Using VBA for microsoft excel based on 6-questions cognitive theory in teaching fraction

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Abstract. Learning media is a tool that is used to make the teaching and learning process easier. In this modern era, most of the students complained that mathematics is hard and boring. Other than that, the traditional teaching method makes students less practical and not mastering the concept taught, which is why there is a need for a learning media innovation using Information and Communication Technology (ICT). Learning fraction in primary school can be helped using VBA for Microsoft excel in supporting the fraction subchapter so that it will be more interesting and easier to understand. The purpose of this research is to develop a VBA for Microsoft excel on fraction, which then is evaluated on their validity and practicality as a learning media. The design of this research is using the experimental design with pre-test and post-test to compare the students’ understanding ability on fraction between the class that uses VBA for Microsoft excel and the traditional teaching method. The result of this research shows that the learning media, we can conclude that VBA for Microsoft excel based on the 6-questions cognitive theory can improve the students’ understanding ability significantly.

1. Introduction
Mathematics is one of the important subjects that everyone needs to learn and it can be learned in every level of education [1]. Not only that every subject is always connected to mathematics, but mathematics is also very useful in everyday life [2]. One of the topics that are closely related to our everyday life is fraction [3–6]. In primary school, students learn fractions in the 3rd and 6th grade wherein the difficulties level are different. Mastering the fraction concept is very important because a fraction is a foundation for calculating percentage and decimals [7].

In reality, students have difficulties in understanding fraction. Most of the students only follow the method that is taught by the teacher and does not understand the concept and meaning of fraction [7,8]. Students only understand that fraction is numerator that is divided by the denominator. This kind of misunderstanding causes a lot of students being unable to solve fraction problems when teachers change the difficulty level or change the fraction into an essay problem.

Information and Communication Technology (ICT) is developing at a fast rate now [9]. ICT can be used as a mathematics learning media to improve the students’ ability [10]. The researcher found that learning mathematics using ICT can help teachers to explain the mathematics concept and improve the students’ mathematics ability [11–13].

Based on Bernice McCarthy’s 4MAT teaching model, a “6-questions cognitive theory” is created by professor Zhou Ying from the perspectives of problem, operation, refinement and completeness of
mathematical knowledge. It starts with the students’ thinking and the systematization of mathematical
textbooks [14,15]. The outline contains six elements which are from where, what is it, what is the
connection, how to use, what is it changes and think about it.

Based on the problems mentioned above, researchers wanted to conduct an experiment using VBA
for Microsoft excel to prove that it is an effective tool to improve the students’ understanding ability on
fraction based on the 6-questions cognitive theory in primary school. This research wishes that VBA for
Microsoft excel can help support teachers to explain fraction to students and improve the students’
understanding ability on a fraction.

2. Method
The design of this research is using the experimental design with pre-test and post-test to compare
the students’ understanding ability on fraction between the class that uses VBA for Microsoft excel and the
traditional teaching method. The sample for this research is taken randomly to determine the
experimental and controlled class. The data analyzed using the statistical t-test and statistic $\chi^2$ test (to
test the connection between variables). The research design is shown below.

A: 0 X 0
A: 0 0
Key:
A: Classroom random sampling
0: Pre-test = Post-test students’ mathematical understanding ability
X: Learning with VBA for Microsoft Excel based on 6 questions cognitive theory.

3. Results and Discussion
Before experimenting using VBA for Microsoft excel based on the 6-question model, the researcher
interviewed with some of the teachers to know what difficulties they faced when teaching fraction.

Table 1. Interview result on the difficulties faced when teaching fraction

| No | Statement |
|----|-----------|
| T1 | I’m out of idea on how to explain fractions in class. |
| T2 | I don’t understand how to use technology to explain fraction. |
| T3 | Usually, I just explain how to solve fraction problems and give students a lot of practice problems. |

Based on the interview on Table 1, we can see that in this modern era fractions can’t be explained
using the traditional teaching method, and teachers are out of ideas on how to explain fractions deeper.
Researchers also did an interview with the students to know the difficulties faced when learning fraction.
Students said that the teacher often only teach them the formula on fraction but did not explain the
fraction concept.

The next step for this research is to divide the students into two classes which is the experimental
and controlled class. Each of the classes given five pre-test problem to know their understanding ability
on fraction to be able to improve the students’ understanding ability and condition.

Table 2. Students’ initial understanding ability on fraction

| Statistic                  | pretest | Controlled class | Experimental class |
|---------------------------|---------|------------------|--------------------|
| Understanding Ability     | N       | 36               | 36                 |
|                           | Average (X) | 1.20           | 1.18               |
|                           | Standard Deviation | 0.72           | 1.04               |

According to the pre-test data that can be seen in Table 2, we can see that score for the controlled
and experimental class are 1.20 and 1.18, respectively. This means that the initial understanding ability
of the students in the controlled class is higher than that in the experimental class. From the data above, we can also see that the standard deviation of the controlled and experimental class is 0.72 and 1.04, respectively. Which means that the initial ability in the controlled class is more evenly distributed than in the experimental class. To see more clearly the difference in the students’ initial understanding ability, the data is then processed using SPSS 25 to know if there is a significantly different or not.

| Table 3. Mann-Whitney Test on the students’ initial understanding ability | mathematical understanding ability |
| --- | --- |
| Mann-Whitney U | 582.500 |
| Wilcoxon W | 1248.500 |
| Z | -.755 |
| Asymp. Sig. (2-tailed) | .450 |

Based on Table 3., The Mann-Whitney value obtained is 582.500, and the Asymp sig obtained is 0.450, and it is greater than 0.05. This means that there is no significant difference in the initial understanding ability of the two classes. After knowing that there is no significant difference between the two classes, the researcher then gives different treatment to the two classes to teach fraction to the students. After a month of teaching, the two classes are given a post-test or final test. From this final test, we can see the ability difference after using two different teaching method in which one class uses the traditional teaching method while the other uses VBA for Microsoft excel based on the 6-questions cognitive theory.

| Table 4. Students’ final understanding ability on a fraction |
| --- | --- | --- | --- |
| Statistic | Posttest | Controlled class | Experimental class |
| Understanding Ability | N | 36 | 36 |
| Average (X) | 3.53 | 3.77 |
| Standard Deviation | 0.30 | 0.79 |

Based on the post-test result that can be seen in Table 4, we can see that there is an improvement in the students’ understanding ability of the two classes. The average point that the controlled and experimental class got is 3.53 and 3.77, respectively. With this result, we can say that the student who uses VBA for Microsoft excel based on the 6-questions cognitive theory understands fractions better than the students that use the traditional teaching method. The standard deviation of the controlled and experimental class is 0.30 and 0.79, respectively, which means that the initial ability in the experimental class is more evenly distributed than in the controlled class. Next, the data processed further using SPSS 25 to determine whether learning mathematics using VBA for Microsoft excel is better than the traditional teaching method.

| Table 5. Mann-Whitney Test on post-test | mathematical understanding ability |
| --- | --- |
| Mann-Whitney U | 361.000 |
| Wilcoxon W | 1027.000 |
| Z | -.3.250 |
| Asymp. Sig. (2-tailed) | .001 |

The Mann-Whitney value obtained is 361.000, and the Asymp sig obtained is 0.001 (Table 5). This means that there is a difference in the average score of the two classes. The average score of the experimental class is higher than that of the controlled class. With this, we can say that the class that
uses VBA for Microsoft excel based on the 6-questions cognitive theory is doing better than the class that uses traditional teaching method.

Throughout the research, the researcher used two different teaching method to the two classes for a month. The lesson design on the fraction that uses VBA for Microsoft excel based on the 6-questions cognitive theory can be seen in Table 6.

| 6-Question Model | Gives issues Issue Given | Example question on a fraction | Mathematically learning using VBA for Excel | Self-confidence | Achievement result of students |
|------------------|---------------------------|--------------------------------|---------------------------------------------|-----------------|----------------------------------|
| From where?      | Researchers direct the students to give out fraction examples in everyday life. | If tommy have 1 Pizza then he divides it evenly by 3. How much will each person get? | Student choose drinks and add a mixture of sugar and water. | Student answers the question given by the teacher. | Students now know examples of fraction in everyday life. |
| What?            | Researchers direct the students to understand the concept of fraction and how to solve fraction problems. | What is fraction? How to you solve fraction problems? | Students see the ratio between the sugar and the water. | Students tried to do an experiment and discussed it with their group mates. | Students know the concept of fractions and how to solve fractions. |
| What is connection? | Researchers direct the students to state the use of fraction in everyday life. | Give examples on the use of fractions in everyday life. | Student tried to play with the milkshake using VBA for Microsoft Excel | Students interact with each other with the help of learning media. | Students know the benefit of learning fraction. |
| How?             | Researchers direct the students to the concept known to solve fraction problems. | What is the first step to compare two fractions? | Students discussed and report their work result. | Students know the steps to compare 2 fractions. | Students know the concept of fraction. |
| What if?         | Researchers direct the students to change the numerator and denominator. | Which one is bigger, 2/3 or 7/8? | Students tried to see which color stands out more from 2 fractions. | Students answer which drink is more dominant. | Students understand the concept of fraction. |
| Think about      | Researchers direct the students to summarize the | What is fraction? How to compare 2 fractions? | Students were able to conclude fraction with | Students give a conclusion of fraction by discussing it. | Students know the concept of fraction, how to solve it and |

**Table 6. Lesson Design on fraction based on the 6-questions cognitive theory**
The 6-questions cognitive theory is used to direct the students to find the concept of the fraction with an experiment method using VBA for Microsoft excel. Throughout the teaching process, students are very enthusiastic and active to answer the questions given by the researchers. Not only that, but students are also very interested in VBA for Microsoft Excel as a learning media, so the students kept on asking about fraction throughout the teaching process.

According to the survey about fraction, students have difficulties in understanding what numerator and denominator, addition and subtraction of fraction and comparing which fraction is bigger and smaller especially when the numerator is not the same is. [16,17]. The other problem found by the researcher is that students often have difficulties in understanding the concept and chooses to not listen to the teachers’ explanation. Based on these problems, researchers made a learning media using Microsoft excel to explain the basic concept of fraction. The software used is Visual Basic Application (VBA) for Microsoft Excel (Figure 1).

First, the students made two kinds of drinks they like. They can choose between strawberry milkshake, green tea latte, thai tea and a blueberry milkshake. Then they can mix the powder and water, however, and they want it to be. With this, students can able to see the ratio of powder and water they put in, which is one example for a fraction. This learning media can also display decimals for the students to see. The last step is the students can able to see which colour in the drink is more dominant and that will mean that the fraction will be bigger. The resulting example using VBA for Microsoft excel can be seen in Figure 2. After the students see the fraction simulation using the learning media, the teacher then explains the concept of fraction and what is the relationship between normal fraction and decimals fraction and also the concept of fraction.

| 6-Question Model | Gives issues Issue Given | Example question on a fraction | Mathematic learning using VBA for excel | Self-confidence | Achievement result of students |
|------------------|--------------------------|--------------------------------|----------------------------------------|------------------|-------------------------------|
| meaning and concept of fraction. | the help of the milkshake game. | how to compare 2 fractions. | |

**Figure 1.** Fraction using VBA for Microsoft excel.
As an evaluation material on the experimental class, the researcher randomly asked students to give response on the VBA for Microsoft excel based on 6-questions cognitive theory as a mathematics learning media and it can be seen on Table 7.

### Table 7. Responses From the Students

| Student | Responses |
|---------|-----------|
| S1      | It helps me to understand the concept of fraction. |
| S2      | I want to make my own learning media using Microsoft excel. |
| S3      | I’m very happy that learning mathematics uses ICT learning media. |
| S4      | I believe my mathematics score will be better if all mathematics topic uses ICT learning media. |
| S5      | I will not make a mistake in solving fraction problems anymore because I now understand the concept. |

### 4. Conclusion

Based on the research result after the final exam and discussion that was done by the researchers, we can conclude that VBA for Microsoft excel based on the 6-questions cognitive theory can improve the students’ understanding ability significantly. Other than that, students also give a positive response to the mathematics learning that uses VBA for Microsoft excel based on the 6-questions cognitive theory. VBA for Microsoft excel based on the 6-questions cognitive theory can be used to teach fraction.

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