

Implementation of Mathematical Knowledge for Teaching (MKT) in the Learning of Mathematics in Elementary School

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Abstract—This case study was aimed to assess implementation of the involvement of Mathematical Knowledge for Teaching (MKT) in the learning of mathematics in elementary school. Specifically, the study also examines the implementation MKT in the development of learning materials for mathematics as well as its effect on the student's learning material mastery. Currently, the learning of mathematics, especially in elementary schools are having some problems, such as learning the math still more emphasis on the ability of mechanic than sharpen the capability of reasoning. MKT gives specific limitation on the content side, knowledge and knowledge against content that must be mastered by teacher and ready to give in the learning of mathematics. This research showed the results that can be implemented on the MKT development of learning materials for mathematics in primary schools so as to increase mastery of mathematics teaching material of elementary school students. The implementation of MKT gives the positive impact against the mathematical ability of students. That is because the math learning resource utilization on MKT. MKT plays a very important role in learning mathematics, especially in elementary school.

Keywords—*learning mathematics; MKT*

I. INTRODUCTION

One of the problems that occur in the process of learning is the school failures. The school failures might be defined as the difficulties in operating the effective teaching-learning process [1]. Learning mathematics, especially in elementary school still leaves many problems. One of them is when teaching mathematics, it is still oriented to textbooks so that there is still the potential for misunderstanding. As a matter of fact, many elementary school teachers, because of their position as a class teacher, have no choice to teach mathematics [2].

The development of recent study on content knowledge and pedagogical content knowledge specialized on mathematics material. It is caused by the complexity of knowledge a teacher should have when teaching mathematics especially in elementary school. This is in according to Schonfield and Kilpatrick "teaching mathematics needs specific knowledge" [3]. The mathematical knowledge and pedagogical competence

of teachers are intertwined, and improving both is key to upgrading students' mathematical achievement [4]. This is strengthened will study conducted by Ball et al that Mathematics Knowledge for Teaching (MKT) consisting of mathematics content knowledge and mathematics pedagogical content knowledge is important factor in mathematics students in school [5].

To address the problems in the teaching of mathematics, one of the things that can be improved is through the increasing of teachers' knowledge, especially in math. Shulman stated seven categories of knowledge necessary to become professional teachers, among them are content knowledge; general mathematical knowledge; curricular knowledge; knowledge of learners (among them are characteristics, cognition, motivation and development); knowledge of educational contexts; knowledge of educational aims, goals and purposes; and mathematical content knowledge [6]. Mathematical Knowledge of Teaching (MKT) gives specific limitation on the content side, knowledge and knowledge against content that must be mastered by teacher and ready to give in the learning of mathematics. MKT as the most influential reconceptualization in learning mathematics [6-8].

The involvement of Mathematical Knowledge for Teaching (MKT) in the development of learning materials for mathematics is expected to be an alternative solution of the problems of learning in elementary school is mainly with respect to the limitations of knowledge and teachers' ability in teaching. This condition is a staple of the study, which will be examined by taking the assumption that learning is a sustainable and continuous activity. MKT includes both the domains traditionally conceived as pedagogical content knowledge (knowledge of content and students (KCS), knowledge of content and teaching (KCT)), as well as two types of subject matter knowledge it self: common content knowledge (CCK), or content knowledge that is used in the work of teaching; and specialized content knowledge (SCK), or content knowledge that is tailored in particular for the specialized uses that come up in the work of teaching [4]. Mathematical Knowledge can be defined as 'the how of teaching ', while Content Knowledge can be understood as

'what of teaching'. In view of the Shulman, Mathematical Content Knowledge is a form of practical knowledge that is used by teachers to manage the learning activities [9]. The practical knowledge can be (a) the knowledge related to how a material should be presented in a more structured and represented it to the students in ways that are more simple; (b) knowledge that is associated with the concept generally, the tendency of the occurrence of misconceptions and difficulties which may be encountered by students when dealing with a certain material; (c) knowledge of the specific learning strategies that can be used to meet the needs of learning on specific conditions [9].

Depaepae et.al mentions three benefits that would have been available from the MKT, which is (a) that it was born from the empirical research based on real knowledge needed by teachers in teaching mathematics; (b) MKT adopted the heuristics idea by Shulman and then converted into a valid measure of teachers of mathematics knowledge in teaching and (c) the MKT provides empirical evidence concerning the correlation of the positive achievements of the students' learning ability by teachers in managing PCK [5,7].

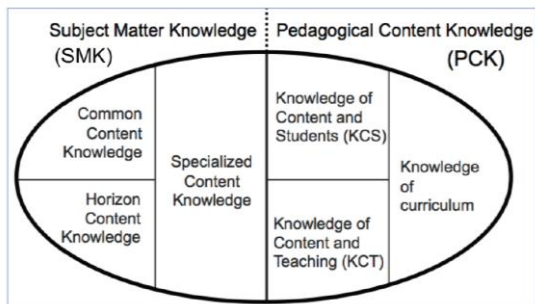


Fig. 1. Mathematical Knowledge for Teaching (MKT) [10,11].

In this article, we describe the implementation of MKT in the development of mathematics teaching materials and the implementation of MKT in mathematics learning in elementary schools. We also measure and analyze teachers' MKT one that has been linked to student achievement gains. Previous studies have shown that the mathematical knowledge for teaching has a positive influence on pre service primary teachers [8,12,13]

II. RESEARCH APPROACH

This is a case study research which examined two group of level 4 elementary schools who joined learning based on mathematical knowledge for teaching and traditional learning. The choosing of sample was based on the result of mathematics learning outcomes. In case study, cause and result can be verified because result is examined in real context [14].

The instrument used in study were test and interview. Mathematical content knowledge test was developed from Cheang et al then consulted to expert and tried on teacher candidate's student [15]. Data credibility of qualitative research can be obtained with data triangulation using different research instrument. Interview was based on mathematical content knowledge test.

III. RESULTS AND DISCUSSION

Mathematical knowledge for teaching is mathematics knowledge that teachers need to carry out their work as teachers of mathematics [16]. Identification process of mathematical content knowledge test in two classes with learning based on mathematical knowledge for teaching which was student centered and traditional learning which was teacher centered was done to know the characteristic of mathematical content knowledge from the learning.

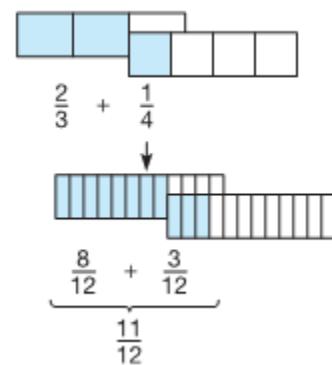
One of the crucial concepts in mathematics that needs to emphasize understanding of concepts is fraction. In class traditional learning, teacher explained that $\frac{a}{b} \times \frac{c}{d} = \frac{a \times c}{b \times d}$ without explaining how and why the concept exists. Students are taught more about exercises than exploring a concept. Consequently, the mathematical content knowledge of students is low.

In class with learning based on mathematical knowledge for teaching, begins with the design of mathematical content knowledge – based mathematics teaching materials. The concept of teaching materialis focused on fraction. Early identification through initial mathematical content knowledge tests and observation showed that students did not understand the concept of fraction addition with different denominators and fraction multiplication.

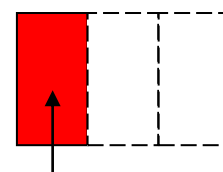
Here is an example of illustrating a mathematical problem concretely in the learning material fractions matter:

At the beginning of a learning teacher giving problem like this:

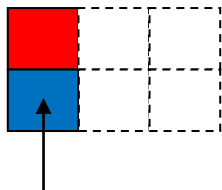
1. Andi has $\frac{2}{3}$ parts of cake and Toni has $\frac{1}{4}$ parts of cake. How many pieces of cake Andi and Toni?



2. The mother has $\frac{1}{2}$ parts of cake, then the brother asked for $\frac{1}{3}$ parts of cake whose mother has, how many parts that the brother asked?



Represent mother's cake $\frac{1}{3}$ parts



Represents the cake which brother asked $\frac{1}{2}$ parts of mother's.

From the picture it looks like the brother has a $\frac{1}{2}$ parts of $\frac{1}{3}$ parts of cake or worth with $\frac{1}{6}$ parts of cake.

Mathematically it is describing $\frac{1}{2} \times \frac{1}{3}$

The following is description of answers given by student in class with learning based on mathematical knowledge for teaching:

1. Give the meaning of $\frac{2}{3} + \frac{1}{4}$!

Teacher : note the following story! Andi has $\frac{2}{3}$ parts of cake and Toni has $\frac{1}{4}$ parts of cake. How many pieces of cake Andi and Toni?

Student 1: one cake.

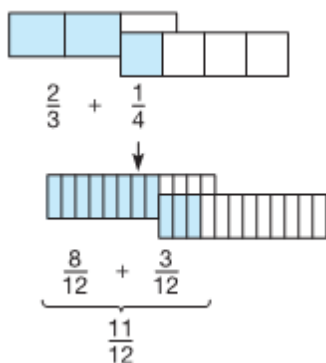
Teacher: why?

Student 2: because I do not know how calculate them.

Student 3: can it be described?

The next activity the teacher together with the students tries to describe the purpose of the story.

After being described, students still find it difficult to add up the fraction, so that the teacher and students did up the knowledge of the preconditions about fractions that have the same value.



2. Give the meaning of $\frac{1}{2} \times \frac{1}{3}$

Teacher : note the following story! The mother has $\frac{1}{3}$ parts of cake, then the brother asked for $\frac{1}{2}$ parts of cake whose mother has, how many parts that the brother asked?

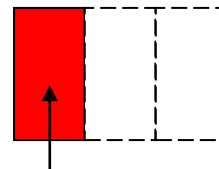
Student : $\frac{1}{3} - \frac{1}{2}$

Teacher : why?

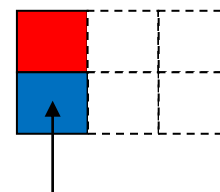
Student : because brother asked moms cake.

The next activity the teacher explore students understanding of the statement “the brother asked for $\frac{1}{2}$ parts of cake whose mother has”. The statement is different from “ the brother asked for $\frac{1}{2}$ parts”.

The teacher guides students to be able to describe the problem in the form of semi-concrete image is as follows:



Represent mother's cake $\frac{1}{3}$ parts



Represents the cake which brother asked $\frac{1}{2}$ parts of mother's.

From the picture it looks like the brother has a $\frac{1}{2}$ parts of $\frac{1}{3}$ parts of cake or worth with $\frac{1}{6}$ parts of cake.

Mathematically it is describing $\frac{1}{2} \times \frac{1}{3}$

In this class, teacher applied mathematic pedagogical content knowledge. Mathematical pedagogical content knowledge is important factor in mathematics success of students in school. Shulman stated that professional competence and pedagogical competence or known as teaching knowledge of the teacher candidates specialized on mathematics content need attention as well [12].

The development of mathematical knowledge for teaching in teacher or in teacher program can be alternative. Teaching task can be improved with mathematical knowledge for teaching. Mathematical knowledge for teaching is a kind of knowledge which is applied in special context to help students develop mathematics ideas.

The next question is how mathematics skills are after learning based of mathematical knowledge for teaching? Mathematical content knowledge test given to students in two group of level 4 elementary schools who joined learning based on mathematical knowledge for teaching and traditional learning. This research uses a paired t-test and Analysis Tools in Microsoft Excel 2010. The result shows that on the significance (α) 0.05 (see table 1). Implementation of MKT on

the learning of mathematics gives positive impacts against the students' mathematical ability.

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TABLE I. THE COMPARISON BETWEEN TREATMENT WITH LEARNING BASED MKT AND TRADITIONAL LEARNING

t-Test: Paired Two Sample for Means		
	<i>Variable 1</i>	<i>Variable 2</i>
<i>Mean</i>	53.3617647	84.5705882
<i>Variance</i>	254.431524	124.407594
<i>Observations</i>	47	47
<i>Df</i>	46	
<i>t Stat</i>	12.809088	
<i>P(T<=t) one-tail</i>	1.1745E-14	
<i>t Critical one-tail</i>	1.67936031	
<i>P(T<=t) two-tail</i>	2.3489E-14	
<i>t Critical two-tail</i>	2.0125153	

What's more, the average scores of students traditional learning is lower than the learning with MKT. The calculation using the normal gain shows that the highest average comes from the higher class students, namely 0.76 (category). While the middle and below groups are at 0.69 and the 0.58 scores is in the medium category. According to table 1, it can be stated that the change in the pattern of teaching and understanding teacher (after implementing MKT) gives positive feedback towards the student improvement in the learning of mathematics materials. Constructivist mathematical content knowledge started to grow in class with learn based mathematical knowledge of teaching.

Furthermore, the findings showed that the development and experience of teachers in lessons and learning activities which participating in helping them to choose the most appropriate learning content, process, product, and environment.

This related to the research findings conducted by Gencturk [17], which states that the support of the existence of mathematical learning resource will be essential in the process of implementation of the MKT in classrooms.

IV. CONCLUSION

Based on the results of this research, it shows that the implementation of MKT in the learning of mathematics gives a positive impact against the students' mathematical ability. It is because that the support of learning resources and the interpretation of mathematics become important in the learning of mathematics, especially in elementary school.

The students in class with learning based mathematical knowledge of teaching in this research were motivated to participate. Students expressed this I can learn a lot myself. In order to continuously increase quality, this is a good principle for students, but also for teacher in primary education.

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