Larisa Teknik Sipil
Volume 1, Number 1, January 2024 pp. 1-7
P-ISSN: XXXX-XXXX | E-ISSN: XXXX-XXXX
Open Access:
Link https://ejournallarisa.academytlp.com/index.php/TeknikSipil

Learning Obstacle On Integral (Antiderivative) Material In Didactic Situation Theory

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ARTICLE INFO

Article history
Received: 2 January 2024
Revised: 15 January 2024
Accepted: 21 January 2024

Keywords: Integral, Learning Barriers, Didactic Situation Theorys

ABSTRAK

Tujuan dari penelitian ini adalah untuk mengidentifikasi hambatan pembelajaran yang dihadapi siswa Teknik dalam menyelesaikan masalah integral sebagai antiderivative. Penelitian tentang materi ini adalah bagian dari teori situasi didaktis, dan hasil penelitiannya sangat penting untuk digunakan sebagai dasar dalam desain didaktis DDR untuk meminimalkan hambatan belajar. Penelitian ini menggunakan metode deskriptif kualitatif dan sampelnya terdiri dari dua kelompok mahasiswa Teknik Sipil di Universitas Madura. Untuk kelompok pertama, yang terdiri dari lima siswa, dan kelompok kedua, yang terdiri dari sembilan siswa, instrument TKR pemahaman konsep integral digunakan untuk mendapatkan data penelitian. Kemudian, wawancara dilakukan untuk mendapatkan data tersebut. Hasil penelitian menunjukkan bahwa mahasiswa teknik menghadapi tantangan pembelajaran ontogenic, konseptual, dan epistemologis.

ABSTRACT

This research aims to identify the learning obstacles faced by engineering students in solving integral problems as antiderivatives. Research on this material is part of didactic situation theory, and the research results are very important to use as a basis for DDR didactic design to minimize learning obstacles. This research uses a qualitative descriptive method and the sample consists of two groups of Civil Engineering students at the University of Madura. For the first group, which consisted of five students, and the second group, which consisted of nine students, the TKR instrument for understanding integral concepts was used to obtain research data. Then, interviews were conducted to obtain this data. The research results show that engineering students face ontogenic, conceptual and epistemological learning challenges.

INTRODUCTION

Integrals were first introduced by Isaac Newton and Gottfried Leibniz in the 17th century. Integrals are very important in many fields, such as industry and science (Monariska, 2019a). In civil engineering, integrals usually help engineers and architects determine the size of buildings. a very important use for increasing energy efficiency by reducing water use (Madonna, 2014).

Most engineering students consider integrals to be difficult material. According to Setyawan & Astuti (2021), integrals are difficult for students to understand. Several relevant studies have investigated the issue. This research includes integral material (Fadillah et al., 2019; Monariska, 2019b) and other mathematical material. Students experience learning challenges, which is one of the

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causes of students' lack of understanding (Kurniawan et al., 2019; Sholekah et al., 2017; Sulistiawati et al., 2015; Susanti & Yulaida, 2015; Yulianti et al., 2021).

In integral learning, students often experience learning difficulties. Several studies also reveal this, such as Mahayukti et al., 2022; Maryono & Sholihah, 2022; Sudarman & Linuhung, 2017). This research looks at the learning difficulties of civil engineering students in studying integrals as antiderivatives using didactic situation theory which has never been studied before, considering how important and difficult this material is for students.

In DDR (Didactical Design Research), this learning challenge is part of epistemology. This finding is in line with research conducted by Prihandhika et al. (2020). Epistemology is concerned with the nature and form of knowledge, namely how knowledge is formed, collected and communicated.

One type of didactic situation theory study is learning challenges. According to Suryadi (2019), this is used as a basis for building or implementing didactical designs for DDR. In didactic situation theory, learning begins with action. External physical and mental stimuli drive action. This didactic situation is very important because it can provide opportunities for students who have perceptual knowledge and memory knowledge to carry out actions that produce understanding of the environment and actions about the environment using their previous experiences and knowledge (Suryadi, 2019). The encapsulation process for forming new mental objects will be easier to carry out in didactic situations (Dubinsky, 2014). In didactic situations, there can be different understandings of the interaction process between teachers and students. This can lead to claims, arguments, or representations that generate internal and external validation (Suryadi, 2019).

It is important to examine learning challenges to see problems and findings related to the discussions outlined previously. The aim of this research is to learn more about the types of learning challenges that Engineering students face when studying integrals (antiderivatives). In future research, the types of obstacles faced by students will be identified, so that appropriate didactic approaches can be created to reduce or even eliminate these obstacles.

METHOD

This research was conducted at Madura University and used descriptive qualitative research methods (Kim et al., 2017). The results will be used to create a didactic design for DDR. Civil Engineering students who are currently in their third semester and are developing calculus courses are the research subjects. This study involved two groups of students. The first group consisted of five students and was given an online integral concept understanding test; the second group consisted of nine students and were given an independent test of understanding integral concepts (Utari & Utami, 2020). This study uses the original Respondent Ability Test (TKR), which consists of three questions driven by the respondents themselves, based on the respondents' answers and explanations. TKR as a benchmark for identifying the types of learning challenges faced by Engineering students. On October 21 2022, TKR will be given to students who work on questions online and offline. Students who work on questions online do the questions within 60 minutes and collect the TKR results file via the Google Drive link. Students who work on questions offline do the questions within 90 minutes, because there are several obstacles, including student delays and unpreparedness to complete the assignment.

The initial TKR results are recorded and studied further to see students' learning challenges. In addition, in-depth interviews were conducted with students who have a tendency to face learning challenges, both from groups who carry out written TKR online and from outside (Carter et al., 2014).

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Subjects interviewed further included students who answered the written exam almost perfectly, students who answered but often got it wrong, and students who did not fill in the exam answers at all. Didactic situation theory is used to ask students to do something. According to interviews, students' learning challenges in integral learning are reviewed based on perceptual knowledge, experience and memory.

According to Alfansyur & Mariyani (2020), the triangulation method is used to carry out data analysis. This method reduces and presents observation information, test results and interviews in field notes, and produces conclusions.

RESULT AND DISCUSSION

Original TKR results can be obtained from the results of written tests and interviews which are used to explain student performance. Next, the interviewer was written P. The student as the first respondent answered TKR online R1, the second respondent R2, and the third respondent R3 answered TKR offline.

Didactic situation theory includes five steps: action, formulation, validation, and institutionalization (Fitriani et al., 2020). According to Suryadi (2019), didactic situation theory is an important component of DDR, which relies on two paradigms: interpretive and critical. The results of this research emphasize the interpretive aspect. In DDR, the relationship with epistemology emphasizes the knowledge that exists within a person and how they obtain it.

At this stage, students as respondents answer each problem using their memory knowledge. Students are given the opportunity to carry out interiorization in their mental actions to find ways to solve problems at the formulation stage. Interviewers also help students ensure that they use prior knowledge as the best way to approach problems. Finally, in the institutionalization stage, students answer problems by combining their previous knowledge with new knowledge. "What do you know about integrals?" is the first question asked during TKR.

R1 appears to have knowledge of integrals, although has not been answered in more detail. The results also showed that R1 lacked knowledge about integrals that he had studied in semester 2. R3 also wrote down knowledge about integrals, but not as detailed.

To clarify respondents' answers, the results of more in-depth interviews with the three respondents can be used to see the lessons learned from this challenge. Many factors can cause learning difficulties. The learning barrier consists of ontogenesis, pedagogy, and epistemology.

Based on the results of the interview with R1, it appears that students face challenges in learning ontogenesis. This challenge is related to learning material that is not in line with students' previous learning experiences. Without scaffolding, material that is too difficult will make students bored and not receive the lesson well (Rohana et al., 2019). On the other hand, material that is too easy will make students disinterested and disinterested in the lesson. R1 was able to explain after P did the scaffolding. Students' learning independence is still lacking because the material is not taught in class, so R1 may not be able to learn independently. Thus, the didactic design that will be made must be more basic in order to accommodate students like R1 who have not or tend to study integral material little before. This will ensure that students will get integral material as new knowledge as a whole even though they study independently (Suhendri, 2011).

The next discussion relates to the answer to question number 2 during TKR. Previously, the number question item read as follows: "Calculate it! (i) If $y = ax + b$, for $a, b \in R$ then $dy\,dx = \cdots$; (ii) $\int a\,dx$; and (iii) what do you understand about relationship between statements parts (i) and (ii)."

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In terms of the first respondent's answer, it appears that R1 had taken action and created the first problem, which enabled him to answer question number 2 well.

Because R2 does not remember the meaning of dy dx, as shown by the results of his written answer, R2 can answer question number 2 using previous knowledge, namely the keyword "derivative". R2 faces epistemological learning obstacles. Epistemological learning barriers are student learning barriers caused by students' limited understanding of the concepts of teaching material when they are first studied. This causes the overall process of understanding knowledge to be interrupted and disrupts students' system of acquiring new knowledge, which causes stagnation or decline in knowledge (Rosita et al., 2020). R2 has difficulty interpreting derivative notation, so it may be difficult to calculate integrals. Moreover, as opposed to antiderivatives in the case of TKR, they do not know the relationship between integrals.

Job & Schneider (2014) have investigated this type of barrier in the study of calculus. This shows how important it is for teachers to face the subject, know what students already know, and be able to create didactic situations so that the learning process runs well and attracts students' interest in learning (Fitriani et al., 2020).

Continue to question number 3 which reads: "Pay attention to the following integral formula! $\int x\,n\,dx = 1\,n{+}1\,x\,n{+}1 + C$ (1). Based on formula (1), calculate: a. $\int x - 2dx$ and b. Can you calculate $\int x - 1\,dx$? Explain!

R1 solved problem number 3 using the knowledge he had about the transcendent function in his memory, but he still had difficulty understanding ln|x|.

R2 can take action and formulate an answer to question a, but he has problems with the answer to question b. Meanwhile, R3 faced difficulties in solving these two questions. According to the interview results, R3 may experience ontogenic, conceptual and epistemological learning difficulties.

The type of learning barriers that are related to students' readiness to learn are called ontogenic learning barriers. According to Suryadi's (2019) teaching experience, there are at least three types of learning challenges: psychological, instrumental and conceptual challenges. Students face ontogenic psychological barriers in learning, namely their reluctance to learn from psychological aspects, such as lack of interest and motivation to learn. Conceptual ontogenic learning obstacles are problems related to learning material that does not correspond to a child's learning experience with previous material. Ontogenical instrumental learning obstacles are technical problems, because a child cannot follow the didactic situation completely. If the material is too difficult without scaffolding (Rohana et al., 2019) it will make students bored and not receive the lesson well. On the other hand, material that is too easy will make students uninterested.

R3 continued to experience difficulties in solving problems even though he was given scaffolding to carry out actions in his memory knowledge based on his experience in learning. The didactic situation here does not work well because a lot of basic mathematical knowledge is disconnected, so that the stages of action, formulation, validation and institutionalization cannot be accommodated properly (Suryadi, 2013).

The research results show that engineering students face a number of learning challenges when they study integrals as antiderivatives. The two barriers to epistemological learning are ontogenic and conceptual learning barriers. These results will be the basis that will be used in the learning flow in didactic design. This can show how important it is for an educator or lecturer to have the ability to properly design learning that suits students' abilities (Kadarisma & Amelia, 2018).

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CONCLUSION

Based on the results of the research and discussion in the previous section, it can be concluded that civil engineering students studying calculus face two types of learning challenges. The first is the ontogenic learning challenge originating from psychology and the second is the conceptual learning challenge. Students may not be very motivated to study integrally. Engineering students previously faced difficulties in learning basic material, especially the concept of number calculations and algebraic operations. The second is the challenge of epistemological learning. Students tend to face difficulties in studying integrals because their ability to understand integral concepts is weak.

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