Pedagogical Content Knowledge of Elementary Math Teachers

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Abstract: The purpose of this qualitative case study is to get an in-depth understanding of how 13 grade 5 elementary school mathematics teachers in professional learning communities demonstrate their pedagogical content knowledge. Data collection uses triangulation techniques, namely document study, observation, and interview. The results showed that by learning in professional learning community teachers would assist in lesson plan, carrying out learning activities, and assessment so that they could improve their pedagogical content knowledge. It was also revealed that the practice of teaching math in class was in line with the learning plans they had prepared in advance. Based on the implementation of professional teacher learning activities it can be concluded that the knowledge and skills of teachers in teaching mathematics are well developed, develop the curriculum, and can better master the characteristics of students.

Keywords: Pedagogical Content Knowledge, Mathematics Teacher

1. Introduction

Important teachers have pedagogical content knowledge, because the main task of the teacher is to provide educating lessons (Ayers, 2017; Deng, 2017; Kleickmann et al., 2015). Without pedagogical content knowledge, the teacher will lose direction in carrying out his duties. Mathematics teachers who teach in elementary schools should be able to have pedagogical competencies that are in accordance with the learning needs of their students.

There have been many studies on teacher's pedagogic content knowledge, knowledge (Deng, 2017; Kleickmann, 2015; Ayers, 2017) and their experiences (Kyung & Park, 2017) During this time, teachers often face difficulties in carrying out their basic tasks, for that it requires a learning community that facilitates teachers to share their knowledge, skills, and experiences and can help overcome the difficulties they face. The better knowledge and skills of the teacher will bring positive changes in teacher attitudes and behaviors that will impact on student achievement (Darling-hammond, 2000; Guskey, 2010; Lieberman & Lieberman, 2009) and school performance.

Through a professional learning community, it is expected that teachers can learn various mathematical knowledge and skills so that they can improve their pedagogical competencies. Teachers can learn by reflecting together through three stages, namely before, during, and after learning. The teacher is also expected to continue to improve the learning design to improve the quality of learning in his class. The results of this reflection are empirical didactic designs (Suryadi, 2010). Based on this description, the main focus of this research is on the development of teacher's pedagogical competence through professional learning communities.

Teachers should be able to prepare themselves before teaching properly. One of the competencies that must be possessed by teachers is pedagogic competence. Pedagogic competence is the ability to manage student learning which includes understanding of students, designing and implementing learning, evaluating learning outcomes, and developing students to actualize their various potentials.

2. Background Theory

Pedagogical content knowledge is knowledge about teaching that must be possessed by the teacher ("shulman1987.pdf," n.d.). (Ball, Thames, Phelps, & Ball, 2008) shared the knowledge of teaching mathematics into two categories, namely subject matter knowledge (Vocational) which relates to the mastery of subject matter and pedagogical content knowledge (PCK) relating to teaching mastery by the teacher.

Pedagogical Content Knowledge (PCK) consists of: Knowledge of Content and Student (KCS), Knowledge of Content and Teaching (KCT) and Knowledge of Content and Curriculum (KCC). KCS is knowledge about how students learn mathematics and how their development level can predict responses and anticipate student responses, and can anticipate difficulties and obstacles to student learning, hear and respond appropriately, so that they can create an effective learning design, which can facilitate students in achieving learning goals. Teachers should be able to master the characteristics of their students and be able to communicate with their students.

Primary school students are those aged 7-12 years. In this phase they will experience development in the physical, intellectual, socio-emotional, moral, spiritual and socio-cultural aspects. Physical development of students will affect their personality, especially with regard to body image, self-concept, self-esteem and self-esteem problems (Nuhrisan, 2007).

In cognitive development, they are in a concrete operational phase (Piaget). In this concrete operational phase, they are able to think operationally, use logical reasoning but are

still in concrete situations. Piaget (Santrock, 2011) argues that one of the important tasks studied in this phase is seriation and transitivity and conservation (Slavin, 2008). In this phase students can master the basic skills of reading, writing and arithmetic (Santrock 2011) and have been able to classify or divide things into different rules or sub-rules and consider their interrelationship (Ojose, 2008). Socio-emotional development is characterized by the growth of self-concept, self-esteem, and relationships with peers.

KCT is knowledge that combines knowledge about mathematics and knowledge about teaching. This refers to the teacher's decisions in the sequence of activities and exercises. Teachers should be able to master learning theory and the principles of learning that educate, and can implement educational activities that educate.

While KCC is knowledge about curriculum content, including "tasks involved ... and mathematical demands of these tasks" (Hill, Ball, Schilling, & Hill, 2012). Teachers should be able to develop curriculum, assessment and evaluation and can develop their students' potential,

3. Method

Researchis a qualitative research with case study method. All data is displayed in descriptive form. This study involved 13 fifth grade teachers from 7 elementary schools in West Bandung Regency. The study began with an assessment of the teacher's abilities, the making of learning designs with angle, discussions and reflections conducted on the teacher's work group, a reflection on the students' work, and a revision of the learning design and learning strategy.

Before, during, and after learning, all teacher activities were recorded and recorded through interviews, classroom observations, video recordings, and document studies. Open interviews were conducted to find out the learning activities carried out by the teacher and the development of the teacher's pedagogical competence during reflection for action and reflection of action. Class observation was conducted to observe the pedagogic competence of the teacher in reflection in action. Video recordings and document studies were carried out at the time of reflection for action, reflection in action and reflection of action. This is done to see the development of teacher's pedagogical competence through professional learning communities.

The results of the interviews were transcribed and analyzed to describe the activities carried out by the teachers. The results of the observation sheet were analyzed to get an overview of the interactions that occur in class that can be used as material for discussion in improving the pedagogical competence of teachers. This is also done to confirm answers to interviews conducted with teachers.

4. Results and Discussion

a. Results

In the reflection for action activity, the teacher plans learning by comparing their learning design last year to the professional learning community. The teachers agree to determine what topics will be discussed, namely determining the area of the triangle based on the angle. This topic was chosen because so far, there are still many students who have difficulty with the material and the teacher is unable to develop learning. Based on the documentation study, the teacher directly gives the topic of determining the area of a triangle based on the magnitude of the angle by drawing angles using a protractor. Based on the results of interviews with teachers, students seemed passive during learning, difficulties in using a protractor and learning outcomes obtained were not satisfactory. The teachers then

discuss and make decisions that the learning design must be changed to be more efficient and effective.

Together, teachers make learning designs. First, the teacher develops the curriculum by making learning goals and teaching materials with the topic determining the area of a triangle based on the angle. Learning objectives are formulated and developed based on competency standards and basic competencies to be achieved by using operational verbs that cover cognitive, affective, and psychomotor aspects. Learning objectives contain the process and description of learning outcomes that will be achieved by students by not causing multiple interpretations, measurable and can be made tests. The purpose of learning is also adjusted to the learning needs of students, which is adjusted to the level and grade level. In compiling teaching materials, teachers consider learning trajectory and learning obstacle for students. Teaching materials are also adapted to the context of life and the development of science and technology.

Second, the teacher develops knowledge of mathematics and knowledge of teaching by planning effective learning activities. The activity is to plan learning strategies and methods that are relevant to achieving learning goals. Learning strategies and learning methods chosen can facilitate students' understanding, adjusted to the level of cognitive, affective, and psychomotor development of students. Each stage of learning is given a time allocation that is proportional to the complexity of the material and student learning needs.

Third, the teacher understands the characteristics of students by choosing learning resources and learning media that are in accordance with the learning materials and strategies. Learning resources and learning media chosen can be used to achieve learning objectives, can facilitate students learning, and in accordance with the development of cognitive, affective, and psychomotor students. The result of reflection for action is a hypothetical didactic design (DDH).

At the reflection in action stage, the teacher held an open class simulated by a model teacher by implementing DDH. Other teachers observe learning activities and didactic situations that occur in class, namely observing: student responses, collaboration that occurs, learning flow, use of learning resources and media, and time efficiency.

The comment given to the model teacher is that the teacher should not immediately give the material draw a corner of the triangle using a protractor, but start learning by calculating the angle using the angle on the clock. Then the teacher teaches students to use a protractor, then draws a triangle based on the angle using the protractor.

At the reflection of action stage, the teachers analyze the learning activities based on observations. Observation results show that students are actively involved during learning because all students participate in learning because the model teacher has conducted learning in accordance with the learning path that has been prepared. The use of contextual learning media and very easy to obtain. The teacher has also been able to do time efficiency. The results of the interviews obtained the following data.

R: "How do you start learning?"
Q: "I do apersepsi and convey competence to be achieved."
R: "Did you feel master the subject matter?"
T: "Yes, I adapt the lessons to the learning objectives. I also associate subject matter with other relevant and contextual knowledge.
R: "Have you applied effective learning approaches / strategies?
Q: "I don't know ... but I have adjusted the learning activities to the learning objectives ...."
R: "What about the use of learning resources and media?

Q: "For learning resources, I use several books and often search the internet. Sometimes I make learning media involve students, but sometimes make it myself or that is already in school. "

R:" How do you motivate and maintain student involvement in learning? "

Q:" I always invite students to always be active with activities. If students look passive, I will give ice breaking .... "

R:" What about using language?

Q: "I think, children understand the spoken language and the writing that I use."

R: "How do you close learning?"

Q: "I reflect and make a summary by involving students ... then giving assignments or exercises problem. "

Based on the interview, it was seen that the teacher was confident in his ability to teach. The result of reflection of action in the form of hypothetical Didactic Design.

b. Discussion

The main task of the teacher is to do learning in class, for that important teacher has Pedagogical Content Knowledge (PCK). PCK will assist teachers in the practice of effective learning (Ball et al., 2008; Koehler & Mishra, 2005; "shulman1987.pdf," n.d.). Effective learning results from study, reflection, training and hard work. Without these activities, teachers will not know about how students learn, what hinders their learning, and how teacher instruction can improve their learning (Mizell, n.d.). Teacher's high pedagogical knowledge will greatly affect students' mathematics achievement (Fung et al., 2017).

Learning practice is a complex skill, which requires special skills (Troen and Boles, 2003). Therefore, teachers must master the knowledge that will be taught and master teaching skills (Santrock, 2014). Before teaching the teacher must master the knowledge that will be provided, as well as knowledge about transferring the information he has through good communication with his students.

Effective learning does not occur due to accidents, but through dynamic interaction between reflections of teaching results and deep knowledge (Nevgi & Löfström, 2015) then discussing their knowledge and expertise and difficulties in teaching to other friends. In addition, they also need to look at other ways of teaching that are more innovative using technology (Alqahtani & Powell, 2017).

Teachers need to learn in a professional learning community (Grosemans, Boon, Verclairen, Dochy, & Kyndt, 2015). In the professional learning community, teachers will improve pedagogic competencies according to needs (Chambers, Lam, & Mahitivanichcha, 2008), gradually, from time to time (Adams, Lo, Goodell, & Nachtigal, 2017), and held continuously to build culture professionals with collaborative learning (Dunne, n.d.). By learning in the community, teachers can share their experiences and knowledge so that they can improve the quality of learning (Guskey, n.d.).

In this study, the teacher professional learning community is a group of elementary school teachers who interact with each other by conducting discussions, looking at learning practices, making decisions and improving learning design through reflection. Reflection involves taking past experience as a starting point for learning (Dewey, 1933). The reflection done by the teacher consists of three stages, namely: reflection for action, reflection in action and reflection of action.

At the reflection for action stage, the teacher makes learning designs together. Teachers need to be 'critical learning design experts' (Bekerman & Zembylas, 2014). The learning design is made through a process of reflection about the concepts to be taught (Mizell, n.d.;

Zwozdiak-myers, 2009). Learning design supports two main learning objectives, namely improving the quality of teaching and facilitating the integration of technology in teaching and learning. In addition, the teacher can do research and analyze all the activities he has done (Lockyer, Heathcote, Dawson, 2013).

First, the teacher determines the learning objectives by paying attention to the suitability of the curriculum and paying attention to the characteristics of students. The purpose of active learning is predicted to be active in overcoming difficulties, providing continuous motivation, and higher achievement in facing challenges because of trying something new (Grant & Dweck, 2003). Teachers who develop learning oriented to learning goals can increase students' capacity to respond constructively to performance failures and negative feedback (Dahling & Ruppel, 2016). Learning objectives will be more easily achieved if students learn collaboratively (Mercier, 2016).

Second, The teacher compiles teaching material in a coherent, logical, contextual and up-to-date manner. The teacher considers students' learning trajectory and learning obstacle and does didactic anticipation. Lesson planning is an important process for teachers to convert textbook content into unique scripts that are different for their teachers and students (Li, Chen & Kulm, 2009). The use of technology in learning must be in accordance with the learning objectives (Mcculloch, Hollebrands, Lee, Harrison, & Mutlu, 2018).

Third, the teacher plans effective learning activities by developing allegations about student responses that may occur over didactic situations that are developed on the goals and learning materials, students' needs and potential in learning and pedagogic anticipation (Suryadi, 2010). Parkay and Stanford (2011) argue that teachers are important in knowing learning and learning theories because they will guide teachers in making decisions. Instructional decision making will have a positive impact on student learning outcomes.

Fourth, teachers choose learning resources / learning media in accordance with learning materials and strategies. Learning resources and media should assist teachers in creating a conducive didactic situation, how to convey learning material supported by textbooks, manipulative objects or with the help of technology (Mårell-olsson, Lars, Jahnke, & Bergstr, 2017). Then the teacher anticipates didactic and pedagogic (Suryadi, 2010).

At the reflection in action stage, the teacher does an open class. Open class is very important for teachers so that teachers can get comments from their peers. The use of relevant learning methods will greatly assist students in understanding learning material.

How do teachers start effective learning, master the subject matter, apply effective learning approaches/strategies. The teacher also observes how to use learning resources / media in learning, how to motivate and maintain student involvement in learning, using language that is correct and appropriate in learning, ending learning effectively.

At the reflection of action stage, the teacher analyzes the activities of model teachers and students, teaching materials and student learning outcomes shortly after the open class activities. Through this analysis, the teacher should be able to give students the widest opportunity to learn and implement the knowledge they master. The results of the analysis are compared with the previous learning design and revise the learning design so that the learning design can provide the widest possible space for students to have independence of thought through the didactic design design of the teacher. The results of reflection of action in the form of learning designs are called the Empirical Didactic Design (Suryadi, 2010).

The activity series reflection for action, reflection in action, and reflection of action are recorded using video. Video recordings are analyzed to see the effectiveness of teacher learning activities (Vrikki, 2017). Analysis of video recordings and teacher learning activities

in the teacher community is a professional learning tool that is useful for teachers to examine and improve their teaching, structural and relational challenges (Cherrington & Loveridge, 2014) so that teachers can continuously improve and improve their performance.

5. Conclusion

This study is to develop pedagogical content knowledge of elementary school mathematics teachers. The findings of this study indicate that (1) the teacher's pedagogical content knowledge will develop if the teacher continuously learns; (2) the most effective way of learning for teachers is through professional learning communities; (3) to improve the quality of learning, the teacher should always revise the learning design. Several factors were identified limiting pedagogical content knowledge of elementary school mathematics teachers so that it was less developed, including previous school experiences, social norms, mathematical knowledge to teach, attitudes that did not dare to act because of habits, time constraints, curriculum, student behavior and learning environment. In addition, weak knowledge of the philosophy of mathematics and learning theory.

The findings of this study show the important role of mathematical philosophy, as a practice of learning (for example, Cockcroft, 1982). Ernest (2012) proposed several arguments about the philosophy of mathematics which holds the key in professional teachers. First, emphasizing the relationship of philosophy with mathematical knowledge related to character, origin and justification, with special attention to proof. Second, that mathematical, constructive and structural theories are related to their character and development, as well as evaluation and evaluation problems. The third is mathematical objects which are related to character, origin and their relationship to the language of mathematics. Fourth, methodology, related to mathematical practice. Fifth, related to the application of mathematics which is related to science, technology, other fields of knowledge. Sixth, value, mathematical ethics, and application. Seventh, relates to the learning of mathematics which is related to the nature, role in the transmission of knowledge and individual creativity. This can be used as input for the elementary school teacher professionalism development program to integrate the philosophy of mathematics into its activities.

The development of sustainable teacher professionalism in Indonesia has become a necessity. It is important that teachers have pedagogical content knowledge but knowledge of mathematical content also needs to be emphasized. This is not because the development of teacher professionalism is more emphasis on pedagogical content knowledge, but the integration of knowledge of mathematical content is very weak.

The importance of experience and knowledge for teachers needs to be addressed by policy makers, by providing other experiences and knowledge on an ongoing basis and not just demanding their hard work. This is useful to provide opportunities for teachers to reflect on themselves from classroom learning practices as a way to develop their knowledge and skills in the future. This can be done in several ways, such as (1) creating programs that provide opportunities for professional learning, (2) involving teachers in the professional learning community, and (3) involving teachers in research activities on an ongoing basis.

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