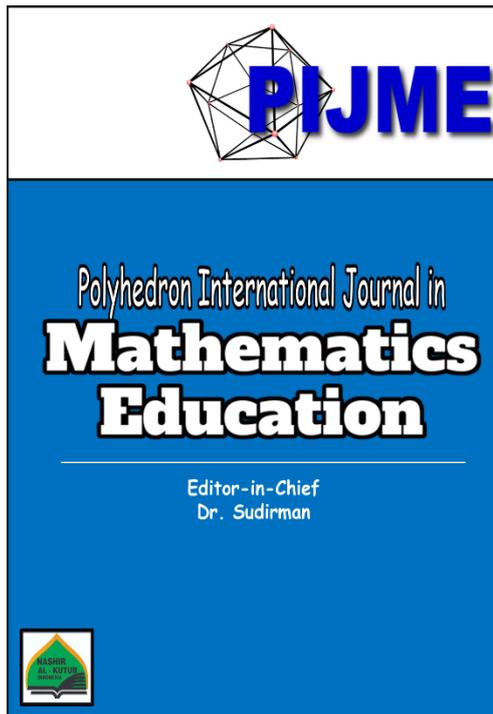


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Meaning and learning fractions: analysis of learning barriers from a mathematics teacher's perspective

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Original Article

Meaning and learning fractions: analysis of learning barriers from a mathematics teacher's perspective

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Abstract

Converting mixed numbers into common fractions is one of the formula problems in learning fractions which is a problem in learning. However, not many studies have examined this conversion. In addition, there are not many studies that try to provide solutions to the conversion problem. Therefore, this study aims to identify the types of learning barriers students experience when converting mixed numbers into common fractions and provide alternative solutions to minimize these learning barriers. The research design used to achieve this goal is *didactical design research*. *Didactical design research* was chosen because it uses the results of identifying types of learning barriers to develop didactic designs in learning fractions. The participants in this study were math teachers with 26 years of age and less than 5 years of teaching experience. The main instrument in this study was the researcher using several additional instruments, such as fraction comprehension tests, interview guides, and didactic designs. The data was then analyzed using qualitative data analysis. The results of the study revealed that students indicated that they experienced learning difficulties with different types of epistemological *obstacles* because they rarely start learning with everyday life problems. The solution offered in the didactical design is the use of the problem as an initial situation in learning which students will then respond to in the form of a didactical situation. The recommendations offered in this study are the implementation of the didactic design itself.

Keywords: *Didactical design research, Fractions, Learning barriers*

1. Introduction

Converting mixed numbers into common fractions is one of the formulas that becomes a problem in learning fractions ([Brown & Quinn, 2006](#); [Fosnot & Dolk, 2002](#); [Isnawan, 2022](#)). In fact, this conversion is often used in the context of learning advanced mathematics and other disciplines ([Brown, 2016](#); [Klothou et al., 2019](#); [Wahyu, 2021](#)). Therefore, this study seeks to examine the conversion of mixed numbers into common fractions in depth. This is also due to the fact that there are not too many studies that examine the conversion of mixed numbers into common fractions.

Research conducted by Yulianingsih et al. ([2018](#)) studied the order of fractions and concluded that only about 20% of students were able to sort fractions properly. Research conducted by Joutsenlahti Perkkila ([2019](#)) examines the selection of models that are in accordance with known fraction forms. The research

revealed that around 61 students out of a total of 102 students were unable to determine the appropriate form of illustration for certain fractions. Several other studies also tend to examine problems related to fractional operations and the order of fractions ([Suwariyasa et al., 2016](#)). In other words, some of these previous studies did not focus on conversion formulations as discussed in this study.

The solution offered in this study is research using a qualitative approach with types didactical *design research* (DDR). DDR was chosen because it is able to provide alternative solutions to problems faced by students in learning ([Suryadi, 2019b, 2019a, 2019c](#)). In addition, DDR also seeks to examine the types of learning barriers experienced by students as a basis for preparing didactic designs ([Suryadi, 2010](#)). Determining the type of learning barriers experienced by students is an important thing that must be done in learning. This is intended so that researchers know the source or main root of the problem in the learning itself. As an analogy, when the learning difficulties experienced by students are caused by the teacher, then the solution must also be related to the teacher, such as increasing teacher competency. Therefore, this study aims to find out the description regarding the types of learning barriers that students experience when converting mixed numbers into ordinary fractions and describe the form of didactic design based on the types of learning barriers before. The research questions in this study are as follows:

- a. What is the description of the types of learning barriers that students experience in converting mixed numbers into common fractions?
- b. How is the didactic design description used by the teacher in learning to convert mixed numbers into common fractions?

2. Method

The approach used in this study is a qualitative approach. The research design used is *didactical design research* (DDR). DDR was chosen because DDR uses a philosophy of how to acquire knowledge (epistemologically) which is in accordance with the stages of acquiring knowledge philosophically ([Suryadi, 2019b, 2019a](#)). In addition, the didactic designs compiled in DDR were developed based on the results of an analysis of the types of learning barriers students experience ([Suryadi, 2019c; Umbara & Suryadi, 2019](#)). Therefore, the implementation of didactical design in learning has a tendency to be able to minimize learning barriers that students have experienced before. The study participants were math teachers with less than five years of teaching experience in one of the junior high schools in Indonesia. The age of the participants is 26 years.

The main instruments in this study were researchers ([Creswell, 2012, 2014](#)) using fraction comprehension tests, interview guides, and teaching-based modules. *Theory of didactical situation* (TDS) ([Arslan et al., 2011; Brousseau, 2002; Mackrell et al., 2013](#)) as an additional instrument. Data from the implementation of learning is then processed using qualitative data analysis. The data analysis includes several stages, such as data reduction, data presentation, and drawing conclusions. Data reduction is related to eliminating some data that tends to be less relevant to research. Presentation of data is done by presenting data in the form of appropriate descriptions, pictures, or tables. The drawing of conclusions relates to what conclusions are generated from the research. Usually, the conclusion relates to the answer to the question or the purpose of the research itself. The research procedure carried out in this study consisted of two stages in DDR ([Suryadi, 2019b](#)). First, a

prospective analysis to ascertain the types of learning barriers and the resulting didactical design (hypothetical didactic design). Second, meta-pedagogical analysis is related to the implementation of didactic designs in learning.

3. Research Results and Discussion

Based on the results of the prospective analysis, information was obtained that students tend to experience problems when converting mixed numbers into common fractions. The snippet of the wrong student answers can be seen in Figure 1.

Figure 1

Snippet of Student Answers (Error in Converting Mixed Fractions)

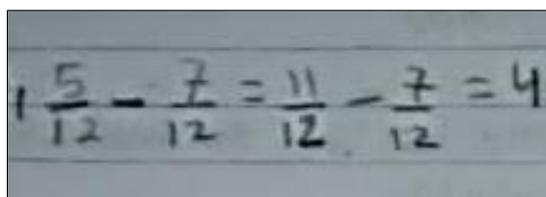


Figure 1 confirms that students are indicated to have problems in changing the form of mixed numbers into ordinary fractions. After a more in-depth analysis through interviews, it was concluded that one of the factors indicated to be the cause of the problem was the limited context used by the mathematics teacher in learning fractions. Teachers usually only use conventional learning when learning. This conclusion was obtained from excerpts from interviews with the mathematics teacher which can be seen in Table 1.

Table 1

Snippet of Mathematics Teacher Interview Results

Researcher	Teacher
<i>Have you ever given problems at the beginning of learning activities?</i>	<i>Once. However, the average student is confused when learning using problems. They are confused and usually ask directly about how to do this. Moreover, the problem is a matter of story. In fact, students should first look for what is known and what is being asked.</i>

If it is associated with theories related to learning barriers ([Brousseau, 2002](#); [Suryadi, 2013, 2019b](#)), it can be concluded that the types of learning barriers that students experience are epistemological *obstacles*. This is because the teacher has limited contexts used in learning fractions. In other words, the mathematics teacher directly gives formulas to students so that they tend not to last long in students' memories ([Isnawan et al., 2022](#)). The results of this study are also in line with several previous studies which revealed that epistemological *obstacle* is a type of obstacle that students usually experience when learning fractions ([Aebi & Linde, 2015](#); [Daut Siagian et al., 2022](#); [Job & Schneider, 2014](#); [Moru, 2007](#)).

Based on these types of learning barriers, a didactic design was developed by presenting the problem as an initial situation in learning fractions. The existence of this problem is expected to be able to direct students to find their own formulas in converting mixed number forms into ordinary fractions ([Dahl, 2017](#); [Jitendra,](#)

2002). The didactic design also utilizes the use of various trigger questions to make it easier for students to solve the problems given (Prihantini et al., 2021; van de Pol et al., 2010).

Figure 2

Examples of Problems in Didactic Design

Masalah



Apakah kamu tahu salah satu contoh permainan tradisional anak perempuan yang sudah mulai hilang karena adanya *gadget*? Ya, salah satu contohnya adalah congklak. Padahal, congklak merupakan permainan yang bermanfaat untuk melatih kemampuan berhitung para pemainnya.

Congklak dimainkan oleh 2 orang dengan menggunakan kerikil atau biji-bijian yang dimasukkan ke dalam lubang yang ada pada suatu papan yang sudah dilubang dengan beberapa lubang kecil dan 2 lubang besar. Sekarang, ambillah beberapa batu yang berjumlah ganjil dan akan kamu gunakan untuk bermain congklak. Misalnya kamu akan membagi batu tersebut dengan teman mainmu, maka berapakah batu yang diterima masing-masing pemain dan berapakah sisa batu yang tidak bisa kamu gunakan?

Following are some snippets of didactical designs given to students in learning fractions in class. Figure 2 shows a description of the problem in the didactic design and Figure 3 presents several trigger questions that students can use to solve the problem.

Figure 3

Examples of Trigger Questions in Didactic Design

Alternatif cara ke-3	
Buatlah ilustrasi banyaknya batu pada tabel di samping dengan menggunakan model area! Banyaknya bagian sesuai dengan banyaknya batu yang kamu ambil.	
Buatlah ilustrasi banyaknya batu yang kamu dan teman mainmu terima. Catatan: Kamu sebaiknya menggunakan warna yang berbeda untuk setiap pemain.	
Ada berapakah banyaknya batu yang setiap pemain terima?	-----
Ada berapakah batu yang tidak bisa digunakan?	-----
Jadi, banyaknya batu yang setiap pemain terima dan tidak bisa digunakan secara berturut-turut adalah ----- dan -----	

This study chose to use the problem as an initial situation in learning due to several reasons. First, the existence of problems at the beginning of learning activities will

be a stimulus for students to respond in the form of action, especially mental action in solving these problems. This mental action then directs students in formation ways of thinking (WoT) and refers to achievements ways of understanding (WoU) ([Elise Lockwood & Eric Weber, 2015](#); [Sari et al., 2019](#)). WoU is basically directly related to the formula for converting mixed numbers into common fractions. Second, provide challenges to students so that they can trigger achievement zone of proximal development (ZPD) that approaches potential development zone ([Adam, 2017](#); [Clabaugh, 2010](#); [Topciu & Myftiu, 2015](#); [Verenikina, 2003](#)).

In addition, the didactic design also uses trigger questions as a form scaffolding which can help students in solving problems. The results of this study are in accordance with the theory which reveals that existence scaffolding enough to help students solve problems encountered in learning ([Pöhler & Prediger, 2015](#); [van de Pol et al., 2010](#)). In fact, it is also disclosed that existence scaffolding able to connect between actual potential development zone with potential development zone students have ([Berns & Erickson, 2001](#); [Davtyan, 2014](#); [Verenikina, 2003](#)). In the context of learning, didactical design also uses the didactic situations that exist in TDS, namely situations of action, formulation, validation, and institutionalization ([Suryadi, 2013, 2019b](#)). The action situation starts with giving problems and solving problems by students. The formulation situation provides an opportunity for students to convey their ideas to other students. The validation situation is a situation when students conclude regarding the formula for converting mixed numbers into common fractions. While the institutionalization situation is a situation when students use formulas obtained when solving mathematical problems in different contexts and situations.

4. Conclusion

There are several things that can be concluded related to the previous description, namely that students are indicated to experience learning difficulties with types epistemological *obstacle*. This is due to the limited use of problems when teachers teach fractions in class. Therefore, the solution offered in the didactic design is giving problems to students with the aim that students are able to find their own formulas in converting mixed numbers into common fractions. In addition, the didactic design also contains various forms of triggering questions that act as scaffolding for students to help in solving the problems presented. In addition, learning series that facilitate action situations, formulation, validation, and institutionalization are also carried out to assist students in constructing conversion formulas correctly. This study then recommends that the didactical design compiled be implemented by the researcher and reconfirms whether the student's learning barriers still exist or not.

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