

Teaching Basic Meaning of Decimal as a Special Form of Fraction

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Abstract

Decimal is a special type of number that some students have great difficulty in grasping the concept. Current trend in the teaching and learning of decimal is by converting from fraction form into decimal form without focussing on conceptual understanding. The process of converting is by performing standard fixed algorithm of division. The usual process is performed by using numerator as dividend and denominator as divisor. The quotient obtained is the decimal number. The process is procedurally correct, but the problem then is whether students can make sense on the meaning of decimal. Many previous studies indicated that students, in some cases including their teachers, hardly make sense of what decimal is all about (Zulkifli & Mohini, 2008; Reys & Yang, 1998). This research, using design research method is to address the issue on understanding the basic meaning of decimal in relation to fraction as an important part of promoting number sense. By using alternative approach that we have developed, students have shown to understand the concept of decimal in a more holistic and meaningful way.

Keywords: number sense, design research, pre service teachers, decimal fraction

INTRODUCTION

Teaching and learning number and operation, particularly decimal, with a high emphasis on standard written algorithm has long been argued (Yang, 2009; Rathouz, 2011; Cheng and Wang, 2012). This approach will not only make mathematics meaningless, but unfortunately it also leads mathematics to be an unfamiliar, boring, and anxiety-prone subject among majority of students. Many studies have proved that putting a great emphasis on standard written algorithm have caused students become mechanics who run the prescribed rules and formulas (Mohini and Jacinta, 2010; Widjaja & Stacey, 2006; Yang, 2009; Tsao, 2005).

Representation of Decimal Concept

It can be a cause of alarm when we hear that the first year university students give the answer that "0.27 is greater than 0.3" when they were asked to compare which one is bigger between the two numbers. They naively argued that 0.27 is greater than 0.3 because 27 is far greater than 3. This response means that they have no proper insight about basic meaning of decimal number, particularly how to compare between two decimal numbers. This phenomenon can be traced back to many previous studies which indicated similar cases (Stacey, et al., 2001; Mohini et al., 2008; Iuculano & Butterworth, 2011).

The current trend of decimal teaching and learning in Indonesia, particularly on how to change fractions into decimals number, is by simply performing standard algorithm of division. The process is performed by considering the numerator as dividend and the denominator as divisor. The quotient of the division is called a decimal number. Other than a study carried out by Widjaja and Stacey (2006), there is scarcity of research in teaching and learning of decimal especially in Indonesia that called for this research to be done.

Based on our preliminary study, we found that it was very difficult for participants to grasp the basic meaning of decimal. Hence, we would like to propose an approach to promote a conceptual understanding of basic meaning of decimals. By using pictorial representation, the activity is intended to introduce the participants of this study the origin of decimal and the relationship between decimal and fraction.

During a classroom activity, we focussed on a specific type of fraction which has denominator of 10, 100, 1000, or any other power of 10. A decimal with one digit after point is a fraction with denominator of 10, a decimal with two digits after point is a fraction with denominator of 100, etc. We can conclude that this particular decimal is a fraction whose denominator is 10 or the power of 10.

As an illustration, the following are pictorial representation of $1/2$ for fraction which is equal to 0.5 for decimal.

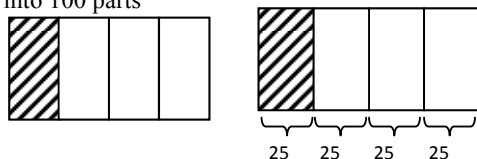


It can be easily seen from the picture above that $1/2$ is equivalent to $5/10$. Every fraction that has its denominator of 10 such as $x/10$ can be written as 0.x. From the picture above $1/2$ is equivalent to $5/10$ which means that $1/2$ can be written as 0.5.

Let's see another illustration for fraction such as $1/4$ as below



We can see from the picture of $1/4$ above that the shaded area is more than 2 parts and less than 3 parts of the unit when it is divided into 10 parts. Therefore, the process needs to be continued to divide the unit into 100 parts



It can be easily seen from the picture above that $1/4$ is equivalent to $25/100$. Every fraction that has its denominator of 100 such as $xy/100$ can be written as 0.xy. From the picture above, $1/4$ is equivalent to $25/100$ which means that $1/4$ can be written as 0.25.

Moving on to a fraction like $1/3$, there is no whole or counting number that can exactly fit into the one third of shaded area if the unit is divided into 10 parts. If the unit is divided into 10 parts, the shaded area needs more than 3 parts but less than 4 parts. If we continue to divide into 100 parts, the shaded area needs more than 33 parts but less than 34 parts. If we continue to divide the unit into 1000 parts, the shaded area needs more than 333 parts but less than 334 parts, etc. This case will result in an unlimited process. Usually, for converting the fraction $1/3$ into three decimal places, it is considered enough by dividing into 1000 parts and it means that $1/3$ is approximately equal to 0.333.

The Purpose

The purpose of this paper is to describe the process of introducing basic meaning of decimal as a special form of fraction. Through this paper we would like to present an alternative approach in introducing the holistic and meaningful concept and also the interrelationship between fraction and decimal.

Participants

The participants of this study were one class of first semester students of preservice primary teachers

academic year 2011/ 2012 attending Almuslim University in Aceh, Indonesia. The preservice primary teachers undertake a four-year bachelor of education degree under Primary Teacher Education Department (Pendidikan Guru Sekolah Dasar) of Teacher Training and Education Faculty (Fakultas Keguruan dan Ilmu Pendidikan).

Procedures

This study was carried out by employing Design Research from learning design perspective. The research approach contains three main phases: (1) preparing for the experiment, (2) experimenting in the classroom, and (3) conducting retrospective analyses (Gravemeijer & Cobb, 2006). The activity we discuss here is only a sub micro cycle of the third macro cycle of the design research on number sense that we have conducted.

Activity

For the purpose of classroom activity, we prepared contextual problem that enable the participant to discover the meaning of decimal as a special form of fraction. This activity was inspired by observing participants' concept of decimal number which is somewhat vague and meaningless. They see decimal number as whole number together with decimal point. We found this case in the previous cycle of instructional intervention. The majority of preservice primary teacher confidently believed that 0.25 is bigger than 0.3. When we asked a question, due to this response, why they said that 0.25 was bigger than 0.3. They simply provided the argument "25 is bigger than 3 so that 0.25 is bigger than 3". This surprising response indicated that most students had a limited conceptual understanding of decimal which encouraged us to find a new approach to introduce the basic meaning of decimal number. Here we fully hoped that the participants would fundamentally understand the basic meaning of decimal and its relationship to fraction.

In preparing the lesson, we agreed to introduce decimal to the participants in the way different from what they have all experienced in primary and secondary school. The past experience of learning decimal is simply by performing division algorithm from a fraction given. The numerator of the fraction is considered as dividend and the denominator as divisor. The quotient obtained from this rule-based activity is called decimal. Usually nobody will enquire why this way works when mathematics teachers give the prescribed reason. Typical respond is "the processes have to be performed that way because the experts suggested us to do that way".

The classroom activity of teaching and learning for understanding the basic meaning of decimal began after basic meaning of fraction class which focus on pictorial representation as a means to understand

symbolic representation. The activity for understanding basic meaning of fraction is separately conducted in the previous meeting.

At the outset of one class, we collaboratively construct contextual problem based on the decimal number properties in relation to fraction (decimal number as a special form of fraction). In preparing this contextual problem, we fully consider the way the participants learned regarding the language and material that can be comprehended by them. What we mean by special form is that decimal number in a form of fraction that has denominator 10, 100, 1000, or any other bigger number of the power of 10. For short, a decimal number can be viewed as a fraction which has its denominator 10 or the power of 10. For example, 0.a is a decimal form which means $a/10$, 0.aa is a decimal form which means $aa/100$, 0.aab is a decimal form which means $aab/1000$, etc.

Based on the meaning of decimal number as we explain above, we provide the following contextual problem for participants to be discussed cooperatively in a classroom setting.

Contextual Problem

The contextual problem that we used in this activity was intentionally constructed by expanding the contextual problem that had been used in the previous class meeting. The expansion problem from pure fraction problem to decimal-fraction related problem was intended to show the closest and inseparable relationship between fraction and decimal. The decimal-fraction related problem means the problem contains explanation of fraction and then proceeded by the process of finding decimal based on the particular fraction. The following is the problem:

There are five groups of children at a party. The number of children in each group respectively consists of 2 children, 4 children, 8 children, 5 children, and 3 children. At the end of the party, each group of children was given a big bread. The group I with 2 children was given 1 bread, group II was given 1 bread, group III was given 1 bread, group IV was given 2 bread, and group V was given 2 bread. Based on the number of bread and the number of children in each group, the following are the part of bread that received by a child in his own group: child in group I get $1/2$ bread, child in group II get $1/4$, child in group three get $1/8$, child in group IV get $2/5$, and child in group V get $2/3$.

Based on the information above, do the following tasks.

1. For the first group, how many pieces every child will have if each bread is sliced into 10 pieces (provide them with picture). Write the result in fraction form.

2. Explore the process of slicing bread for all other groups. If a bread has been sliced into 10 pieces but they can be distributed in the same number of pieces to each child, try to slice into 100 pieces and distributed them. If 100 pieces will also have the same problem, try to slice into 1000 pieces, etc.
3. If $1/10$ will be written as 0.1, $11/100$ will be written as 0.11, $125/1000$ will be written as 0.125. Write all the fractions obtained in the new format.
4. Write down each group position in number line based on the part of bread it has.

The classroom activity began with introduction by lecturer of what the class would do in the meeting. The lecture gave short explanation of the contextual problem relating to the previous meeting. The explanation included how the conventional process of getting decimal from fraction had made mathematical activity as a less meaningful activity.

The objective of the meeting is to fundamentally understand the basic meaning of decimal as a form of fraction. The participants were encouraged to work diligently in groups with the help of lecturers.

The participants work in group of 5 within a total of 9 group altogether. The composition of the group is heterogeneous with reference to student's ability which has been determined through initial test and interview. Participants work cooperatively discussing and debating on the material and probing the answers based on the contextual task given. The lecturers function as facilitators who are ready to help and give any clues or hints when questions arose among the groups. Participants seemed to work enthusiastically and diligently in each group.

Generally, after a long discussion, most groups can understand the relationship either between decimal and fraction or between the pictorial representations of number such as $1/2$ and $1/4$. There were only 2 groups out of 9 groups that failed to understand the pictorial representation between $1/2$ and $1/4$. The following are the comparison between correct pictorial representation (Figure 1) and the incorrect one (Figure 2).

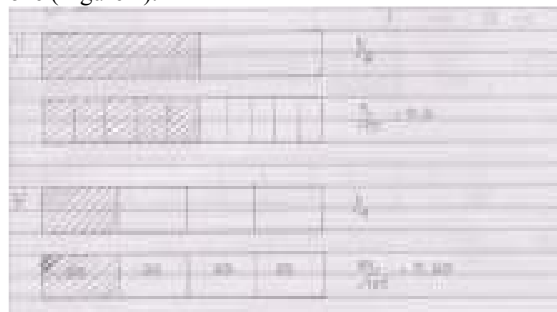


Figure 1. Correct pictorial representation of $1/2$ and $1/4$

It can be seen from the Figure 1 above that the participants had drawn the pictorial representation for fraction and decimal correctly. This pictorial representation was drawn by participants of group 5. From the picture above, it can be seen that $1/2$ is greater than $1/4$.

It also clearly appears that $1/2$ is equivalent to $5/10$, $5/10$ can be written as 0.5 . Therefore, the fraction $1/2$ is equal to 0.5 in decimal. For $1/4$, the shaded area cannot be counted exactly if the unit is divided into 10 parts (the shaded area will be more than 2 parts and less than 3 parts). Due to 10 parts that cannot work, it should be expanded into 100 parts. If the unit is divided into 100 parts, the shaded area of $1/4$ can be partitioned into 25 parts. This means that $1/4$ is equivalent to $25/100$ and $25/100$ can be written as 0.25 . Therefore, the fraction $1/4$ is equal to 0.25 in decimal.

One more thing that can be learned from the pictorial representation above is 0.5 is greater than 0.25 . Pictorial representation can be used to show the incorrect conceptual understanding of basic meaning of decimal mentioned earlier (0.25 is not greater than 0.5 even though 25 is greater than 5).

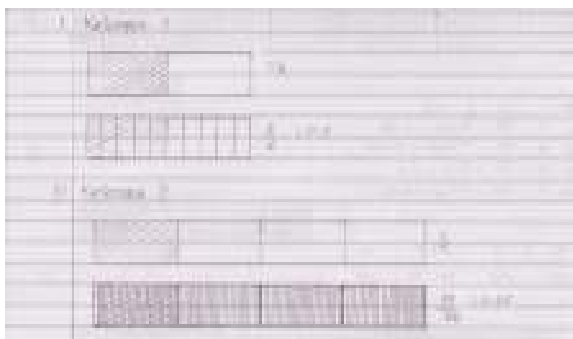


Figure 1. Incorrect pictorial representation of $1/2$ and $1/4$

The pictorial representation above shows an inappropriate representation of $1/2$ compared to $1/4$. The group has shown how to change fraction into decimal based on the power of 10 correctly, but it has failed to grasp a deeper understanding, particularly the relationship between $1/2$ and $1/4$. This type of incorrect understanding was performed by only 2 groups. Generally, the majority of the group have shown their understanding of decimal as the special form of fraction.

Similar to the process of changing from fraction to the decimal, a majority of the group also had understood correctly the orderliness of decimal. This is a significant progress in the understanding of decimal. As the task number 4 requires participants to put each group of children based on the part of bread each child receives (in decimal) in number line, generally they put it in correct position. Locating

decimal position in number line may be interpreted as a process of recognising the orderliness property of decimal.

CONCLUSION

This study had shown that introducing decimal as a special form can benefit participants in a way that they can learn the fundamental meaning of decimal. They gained new insight of what decimal is about instead of simply dividing numerator and denominator of a fraction using division algorithm or calculator.

Based on the observation using instructional activity, all observers and inter observers involved in this study agreed with 90% agreement that participants were enthusiastic in exploring, discussing, probing, and helping each other throughout the instructional activity.

We hope the process of using instructional package of this study can be an alternative approach in performing a meaningful, joyful, and creative learning atmosphere in mathematics classrooms, particularly on the topic of fraction and decimal.

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