BASIC MATHEMATICS KNOWLEDGE
OF EARLY CHILDHOOD TEACHERS

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Abstract

The purposes of this study are; 1) to analyse basic mathematical knowledge; 2) to identify the difficult materials for Early Childhood Education (ECE) teachers to perceive; and 3) to provide solutions that can overcome the problem. The research subjects were 35 kindergarten teachers with 10 years of teaching experience in one of the districts in the West Java province, Indonesia. The data was obtained by providing mathematics questions, interviews, and observations. The results showed that the average basic mathematics score was 46, with the lowest score of 16 and the highest score of 78. Geometry material was the most difficult question for the participants with the score of 19. During interviews and observations in class, some participants had an inaccurate understanding of the geometry and plane. Based on these results, the researchers contributed in the form of professional development programs using the building block (known as model technology-enhanced), research-based learning system, instruction, assessment, and professional development intervention. This model teaches to enrich the knowledge of geometry for the teacher as well as the understanding the trajectory of children's learning about geometry. Through this program, it is expected to increase the knowledge of geometry both in content and pedagogics.

Keywords: Basic mathematics, Early childhood education, Teachers.

1. Introduction

Mathematics at early childhood education (ECE) is very important and has positive effect upon a child's development [1]. Duncan et al. [2] found that there is a significant effect of the ability of 54-month child upon the child's mathematics achievement. The early childhood skills of mathematics also affected their future abilities, including mathematical ability or others [1-4]. In addition, good quality, challenging, and easily accessible mathematical education for child age 3 to 6 is considered an important foundation for mathematical learning in the future [5, 6]. Therefore, the introduction process should be conducted by play-way method to make the child happy. The impact of playing on child's development is huge [7]. At these golden ages, a child must receive proper stimulus in order to get to know mathematics. The key of this lies at the way the knowledge delivered. Based on the statements above, it can be seen that teachers have important roles in developing the children mathematical skills. Therefore, to be quality educators, teachers should possess good mathematical content knowledge. It is done to avoid misconception when teaching the knowledge. It is stated that a good teacher must have content mastery [8].

Some researchers showed the weakness of early childhood teachers related to content knowledge. It is the fact that there are some early childhood teachers' lack of understanding of basic mathematics knowledge, students' mathematics learning, and effective mathematics teaching strategy. Meanwhile, in terms of teaching material, some teachers face difficulties in introducing numerical concepts to children, compared to other concepts of early childhood mathematics [9].

The purpose of this study was to analyse basic mathematical knowledge of ECE teachers. This knowledge is related to the basic knowledge of mathematics that is often taught in ECE including the concepts of Numbers, Geometry, and Measurement. In addition, the researchers also analysed the material that is considered difficult by the teacher and provide the right solution to overcome the problem.
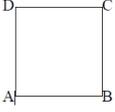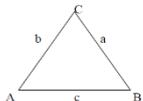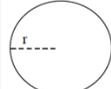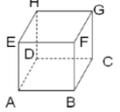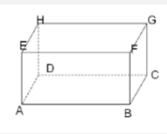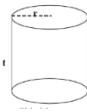
Theoretical framework

Basic mathematics skill for teachers is a part of theory of Mathematical Knowledge for Teaching (MKT) which was developed in previous report [9]. This basic mathematics knowledge is included in the domain of Subject Matter Knowledge (SMK). SMK is related to the level of teachers' knowledge in mastering mathematics particularly material that is taught [10].

SMK is described into some components; they are Common Content Knowledge (CCK) and Specialized Content Knowledge (SCK). Common Content Knowledge (CCK) is defined as the most basic of mathematics knowledge and it is very general [10]. This knowledge refers to mathematics knowledge and skill which is used in situations aside from teaching [11]. Meanwhile, Specialized Content Knowledge (SCK) is specific knowledge which belongs only to mathematics teachers.

On the other hand, mathematics at ECE contains number sense, geometry, and measurement. Therefore, a teacher is encouraged to have basic mathematics knowledge related to the core areas. One of the mathematical concepts that must be mastered by the teacher is according to literature that a teacher must expand the understanding of the concept of numbers. There is a tendency to consider counting as something we do with just whole positive numbers, i.e., 1, 2, 3 and so on. Then, another

one is geometry. Literature advised the teacher to understand the shape of things related to geometry [12]. The materials of geometry that the teacher of early childhood must know are available in Table 1.

Table 1. Shape characteristics.

Type	Property
Square	1. All sides of a square are congruent and all of the opposite sides are parallel. 2. Each angle is 90-degree angles. 3. It has two congruent diagonals, intersect at midpoints, and meet at 90-degree angles. 4. The diagonals bisect each other at right angles. 5. It has four lines of symmetry.
Rectangle	1. The opposite sides are congruent and parallel. 2. Each angle is 90-degree angles. 3. It has two congruent diagonals and intersect at midpoints. The point bisects the diagonals. 4. It has two lines of symmetry; vertical and horizontal lines.
Triangle	Formed if three points which do not lie on a straight line are joined.
Circle	Set of dots that are equidistant.
Cube	1. It has 6 congruent square sides/faces (ABCD, EFGH, ABFE, BCGF, CDHG, ADHE). 2. It has 8 vertices (A, B, C, D, E, F, G, H). 3. It has 12 congruent edges (AB, CD, EF, GH, AE, BF, CG, DH, AD, BC, EH, FG) 4. All angles are 90 degree. 5. It has 4 space diagonals and 12 face diagonals (4 space diagonals = line AG, BH, CE, DF and 12 face diagonals = line AC, BD, EG, FH, AH, DE, BG, CF, AF, BE, CH, DG)
Block	1. The bases are rectangles. 2. It has 12 edges 3. It has 6 sides. 4. It has 8 vertices. 5. All angles are 90 degree. 6. It has 4 s[ace diagonals and 12 face diagonals.
Cylinder	1. It has 2 edges. 2. The bottom and the top are circles. 3. It has 3 sides (2 circles; bottom and top, and 1 flat side
Spare	1. It has 1 side. 2. It has no angles and edges.

2. Research Method

For this study, we collaborated with the district office to invite one kindergarten teacher representing each sub-district in the district. There are criteria for post-registrations for kindergarten teachers who teach children aged around 5 years and having teaching experience of 10 years in one of the districts in the West Java province, Indonesia. Based on this collaboration, there were 35 participants with a background in Bachelor of Early Childhood Education.

The data collection methods in this study are as follows:

(i) Provision of Basic Mathematics questions

The questions given for 45 minutes. The questions were about geometry, number sense, and measurements of 30 items. The following are examples of the questions given.

- In each of the counting patterns, there are some missing numbers. Can you complete the counting in each case?
  ___, ___, ___, 39, ___, 59, ___, 79
- What do you know about circles? Explain the difference with a ball?
- Is πa rational or irrational number?
- Distance to the city of Jakarta-Bandung 200 km. Mr. Halim departs from Jakarta at 09.00 and arrives in Bandung at 11:30. The average speed of the vehicle Mr. Halim is riding on ... km / hour

(ii) Interview

In addition to the questions given, the interview was also conducted to several participants to follow up the answers to the questions they were working on. The interview was conducted randomly based on the results of the answers to the participants' questions.

(iii) Observation

Due to research time limitations, observations were made just on three participants based on the results of working on basic math questions in the categories of good, medium, and low. The observations were conducted in 5 meetings.

Quantitative descriptive analysis was used in this study. Descriptive Analysis is an analysis carried out to assess the characteristics of the data. We also used SPSS program for analysing the data.

3. Results

3.1. Provision of basic mathematics questions

As stated earlier that the results of the study were processed descriptively with the help of the SPSS program. According to SPSS data, it can be seen that the skewness statistic shows -0.08 with a standard error of 0.398. This showed that the data in this study were normally distributed. Out of the 30 questions given, it can be seen that the average basic mathematics achievement of participants was 46.34%. The lowest score was 16, and the highest score was 78. Next, the distribution of the participants' scores is shown in Fig. 1.

From the results in Fig. 1, it can be seen that the highest scores were obtained by 2 participants at 78. On the other hand, the lowest score was obtained by 2

participants at 16. Furthermore, the graph showed 48.6% of participants obtained scores of less than 50. The results obtained by these participants were considered unsatisfactory, reminding that the score obtained was less than 50 or almost 50%.
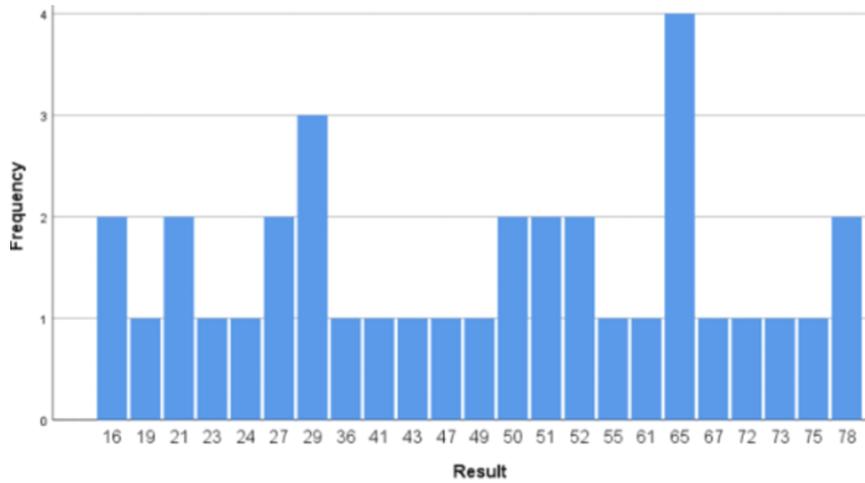

Fig. 1. Participants' scores.

As stated earlier, mathematics for ECE is divided into three categories, namely number sense, measurement, and geometry. From the results, it can be seen that the geometry was the most difficult question for the participants because it obtained an average score of 19.15. It is followed by the acquisition of an average measurement of 47.73, while the number sense obtained the best average of 81.33. This prompted researchers to interview why participants had difficulty in answering questions about geometry. The statistics of average score can be seen in Table 2.

Table 2. Average score of participants.

	N	Mean	Standard deviation	Standard error	95% Confidence Interval for Mean		Min	Max
					Lower Bound	Upper Bound		
Number sense	15	81,33	27,059	6,987	66,35	96,32	26	100
Measurement	5	47,43	35,491	15,872	3,36	91,50	9	89
Geometry	10	19,14	16,717	5,286	7,18	31,10	0	49
Total	30	54,95	37,761	6,894	40,85	69,05	0	100

3.2. Interview

The results of the basic mathematical achievements of the participants were not satisfactory. Based on the results of interviews, all respondents stated that they had obtained this knowledge. But, they had difficulty in answering the questions.

In addition, geometry was also the most difficult material for participants to do (see Table 2). For this reason, the interviews were conducted with several participants who received unsatisfactory results. The results of the interview show that there were limitations to the participants in understanding the geometry and plane. As an illustration, the following was an example of an interview with one of the participants

Researcher (R): what do you know about square?
Participant (P): The square is the box with the same side. But the children sometimes call
it a box
R: What is the shape of this object, ma'am? (While showing a box-shaped object)
P: box (with a smile)
R: What does this paper look like? (While showing a rectangular shape)
P: square
R: What is the difference between square, rectangle, and box?
P: sorry ma'am I'm confused (while laughing).

Furthermore, some participants revealed that they knew about geometry and plane and often applying it in class. However, they never pay attention to the definitions of geometry and plane as they thought that they never applied the definition to the children. They have gained such knowledge when they were in school and college.

Lack of knowledge about mathematics, which caused participants to feel less confident in introducing mathematics, was found. This is because they were afraid of misconceptions. However, most participants did not want to take basic math training. They revealed that the material about basic mathematics was given enough from the books or enrichment material that aimed to refresh their knowledge.

3.3. Observation

As revealed in the research method section, observations were carried out on three participants based on the results of working on basic math questions in the categories of good, medium, and low, in which this standard is the same with the literature [11]. The observations were conducted in five meetings. In this observation, the researchers used pseudonyms for the three participants namely Iyet (score 78), Novi (score 50), and Putri (score 16). In its implementation, the observations were carried out inside and outside the class.

During activities in the classroom, all participants carried out the development activities well and there were no mistakes in the concept of teaching. The media used were very diverse including lego, picture media, balls, and other toys. As for outdoor activities, Iyet brings children with running racing games. Iyet asked the children to put the ball into the bucket. Students race according to carrying the ball in accordance with the amount requested by the teacher back and forth. Putri invites children to play the game "Hopscotch" or in Indonesia famous for the game Sondah. In the Hopscotch game the Player jumps from one square to the next. A square containing precarious fragments should not be stepped on. The player was defeated if stepping on the line or outside. Unlike Iyet and Putri, Novi invited the children to play snakes and ladders. The snakes and ladders game is a game for kids that is played by two or more participants. Children will walk according to the number of dies that come out. If the children are under the stairs, the children will go up the stairs, but on the other hand if they are on the snake's tail, they have to go down, so they used the mathematical process in this game namely addition and subtraction.

But in the implementation of the game given, there were interesting findings when Putri explained about playing Hopscotch. Putri explained several times that

the children must jump inside the square. The shape made by Putri was rectangular. When interviewed, Putri stated that she was still confused by the definition of numbers and geometry. So, at the end of the meeting, we discussed the basic mathematical definitions.

4. Discussion

Based on the results of the study, the participants had limited knowledge of mathematical content. These results are seen in the low number of participants obtained in answering basic math questions, interviews, and observations. The participants' limitations were related to the Subject Matter Knowledge (SMK). These findings are in line with other researchers [13], which state that teachers tend to rely on text for context, not emphasizing interactive discourse that supports the task. Most ECE teachers identified this discipline as an area of their weakest concentration [14]; often uncomfortable with mathematics.

Furthermore, the results of the study also showed that geometry material obtained the lowest average score compared to the measurement material and number sense. Based on the results of the interview, the participants tended to ignore mathematical knowledge including the definition of geometry for reasons never set in the classroom. This is in line with reference [14], which states that most ECE teachers acknowledge the lack of knowledge about the concepts of geometry and mathematics in general. In fact, geometry is very important both as an area of mathematical content and as a focal point for teacher professional development [7]. They added that ECE teachers always ignore geometry even though geometry underlies all aspects of mathematics and other scientific disciplines such as science.

On the other hand, as professional educators, teachers are not only required to carry out their duties professionally, but also must have professional knowledge and abilities. Teacher's knowledge influences students' mathematical achievements [15]; produce solutions, strategies, and provide explanations to students, and are able to evaluate well [16]; influences how teachers arrange and teach material [16]. Especially for ECE teachers, it is expected to master the mathematics content that will be taught to children. Knowledge of teacher subjects influences the specific decisions of their pedagogical content [17].

Although based on the results of the research, the teachers do not really require professional development related to basic mathematics, but in this study, it still recommends professional development for ECE teachers. We suggested professional development known as technology-enhanced building blocks, research-based learning system, instruction, assessment, and professional development interventions [7]. This model serves to enrich knowledge of teacher's geometry content along with understanding of children's learning trajectories. Specifically, through this model the teacher builds knowledge of general content, clarifies misconceptions about the concepts of geometry and explores best practices for teaching geometry. They also examine children's mathematical thinking, and design lessons to advance the understanding of children's geometry.

5. Conclusion

This research showed how good the basic mathematical knowledge of ECE teachers is. The results showed that the average basic mathematics achievement of

participants was 46%, the lowest score was 16 and the highest score was 78. Geometry was the most difficult question for the participants because they got the lowest average score of 19. Based on the results of the interview, participants had limited understanding about plane and geometry. Likewise, the observation showed that one of the participants wrongly mentioned the name of the planes repeatedly. This study provides recommendations for professional development for ECE teachers. The models suggested are technology-enhanced building blocks, research-based learning system, instruction, assessment, and professional development interventions. These models serve to enrich the knowledge of teacher's geometry content along with understanding the learning trajectory of children. In practice, the teacher builds knowledge of geometry content, clarifies misconceptions about the concept of geometry and explores the right teaching practices to finalize geometry to children.

Acknowledgements

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