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An Analysis of Teachers' Pedagogical Content Knowledge on Number Sense Learning of Early Childhood

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ABSTRACT: This article is about an analysis of teachers' Pedagogical Content Knowledge (PCK) during teaching the concept of number for early childhood. Research subjects were three kindergarten teachers in Depok area, West Java, Indonesia. This type of research is qualitative that analyzed the phenomenon of PCK when teaching the concept of numbers to children aged 5-6 years. Researchers conducted two observations, interviews and documentation studies. The results showed that the three respondents did not understand the concept of numbers as a whole. Respondents also did not comprehend the definition of the concept of numbers and the appropriate stages associated with the concept of numbers. In addition, the three teachers did not understand the overall curriculum of early childhood education. However, with their sufficient teaching experience, they were considered to have good teaching skills and good evaluation of learning process. The obstacle faced by them was quite the same in which they still found it difficult to teach the concept of numbers with different characteristics of children. It required a particular strategy for the teachers to overcome these obstacles. The results of this study is expected to be a consideration to hold a professional workshop development program in order to improve the professionalism of early childhood teachers particularly in teaching mathematics.

***KEYWORDS**: Number Sense, Pedagogical Content Knowledge, Teachers.*

I. INTRODUCTION

Early childhood learning phase is proven to be a significant factor in children growth particularly because studies indicated that those who are exposed to high quality learning at the age of 0 to 6 will tend to perform better on academic tasks such as reading, writing and maths. However, it is known that early education historically emphasizes merely on the language development and pre-reading skills of young children, often at the expense of mathematics education (Linder, 2011). This is quite disappointing as research has demonstrated that early mathematics skills can be used to foresee both mathematical and literacy skills (Cohrssen, 2016). National Association for the Education of Young Children (NAEYC, 2010) indicates that children's early math experiences will have "long-lasting outcomes". For example, an early math concepts, such as knowledge of numbers and ordinal (eg , first, second, third), were the most powerful predictors of later on learning. This is also supported by Duncan's study (2007) which found that early math is a more powerful predictor of later reading achievement than vice versa. The early childhood years, from age 0-8, serve as perhaps the most important developmental years of one's life. In recent years, the importance of this development has been recognized and embraced by teachers, parents, and researchers, particularly in the area of mathematics (McGuire, 2012).

Based on the results of interviews with teachers who teach children aged 5-6, it is found that one of the most concerning problems of learning in the classroom is on teaching the concept of number (number sense) as the material is found to be quite difficult for children to learn. In fact, the number sense is the most important concept for early childhood education. Number and Operations is arguably the most essential of the areas. The learning of numbers and operations in the early childhood years might be the best-developed area in mathematics education research (Baroody, 2010; Kilpatrick, 2001). Research suggests that targeting number of sense development in early mathematics prepares students to learn more complex mathematics concepts such as value (Van de Walle, 2003). In general, early exposure to number sense concepts will equip students with an understanding of core mathematical properties and promotes numerical fluency (Baroody 2009). Number sense skills developed in early elementary can also be highly predictive of one's mathematics achievement as late as high school (Duncan et al., 2007).

In Indonesia, the government has provided guidance on the level of achievement of early childhood development. The reference is contained in the Minister of Education and Culture of the Republic of Indonesia number 137 of 2014 on the National Standard for Early Childhood Education especially for children aged 5-6. The concept of numbers lies in the scope of logical and symbolic development. The teacher plays an important role in the success of children in understanding the concept of numbers. A teacher must also acquire the pedagogic concept of numbers as well as to master the content. Teachers were expected not only to be able to deliver information to students but also incorporate some interesting activities and strategies in order to gain a successful learning outcome. Moreover,it isalways believed that good pedagogical content knowledge must also be part of this process.

Shulman (1986) argued that pedagogical content knowledge is a distinctive form of teachers' knowledge that is resulted from their pedagogical knowledge and content knowledge. Pedagogical content knowledge is commonly manifested as representations of content knowledge through means such as analogies and narratives that bridge the gaps between students' understanding and the content knowledge (Hsu, 2013; Hill, 2008; Leong, 2015). Tasmir (2012) stated that pedagogical content knowledge focuses on definitions and its components and developments in one's cognitive domain. Pedagogical content knowledge consists of 4 components: teaching concepts and objectives, knowledge about students, knowledge about curriculum and knowledge of teaching strategies(Grossman, 1990; Peng, 2013).This study analyzed the pedagogical content knowledge of teachers when introducing the concept of number for early childhood. In this study, the concept of number material is limited to learning about addition and reduction of numbers.

II. METHODOLOGY

This type of research is qualitative which analyzed the phenomenon of Pedagogical Content Knowledge particularly in teaching the concept of number. Research subjects were three kindergarten teachers. Children aged 5-6 were chosen as they were expected to be able to articulate numbers when the symbols of numbers shown. In this case, the researcher conducted two observations to analyze how the learning process of addition and reduction of numbers. The three teachers were kindergarten teachers in Depok area of West Java, Indonesia.The procedures of data collection in this research were as follows: 1) Observation by using video recording. All activities of class respondents were recorded to facilitate the process of analyzing respondent's PCK. 2) Interviews were conducted to delve deeper into information that was not obtained on videotape. 3) Adocumentationstudy was conducted on documents pertaining to respondents' backgrounds such as GPA, educational credentials and so forth. After all the data collected, the next step was data analysis. The research instrument refered to a chart compiled by Wilson (2013) on Learning Trajectory Interpretation for Mathematical Knowledge Teaching Categories, which was further adapted to the pedagogic competence of the Minister of Education and Culture of the Republic of Indonesia number 137 of 2014.

III. FINDINGS

Description of Respondents

Respondents consisted of three female teachers who were under a pseudonym: Ina (49), Ola (40) and Rita (34). All three graduated from undergraduate programs. Ola and Rita graduated from Early Childhood Education, while Ina graduated from Religious Studies Education. Nevertheless, Ina has a sufficient experience for having been teaching in a Koran-based school for 15 years and teaching in kindergarten for 6 years. Ola and Rita have teaching experiences for 16 years and 8 years respectively. Ola and Rita considered their educational background to be important instruments to support them in their teaching career. They also believed that some subjects they had studied in college such as curriculum development, psychology, and class administration had significantly contributed to their careers as kindergarten teachers.. On the other hand, Ina is assisted only by her experience and several trainings in order to be prepared with her teaching career. Ola is currently teaching at a school with good facilities where she can easily employ varied learning media. She has around 20 students in her class and also one assistant teacher. In contrast, Ina and Rita are being constrained by the poor availability of learning media and facilities. Therefore, they are forced to think about finding alternatives. These two teachers do not have any assistants. There are around 10 to 12 students in their kindergarten class which is situated in the area of Depok, West Java, Indonesia.

Knowledge of Content and Students

The basic ability of a teacher is to be able to group students according to their needs. It is indeed a difficult task to do, thus, it takes a particular strategy in order to implement it successfully. Ina and Rita work in schools that use learning models with a group approach. Group-based learning is a learning pattern in which children are divided into groups. In this model, students will be divided into (three) groups and each group performs different activities. In one meeting, the students must complete 2-3 activities in groups thoroughly. But in the implementation, Ina did not divide the group because the number of students was only 9. Therefore, she decided

to apply the same activity in which students were asked to work on worksheets and make numbers by using candles / clay and fruit props. Ina was found to be having no challenges and difficulty in running the class. In contrast, Rita divided her students into three groups. She understood the characteristics of her students which she used as knowledge to group them based on the level of ability. She also gave different treatment to each group. Those categorized as fast learners were given worksheets. As for students with lower ability, she provided more guidance on how to add up numbers by using beam props.

Ola's school is known to apply the center learning model. This model is a learning approach where the "circle" (circle times) and play centers are involved. The circle is when the teacher sits with the students in a circular position to give them a cue for starting and finishing the game. The preparatory center emphasizes the introduction of early literacy in children. The use of books and stationery can be done in all centers but the preparation center is enriched dominantly with the type of play activities. Ola gathered the students in one group but it seemed that she was not really able to lead the class. The kids were found to be noisy and paid no attention to the teachers' explanation.

Ina, Ola and Rita performed similar activities at the beginning of learning. Ina asked one of the students to talk about the previous meeting. Ola started the lesson by asking the children to sing about the names of days, months and year. She also asked them to connect the days, months, and years with numbers. For example, Monday is the first day; Tuesday is the second day and so on. In order to find out the students' early abilities, she asked them to answer some questions. The teacher's next activity was to explain the sum on the board then asked the students about the concept. The students were excited and scrambled to answer. Unfortunately, the children were found to be noisy and did not pay any attention to the teachers. What Rita did was not much different from two of her peers. Rita asked some students randomly about numbers and strategies of addition. She drew banana on the board and then asked her students randomly to calculate and write the number of the banana. This was done by her to acquire initial information about her students' early ability in the first meeting.

The obstacle faced by teachers when teaching the concept of numbers is that there is different level of children in understanding the concept of the number itself. Teachers should be able to identify early childhood difficulties in various areas of development. Rita stated, "there is a child whose concept number up to 10 is a very fast learner but there are some other children who still find it difficult to memorize basic number." Ola also said that the development of each child is different. Some of them are actively learning and some are not really enthusiastic. Their responsive period might have not yet appeared for some children. Learning also needs a process of maturity." Obstacleswere also encountered when new children enter school. Some children may have already acquired the concept of number at home but some are not prepared at all. She admitted that this can be a serious constraint as some students who have acquired the numbers will tend to disturb their friends due to having no attention to study. Teachers certainly have their own strategies with these constraints. Unlike Rita, Ola has a different strategy; she prefers to devote full attention to children who are slow in understanding the concept of numbers. "The strategy is to help those who are slow until they understand. However, some are still having hard time to understand and teachers will teach them back tomorrow and still provide special attention."

Knowledge of Content and Teaching

The teacher's knowledge of the concept of numbers is essential because it is the basis for them to introduce numbers to children properly. When asked to explain the concept, the three teachers were not able to explain correctly. Ina and Ola could only explain how to teach the concept of numbers without knowing the actual concept of the numbers. They claimed there had been no socialization of the government regulation. However, when the document analysis was conducted, the manuscript on government regulations was owned by the three teachers. Once confirmed, Ina replied that she did not know that the questions given were related to the manuscript. Ola thought that the book does not contain any government regulations but curriculum 2013. However, all of them admitted that they have used the manuscript as a guide in designing the learning strategies.

The three teachers did not understand the various learning theories and the principles of educational games which were related to various fields of development in early childhood education. Ola and Rita said that they actually learned about it when they were still at the university specializing in Early Childhood Education, whereas Ina said that she did not know much because she had no foundation on early childhood education. Similarly, when asked about the objective of achievements of early childhood learning, all three were not able to answer well. Regarding the design of learning, all three respondents prepared it very well. Each teacher has drafted the design of game activities in the form of annual, semester, weekly, and daily program. After the documentation study, the teacher's design was found to be in accordance with the current curriculum. Ola explained that the drafting was finished by the assistance of other colleagues. She also said that they also have Teachers Working Group where they can discuss about learning/ lesson plan. The curriculum guidelines are also based on the government's 2013 curriculum and also adapted to the characteristics of the school. Ina explained that she has designed the lesson plan by herself and based on the current curriculum. She realized that the curriculum can be changed every year. However, she followed the latest evaluation from the previous academic year. In addition, Rita also second the previous statement from her peers and said she also did not make the

slightest change from the previous year. As previously revealed, the three teachers did not understandthe theory of learning and approach in teaching the concept of numbers to children. Nevertheless, all three employed instructional media and principles of educational and meaningful playing while learning strategy.

At the time of second meeting observation, Ola introduced numbers to the students with one-on-one correspondence. She asked the students to connect the numbers to the image of the animal according to the drawing shown. At the end of the learning, the teacher gave worksheets so that the students would do the sum. At that time, the teacher also called upon some students to answer questions of teachers especially those who had difficulty working on student worksheets. In contrast to Ola, Rita introduced numbers with images of fruits. She asked the students to group fruits based on different types. Furthermore, the teacher asked the students to add the fruits. The questions were varied. The teacher gave the student worksheet for the students to do the addition questions. The teacher roamed around helping students doing their work. At the end of the lesson, Rita asked the students to play hide and seek which was aimed to eliminate the boredom situation. Ina did the same thing by asking about the previous meeting. She took the children to the garden to look for leaves and then invited them to add the leaves. She tried to bring the children into a fun situation in order to have a memorable experience when learning the concept of numbers. Furthermore, she also gave rewards to those who completed the task by drawing stars on their paper tasks. This can be considered as positive move as students became motivated and always eager to be parts of the learning process. When interviewed and were questioned about information technology,they said that it was seldom for them to employ the internet (websites) as a source of learning. Learning resources can only be obtained from additional activities such as training or gathering in group teacher activities. However, they said that the use of additional props like VCD and computer was still necessary. Not much information was gained regarding the question on the use of information technology.

IV. DISCUSSION

The ability to recognize the charactersof learners is one of the pedagogic aspects that the teacher should possess. The orientation phase can determine diverse strategies to cater students with different characteristics. Identifying early childhood students' skills needs to be carried out because teacher teaching plan must be oriented to the needs of the children. Early childhood education is in need of educational initiatives to achieve optimization of all aspects of development. Tina Bruce states that the first sequence of 10 common principals of early years of education is the best way to prepare children for their adult life as children. Teacher should be more alert about the need of the students (in Hussin, 2016). The research finding also showed that respondents completed some appropriate instructions. Respondents grouped their students in the classroom. This step was carried out by identifying early abilities and difficulties of the learners/children.

This is in line with the CCEA study (2017) which states that progression in activity reflects the observation and assessment of children's knowledge, skills and attitudes in order to provide appropriate developmental experiences. Children who come to pre-school are already identified as skilled learners. Through observations, assessment and professional judgments, valuable insights into how each learns best can be gained. This information informs the planning process about meeting the needs of each individual. Progression in playing games comes as a result of a real understanding of the interests, needs and experiences of the child. As practitioners, we need to understand that there must be a progression in the provision of activities to meet the developmental needs of children. A teacher must understand the concept of number, the curriculum of early childhood as well as learning theories and the principles of educational games while learning related to various areas of development in early childhood. It is a prerequisite of teachers to design learning activities. From the questions asked through interviews, it appeared that teachers still did not acquire the theories of numbers. In fact, theoretical knowledge/ content are undeniably needed by the teacher. Moreover, pedagogical content knowledge has been defined as the intersection of knowledge of the subject with knowledge of teaching and learning (Niess, 2005).

Teachers should also be familiar with the time management, subject of learning, content of the co-curriculum and many more (Hussin, 2016). Respondents were not able to meet aspects in terms of content knowledge and criteria mentioned by McCray (2012) which states that pedagogical skill for preschool mathematics requires an understanding of the concepts of mathematical content combined with the skill to closely observe children's game activities. Teacher content knowledge is important because it is necessary for good teaching (Ball, 2005; Ball, 2008; Evans, 2011). The introduction of pedagogical content knowledge will have contributed to the understanding of the concepts and the learning of subjects (Ball, 2008). As a result, it is suggested that some socialization or training should constantly be held so that teachers can understand the concept as a whole and gain knowledge about the concept of numbers, curriculum and learning theory.

Furthermore, the ability of teachers in designing the learning process is another important skill to possess. The learning plan should be made before the implementation of the lesson. The lesson plan should refer to the characteristics (age, social culture and individual needs) of children involved in the learning. In the implementation of the learning, this plan must also be prepared with different period of academic such as learning plan on annual, semester and weekly basis. Besides, Study Implementation Plan and Daily Learning

Implementation Plan must also be taken into account. The purpose of making lesson plan are 1) as a reference for teachers in implementing learning process; 2) as a supporting tool in achieving the successful implementation of learning; 3) as an instrument in directing teachers to prepare necessary materials and educational devices; 4) and as a direction for teachers to build the attitudes, knowledge and skills that children are expected to have (Mod, 2017)

Of the three teachers, it appears that Ina had better ability to lead the class than the others. This was probably influenced by the fact that she has longer experience of teaching. Ina was also able to control her nerve when facing problems in the classrooms. She was also deemed competent by making quick respond to students' complaints and demands. This might be affected by the number of teaching hours which improved her skill of teaching. However, further research is needed on the extent of the influence of teaching experience on pedagogical content knowledge of teachers, especially teaching the concept of numbers for early childhood education level in Indonesia.

The purpose of classroom assessment and evaluation is to give students the opportunity to show what they have learned rather than catching them out or to show what they have not learned (Jabbarifar, 2009). As part of reflective teaching movement, teachers are encouraged to conduct research in their own classrooms (Nunan, 1989; Ailwright, 1991; Richards, 1994). Thus, topic related to classroom assessment and evaluation is an important part of such research. Classroom assessment and evaluation under the active management of teachers can also serve important professional development purposes since the information resulting from such evaluations provides teachers with valuable feedback about their instructional effectiveness that they can use to develop and improve their professional skills.

Regarding the obstacles of teachers at the time of teaching, the three respondents had the same things to face. They still found it difficult to teach the concept of numbers with the different characteristics of children. However, all the three teachers encompassed the same goal which is to eventually become successful in delivering their lesson to the students particularly to teach concept of number. Therefore, a certain teaching strategy must be applied. Nevertheless, the results of this study is expected to be used as a consideration or suggestion for holding a better workshop in development program and improving the professionalism of teachers in Early Childhood Education particularly in the field of mathematics.

V. CONCLUSION

The results showed that respondents had taken several steps to identify the initial ability of their students and possible difficulties faced by them. Besides, they also made use of the findings to group young children in accordance with their needs. However, the respondents still did not understand the theory of the concept of numbers as a whole. The theory is obviously crucial to be mastered by teachers in order to avoid errors in teaching concept of numbers. However, they have been applying the praxis of classroom learning well. Respondents have also used appropriate media and teaching strategies in teaching. Besides, they conducted learning evaluation which was also used as a reflection in teaching. The constraint faced by these teachers during the teaching session was quite the same. They still found it difficult to teach the concept of numbers with the different characteristics of children. However, the three teachers envisioned the same goal in which they expected to make the students understand the concept of numbers as a whole. The results of this study can be used as a reference for other researchers and other related institution to hold better workshop of development programs in order to improve the professionalism of teachers in early childhood education especially in the field of mathematics. The workshop should provide teachers with the kknowledge about the concept of numbers and strategies to overcome constraints particularly pertaining to the difficulty faced in teaching the concept of numbers with the different characteristics of children.

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