Logical-Mathematics Intellegence in Early Childhood Students

Iyan Rosita Dewi Nur, Tatang Herman, and Rita Mariyana

***Abstract*—Mathematics for early-childhood (4-6 years old) is a tool that can be used to increase the thinking ability, support the children to increase various of intellectual potential, as well as a medium to increase various attitude and positive habitual, in order to apply the basic personality as early as possible, such as critical and creative thinking ability, diligent, self-supporting, scientific, rational, etc. This qualitative study investigated children's tendency how their logical-mathematics intelligence work. It focused on analyzing how their abilities to understand the operational basics in mathematics with numbers and its principles, along with the sensitivity to see the pattern and cause-consequence relationship and its effectiveness. The subject is 5 children. The results explain that more than 50% of children intellectual potential has been formed since 4 years old and children can consider shapes, measurement, and things based on their interpretation and experiences.**

***Index Terms*—Early childhood education, logical-mathematics intellegence, mathematics education, multiple intelegences.**

I. Introduction

Early childhood education in Indonesia is experiencing a period of dilemma. Educators up to this day still apply the academic approach full of rote-learning. Practices that match with the needs/development of children have not been fully implemented. The success of children's learning is measured by adherence, cognitive and social abilities of children. Inded every child is born intelligent with the potential and uniqueness of each that allows them to be intelligent. Children with kinesthetic, intrapersonal, and naturalist intelligence are considered troublesome children. Some educators, in fact, brand them as hyperactive, less of social intercourse and dirty children. This view has an adverse effect on children, especially for their development.

Charlesworth [1] said that between 3,5 and 4 years of age they begin to be able to compare the amounts in groups using their counting skills. The results of preliminary studies that have been done by researchers found that about 50% of human intelligence capabilities occur when children aged 4 years, 80% has occurred when the age of 8 years, and reached the point of culmination when children aged about 18 years. This means that developments occurring within the first 4 years are as great as the developments that occur over the next 14 years, and then the development of the brain will stagnate. That is why this period is called golden age and after this development passes no matter how much intelligence capability achieved by the individual, it will not experience an increase again or in other words have no meaning.

Piaget's Theory in Wadsworth, B. J. [2] said that knowledge consists of three types, namely physical knowledge, knowledge of mathematical logic and social knowledge. Cognitive development is closely related to logical-mathematical and naturalist intelligence. Stimulation of logical-mathematical intelligence promotes cognitive development, especially in terms of logical thinking, information processing, thinking capacity, memorization, reasoning, conceptual acquisition, classification, problem solving, and concentration. Prasetyo and Andriyani [3] argued that logic-mathematical intelligence is defined as the capacity to use numbers, think logically to analyze cases or problems and perform systematic calculations. While in Yus [4], the intelligence of mathematical logic is the ability to understand operational basics relating to numbers and principles as well as the sensitivity of seeing patterns and causality relationships and influences. From the opinion of the experts above, it can be concluded the intelligence of mathematical logic is the ability to understand the basics of operational, logical thinking to analyze cases or problems and perform systematic calculations.

Basically, every child is endowed by the intelligence of mathematical logic. Lwin, et al. [5] explained that logical mathematical intelligence is the ability to handle numbers and calculations, patterns, and logical and scientific thinking. Hakim [6] said that a person with logical mathematical intelligence will be able to classify information, compare information, and strategies to solve problem appropriately, process numbers and use inductive or deductive thinking in solving problems. It is accordance with the oppinion of Willis & Johnson [7] which reveals that logical mathematical intelligence has 5 components, namely classification, comparing, mathematical operations, inductive and deductive reasoning, and forming hypotheses and rechecking hypotheses that have been made. Handayani [8] based on her finding research she said tha logical mathematical intelligence can enhance student active learning since it drive the students to be a "an independents person".

Gardner [9] defined the intelligence of mathematical logic as the ability of scientific reasoning, mathematical calculation, logical thinking, inductive / deductive reasoning, and the sharpness of abstract patterns and relationships. Can also be interpreted as the ability to solve problems related to the needs of mathematics as a solution. Children with this ability will be happy with abstract formulas and patterns. Not only in mathematical numbers, but also in activities that are analytical and conceptual.

This intelligence is characterized by sensitivity to logical

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patterns and has the ability to digest these patterns, including numeric and able to cultivate a long flow of thought. Someone with this intelligence tends to like and be effective in terms of calculating and analyzing counts, finding functions and relationships, estimating, predicting, experimenting, finding logical solutions, finding patterns, inductioning and deductioning, organizing / outlining, making steps, playing games that need strategy, think abstractly and using symbols, and use algorithms. According to Lestari [10] she explained that there are several mathematical concepts that should be taught to the early childhood. For groups of children aged 0-3 years need to recognize mathematical concepts. While for groups of children aged 3-6 years carried out the development of mathematical concepts to children. Based on the description, the researchers are interested to conduct research on the intelligence of mathematical logic of children aged 4-5 years in early childhood Bandung, Indonesia.

II. Methodology

This research is a qualitative descriptive study. Descriptive data was obtained by using various data collection techniques including observation, interview and questionnaire. This research is conducted in four stages. The first is preliminary stage that was done by field observation. The second stage is the researchers involved in the field to collect the data by providing test logic mathematical intelligence directly to the child and complete the results of his test by filling the intelligence questionnaire mathematical logic of children. The third stage is to analyze the data obtained, and the fourth step is to prepare the report of field analysis results. Subjects of this research were 5 PAUD students aged between 4-5 years. These early childhood students were given several tests that included indicators of mathematical logic intelligence. Besides giving test, the researcher also distributed the questionnaire of mathematical logic intelligence which have been prepared to help analyze the result of student's answer which become subject of research in early childhood.

In the first stage or the preliminary stage, the researcher conducted a direct observation in the field to conduct preliminary studies on the condition of the school, the ability of children, and learning activities at school. The second stage is the data collection phase. At this stage, the researchers went into the field directly to give the test of mathematical intelligence in early childhood, observed the behavior and ability of each child by filling out the questionnaire of the intelligence of mathematical logic that has been compiled. The researchers also recorded the students' activities at school by using a handy cam. In addition, to strengthen the results of research and data analysis process, the researchers also conducted interviews to teachers who teach children of early age. After the data collection and research in the field were enough for the researcher, then the researcher continued the research to the fourth stage that is the stage of analyzing the results of research and preparation of reports.

III. Result and Findings

A. Achievement Test Findings:

The application of learning at each stage of child development can not be generalized. Children aged 4 and 5 years have different stages of development with other stages of development of age. At the age of 3 to 5 years, the child is increasingly showing interest in numbers and quantities (counting, measuring and comparing activities) and they like more complex mixing and grouping activities. Nonetheless, they face the inherent difficulty of one feature in sorting out some objects into a class. Stimulation of logical-mathematical intelligence is able to show the achievement of sensitivity indicators on numbers, the ability to count, categorization, and classification objectively.

From the results of data analysis in the field, it was obtained the results that the child has begun to understand the concept of numbers, and develop sensitivity to the concept of the existing size around. The relative can be seen from the level of achievement of age 4-5 years development is the development of children's ability to:

1) Get to know more of yourself and recognize the similarities and differences of himself with others
2) Connect the size with the objects around it
3) Connect geometric shapes with objects around them
4) Estimate the size of the quantity, the short length, the light weight of the object he or she encounters
5) Sort objects by color, size, type of surface with a specific pattern
6) Observe changes in liquid form, frost, steam and dew
7) Determine the position of the left-right, front rear
8) Know the concept of time based on activities
9) Know the concept of the day
10) Know the concepts and symbols of numbers 1 - 20
11) Know the letter symbol.

From the research results, it also obtained new knowledge that the intelligence of mathematical logic of children can be illustrated with the presence of the following levels of achievement to:

12) Have the ability to classify objects by shape and color
13) Be able to classify objects into the same group or similar groups or groups paired with 2 variations
14) Sort objects based on 5 size or color series
15) Know the concept a lot and a little
16) Spell out many objects one to ten
17) Know the concept of numbers
18) Know the number symbol
19) Know the letter symbol
20) Their pleasure in numbers, being able to read numbers, and counting. Children who have the intelligence of mathematical logic will quickly and effectively add, subtract, and read numbers symbols
21) Their skills are thinking and using logic. Children who have logical mathematical intelligence will be able to solve problems logically, quickly understand the problem, able to trace the cause and effect of a problem
22) Their favorite is asking and always curious
23) Their tendency to manipulate the environment and use a trial-and-error strategy, as well as guess and test it
24) Their tendency to play constructively, play with patterns, strategy games, enjoy games with computers or calculators
25) The tendency to construct something in a category or hierarchy such as a sequence of large to small, long to

short, and classify objects that have the same properties.

B. Interview Findings

In addition to the findings about characteristics of a child who possess mathematical logic intelligence, there have also been found characteristics of children who have difficulty learning math. But this does not mean that the child does not have the ability, those who are not prominent in their mathematical logic intelligence can have intelligence in other respects, such as spatial intelligence, kinesthetic intelligence, musical intelligence and others. Here is an invention of the characteristics of children who are not prominent in the intelligence of mathematical logic, namely:

1) Children have difficulty in understanding the concept of quantity. Children who have this difficulty can be seen when they are difficult to distinguish between goods with more or less quantity. In general, children naturally have the ability to conceptualize the quantity of everyday life they normally live in, for example, in interactions with the community environment, friends and also in the family. The interaction with the social environment greatly affects their ability in the intelligence of mathematical logic. a closed family environment, impaired brain function and social environment that is not well created is the reason behind children having difficulties in understanding the concept of numbers.
2) Impaired spatial relationships. Children who still have not developed the intelligence of mathematical logic is often problematic in communicating with other people. This resulted in the child being hampered in understanding the concepts of spatial relationships which further distort the child's understanding of the overall learning system.
3) Difficulty in understanding the concept of time. Understanding the concept of time is seen when the children can not distinguish the meaning of the word yesterday, today and tomorrow, briefly, long and so on.
4) Visual-motor association. The form of visual-motor association is a form of learning difficulty that emphasizes their learning process by simply memorizing numbers without understanding its meaning. An example of a visual-motor association form is that a child can not count objects in sequence while naming the numbers "one, two, three, four, five". The child may just hold the third object but has said "five". This is a form of learning difficulty counting in words with their motoric activities.

We introduce the number to the child not only as a symbol, for example we have two apples, so we provide two apples. Thus, the children understand the concept of numbers. Songs can also be a medium to introduce various themes about numbers, like five balloons song. Or we can be creative to create our own simple songs while demonstrating our finger as a tool to calculate, so that children slowly catch the abstract concept in numbers. After the child knows the number 1 to 10, it can be introduced to zero. Giving an understanding of the concept of zero in early childhood is not easy. This game can be done by calculating the magnet attached to the refrigerator. Try taking one by one and have the child count the remaining ones. Do it repeatedly so that the magnet in the refrigerator no longer attached. It can then be shown that what is seen in the refrigerator is a 0 (zero) magnet. While in the kitchen, we can introduce the concept of classification and grouping associated with the concept of mathematical logic, for example children are asked to group vegetables by color. Students can also sharpen the ability to count in the operation of simple numbers, for example when three apples eaten one fruit then how many. They can also make geometry shapes through vegetable pieces. Every now and then do the activities to make a cake together, in addition to adding family friendliness and warmth, children can also learn math through the activities of weighing, measuring, counting time. Cooking while viewing recipes also practice reading and vocabulary skills. Do not worry about the kitchen situation that will become dirty and messy with flour and stuff that scattered, because like a slogan an ad that dare to dirty is good. Children are happy and unconsciously they have learned many things. When we even eat at the table we teach the division by asking the children, for example we all family cut a pudding. Then when the pudding has been cut into pieces, remove one part and ask how much it is. This is related to the concept of fractions. We can also provide mathematical concepts such as understanding quantity, such as how many ornamental fish in the aquarium. When relaxing in front of the house, children are invited to calculate how many motorcycles pass within 10 minutes. Also recommend the concept of comparison such as bigger, smaller and so forth, for example by asking the child sponge bread with donut bread which is larger size. When we introduce and ask the child that the car is moving faster than the motor, the coconut tree is taller than the guava tree, or the sister's handbag is heavier than the sister's purse, in fact it includes teaching the concept of speed, length and weight, the math becomes active. For activities outside the home, when we invite children to shop, involve them in transactions so as to further train operational skills such as addition and subtraction. It could also be a game of shops or markets with his friends. We can also give children educational toys such as blocks, imitations of geometric shapes with associated objects around them. There are geometric shapes like triangles, rectangles, circles, rectangles and others. The introduction of a good geometry shape will make children better understand the environment well. When looking at the wheels of the car for example the child will know that the shape of the circle, the table form rectangular, the roof of a triangular house and so forth. We can also provide games in educational computer that is able to stimulate children's intelligence. Traditional games can also stimulate and improve the logical intelligence of children such as congklak or dakon game as a means of learning to count and also useful to train the ability of fine motor manipulation, especially to train the strength of the fingers which in the future is useful for writing preparation. During the play, children are required to focus on the flow of games which in turn will train the concentration and diligence of children that are needed when children attend school lessons.

IV. Conclusion

Based on the findings of the research that has been done on the child early childhood, the conclusions can be drawn from the observations. The characteristics of children who have the

intelligence of mathematical logic at the age of the toddler of children, likes to explore to meet his curiosity like exploring every corner, observing objects unique to him, a hobby of fiddling with objects and doing trials. For example what if their feet get into a bucket full of water or curiously crafting a puzzle. They also often ask about various phenomena and demand a logical explanation of each question posed. In addition children also like to classify various objects based on color, size, type and others and likes to count. Knowledge of mathematical logic is built when children play or manipulate material / objects that exist around it. In addition, the interaction of children with adults can also build this knowledge. When an adult guides, asks, responds, reacts to the child as they manipulate objects, the desire to learn mathematical logic will emerge. The child's ability with regard to mathematical logic can be improved from an early age. Parents play a big role in this part. Attempts to do in developing:

1) Children's Ability to remember abstract patterns
   a) Explain first to the child about concrete and memorable patterns of the child before the abstract, giving a concrete example first and then an abstract example.
   b) Explain and give examples of things that are easy to things that are difficult.
   c) Trough game, by learning while playing, as well as by using appropriate media props.
   d) Often repeat the material or explanation, so that children can better remember it.
   e) By providing private learning for children who do need it.
   f) Trying to bring the situation in line with reality, for example in the center of construction, to introduce a small concept (theme: My needs) can be with the original fruits, or introduce the concept of light-weight can with real objects, eg fruit, stone, pebbles , books, and so on.
   g) By giving stimulus to the real form, for example the concept of "light weight" can be known by comparing the many and the least goods, while the concept of "high low" is the real form of high and low real objects.
2) Children's ability to express logical reasons inductively:
   a) By providing those questions
   b) easy to understand children and conduct discussions with children both in class and individual and practice.
   c) Understand the abilities and character of the child.
   d) Try to be patient and keep doing the repetitions needed to explore the potential of the child.
   e) Conduct dialogue or discussion before and after KBM center running.
   f) By giving stimulus, for example by giving a question that mentions the characteristics that exist in an object.
   g) By understanding each typical child, understanding child psychology, only then develop the logic of the child according to the psychological condition of each child
3) The child's ability to express logical reasons deductively:
   a) By discussing and direct practice (exploration) so that children can see and learn directly before expressing the logical reason, as well as with question and answer method.
   b) Understand the abilities and character of the child.
   c) Trying to always be patient and keep doing repetitions.
   d) Understand your child to keep things simple.
   e) Through games, such as a picture taking game, the child is asked to take a picture provided, then the child is asked to provide information about the images he gets.
   f) The teacher provides guidance to the child in order to provide answers to a detailed question.
   g) By giving a simple "logical analogy" to the child.
4) Child's ability to understand causal relationships:
   a) Children do the practice directly.
   b) Learn by looking at pictures and listening to explanations from teachers.
   c) Talk about an event that is associated with everyday life that is in the environment around the child. And explain the language of the child
   d) accompanied by a supporting image
   e) In the computer center, it can be explained to the child that the pictures are on the screen
   f) the computer will result in an activity. if the pictures we click with the mouse.
   g) By telling stories, for example in the teacher's language center explains about the flooding which is the result of the amount of garbage that closes the water channel.
   h) By discussing the laws of "cause and effect" according to each individual's thinking stages are adjusted to the class average ability standard.
5) The ability of the child to calculate off the head quickly
   a) By giving an example to the child how to calculate quickly, and the child can do alone, with direct practice and question and answer about the calculation results.
   b) By maturing the concept of numbers and counting correctly.
   c) With memorizing activities.
   d) With the help of objects (eg shells, wooden fruits, etc.) or with the help of the senses (eg fingers).
   e) With the concept of save count (for the sum), eg 19 + 2, the way 19 is stored in the head, then added 2 (with the help of fingers), ie after 19 is 20, continued 21.
6) Child's ability to understand computer language:
   a) Some centers have not used computers in learning in the center class
   b) At the computer center, provide practical instructions in the computer by showing the symbol, eg enter with the symbol .
   c) By direct practice (children typing or running their own mousenya).
   d) Through a variety of construction games that use computer media, eg playing puzzle pairs, play maze, looking for a pair of objects.
7) Critical attitude of the child to always ask why this, it and others:
   a) With a discussion.
   b) By using the image media, the child is asked to observe

and ask questions.

c) Teachers should be active and look for interesting methods so as to cultivate great curiosity in children.
d) Provide interesting pictures that can stimulate children to ask questions.
e) By motivating the children.
f) By telling stories.
g) Provide a fishing question or point to that ability
h) Using the "feedback" question method or the review method in the form of a storyteller.

8) Interest in other strategy games:
a) At the computer center, on the computer there is a puzzle game with a variety of interesting images, children are stimulated to create a puzzle by arranging pieces of the puzzle into an interesting image.
b) With the media maze (search for traces) difficult path (according to the ability of the child).

9) Children's ability to explain the problem logically.
a) With discussion and question and answer.
b) At the computer center, the child is asked to explain the existing symbols with simple language.
c) By giving a "simple analogy" so that the child is able to explain a problem.
d) Invite the child to experiment, make observations, stimulate to ask what-why, spur the child to develop simple analysis, then summarize it.

10) Ability of children to experiment and test:
a) The teacher gives an example and the child tries to do it.
b) With demonstrations and direct practice.
c) In the computer center, the child immediately practiced on the computer.
d) Provide experimental or experimental learning.

11) Child's ability to do a logical crossword:
a) By providing exercises.

12) Child's interests make categories and hierarchies
a) With the method of direct practice and the child is involved in a project, such as building a building.
b) By varying interesting media.
c) Play grouping objects (by color, shape, size, etc.).

13) Child's pleasure in mathematics and science
a) By creating an attractive display for the child.
b) By teaching fun and learning while playing, playing while learning.
c) Giving computer games from Interactive CDs, for example "Happy counting" in it contains simple counts with pictures and interesting game.
d) To count can use the media (can be a display of fruits, animals, shellfish, ice cream scoop), not always with numbers.
e) For IPA with exploration centers doing experiments (children are very fond of new things he does not know yet).
f) Provide stimulants in the form of games, such as metamorphosis puzzles, puzzles growing frogs, tree growth puzzles, and others.

14) Child's ability to understand cause-and-effect events
a) With question and answer
b) In computer centers, teachers practice on computers in front of children.
c) By telling the story according to the flow.Give the question "flash back".
d) Son recounts.
e) Invite children to observe events directly.

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