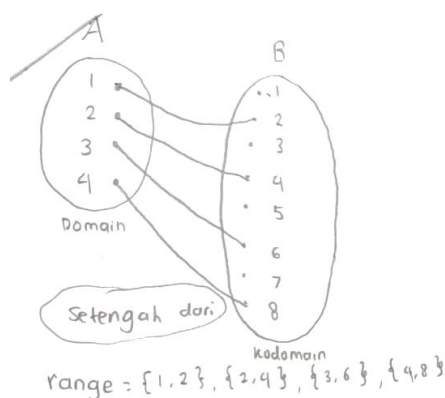


Figure 4. S22's Answer

In Figure 4, student S22 can write the domain, codomain, and range. However, there is still a mistake in writing the range. Based on the interview, student S22 knows that relation and function are two different things. According to him, the difference between the two is the different ways of calculating. In addition, the student also stated that in the picture of the relation, the direction of the arrow states the relationship of the members of set A to set B, and the relationship will not reverse from set B to set A. In other words, the direction of the arrow will always be from left to right.

### Question Number 2

2. Diberikan fungsi  $f(x) = 2x$ , dimana  $0 < x \leq 5$ ;  $x$  bilangan bulat.
  - a. Nyatakan fungsi tersebut dalam diagram panah!
  - b. Tentukan nama relasi dari rumus fungsi tersebut!

Figure 5. Question Number 2

In question number 2, some students could not determine the value of a function, or present a function using an arrow diagram, and some students could not define a relation from the function formula that had been given.

Students S1 and S5 could not answer question number 2. Based on the results of the interviews conducted, students S1 and S5 could not find the shadow of  $x$  based on the function that had been given. Students S1 and S5 said that they had seen similar problems, but the value of  $x$  was not given in interval form. So, he was confused to determine the value of  $x$  and the shadow of  $x$ .

S2 students can draw an arrow diagram in answer number 2. The following answer can be seen in Figure 6.

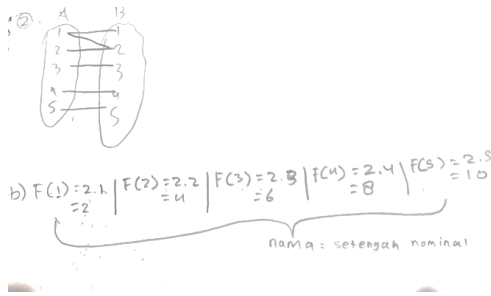


Figure 6. S2's Answer

From Figure 6, the student's answer in part A does not match the student's answer in part B. The researcher interviewed to explore students' understanding more deeply. Student S22 stated that the answers to part A and part B had no relationship with each other. However, in part B, he can determine the shadow of  $x$  and can determine the name of the relation from the given function formula.

Another student who experienced obstacles in solving problem number 2 was student S17. The following answer can be seen in Figure 7.

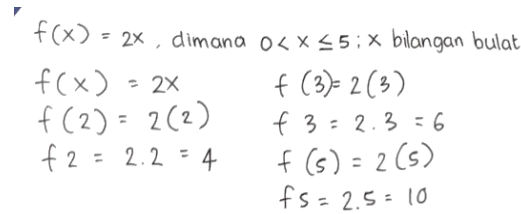
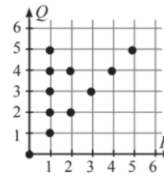


Figure 7. S17's Answer

In Figure 7, student S17 could not present the function in the form of an arrow diagram. Based on the interview conducted with student S17, he stated that he did not understand what he had to do to start presenting the function in the form of an arrow diagram. The researcher had tried to present an arrow diagram for student S17 to fill in, but he could not determine the members of the two sets on the arrow diagram. In addition, student S17 was also unable to determine the name of the relation from the function formula that had been given.

### Question Number 3

3. Perhatikan gambar berikut!



- Sajikan relasi tersebut dengan himpunan pasangan berurutan!
- Sajikan relasi tersebut dengan diagram panah!
- Tentukan nama relasi dari gambar di atas!

Figure 8. Question Number 3

In problem number 3, some students could not present the relation to other representations, namely arrow diagrams and ordered pairs, and students were also unable to determine the name of the relation that had been given.

Students S5 and S6 could not answer question number 3 for the same reason, namely, they could not understand the presentation of the relation into an arrow diagram and the set of consecutive pairs of a known cartesian diagram. Based on the interview with S5, he did not understand question number 3 so he did not answer. Meanwhile, student S6 did not respond to questions from the researcher. This is because he also did not understand question number 3.

In addition, some students experience obstacles in question number 3, namely student S8. He could not answer question number 3 and he also could not mention the ways of presenting relations and functions when he was interviewed. The same thing was also experienced by students S5, S6, S10, and S22. They also could not know at all about the ways of presenting relations and functions.

Apart from the obstacles discussed above, there is also another obstacle, namely students cannot determine the name of the relation in problem number 3. All students experienced this obstacle. Some can mention the name of the relation, but the answer is still wrong. Student S21 stated that the name of the relation

was "equal to more than". However, based on the results of the interview, Student S<sub>21</sub> stated that he had difficulty determining the name of the relation.

## Discussion

Epistemological obstacles are obstacles related to students' understanding of knowledge. On the topic of relations and functions, students can solve problems that have been given to them in the same context. However, when given problems with different contexts, students experience obstacles in solving them. This obstacle can be experienced by students when they experience limitations in understanding knowledge in certain contexts (Hidayah & Maemonah, 2022). This can mean that he can understand a piece of knowledge in the context of other problems.

Students' knowledge will be perfect when they can understand a concept well. Another epistemological obstacle is that students cannot understand the concepts of relation and function correctly. Understanding the concept of a topic is very important in learning. A good understanding of the concept allows students to solve problems about the concept even in different contexts. This is because students already have complete knowledge. Lithner (2011) and Tanjungsari *et al.*, (2012) which state that the difficulties experienced by students in solving mathematical problems are caused by students' difficulties in understanding mathematical concepts. Students' understanding of a concept tends to be due to students memorizing without understanding the concept correctly.

The next fact is that there are also students who are still unsure of their answers. They tried to validate the answer to the researcher. It shows that students do not have confidence in their own answers.

Knowledge as "justified true belief" is not applied by students. In this case, the knowledge possessed by students is not empirically constructed (Cleve & Bonjour, 1988). Students' lack of confidence in their answers is caused by their lack of understanding of the material, which can be in the form of basic knowledge of the material (Firda & Juandi, 2023).

Knowledge must be understood by students thoroughly. The imperfection of knowledge can make students experience obstacles. This can happen on the topic of relations and functions where students cannot determine the domain, codomain, and range correctly. A thorough knowledge can make students understand a concept more perfectly. By research (Kartikasari & Masduki, 2017) which states that students have difficulty in distinguishing the codomain and range. These two things tend to be considered the same by some students because they cannot understand the definition of codomain and range correctly.

Another epistemological obstacle is the use of arrows on the arrow diagram. Students always describe the direction of the arrow connecting the members of Set A to the members of Set B. The use of this arrow direction is due to the use of books that always describe arrow diagrams like these conditions. This epistemological obstacle can be caused by several factors, one of which is the use of textbooks in the learning process. The textbook used must support students' knowledge construction epistemically (Chevallard, 2006).

The use of textbooks greatly influences students' knowledge. The material presented is expected to be able to construct knowledge epistemically. However, the book used does not present the concepts of relations and functions perfectly. This is in accordance with (Utami, 2022) who state that the concepts of relations and functions presented in the book are

not epistemic.

Regarding representations of relations and functions, some students only know about one representation or two representations. Some students do not know the representation of relations and functions at all. This is by research Muzaiyana et al. (2021) which states that students' imperfect abilities cause students to be unable to express relations and functions to various representations.

In terms of presenting relations and functions, students' thinking processes are by Vygotsky's learning theory which states that students must start with what they have mastered to start learning (Vygotsky, 1978). Students must get used to repeating the thinking process at the same level to obtain a behavior change. In this study, students begin to solve the problems given with concepts they already know such as knowledge of number concepts, number intervals, and coordinate planes. The basic principle of learning mathematics is the knowledge that can be achieved by students themselves (Suryadi, 2019). In acquiring this knowledge, students try to confirm their answers by discussing and asking questions.

To support students' thinking processes, teachers should be able to build mathematical didactical situations. In the learning process, teachers can plan the learning process by starting to elaborate basic competencies into supporting and core indicators. In this finding, some students could not answer and differentiate relations and functions correctly. This is due to the gap between theory and practice because students lack practice (Brousseau, 2002).

Teachers must be able to create a learning process that supports students' thinking processes. This can be done by implementing active learning. In this ac-

tive learning, students are directly involved in acquiring knowledge, so that students experience directly. The process of experiencing that students go through is a characteristic of active learning that will be more meaningful to students (Fink, 2003). In addition, teachers must also select and sort out the material that will be delivered to students. Teachers must go through a transposition process by thinking about how the material will be conveyed to students and teachers also do not ignore the level of students' thinking abilities.

### **Implication of Research**

This research is expected to enrich the knowledge regarding the existence of student learning obstacles and as a reference for further relevant research. This research is also expected to be used as a reference content in designing and developing mathematics learning by considering students' learning obstacles.

### **Limitation**

The limitation of this article is that there is no didactical design research as an effort to minimize the occurrence of learning obstacles in students.

### **CONCLUSION**

Based on the results of the study, several epistemological obstacles experienced by students on the topic of relations and functions were obtained, namely students' obstacles in understanding the concepts of relations and functions, students' obstacles in understanding the concepts of relations and functions in different contexts, students' obstacles in determining the domain, codomain, and range, and students' obstacles in presenting relations and functions to various representations.



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