

An Analysis of the Mathematical Experiences of Young Children in Spaceship and Fruit Store Role-Playing Activities

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Abstract

The purpose of this study was to investigate the mathematical experience while children role-play in a spaceship and a fruit-store. The subjects were the children involved in the role-playing area during their free-choice activity period. The kindergarten was located in Seoul, Korea and the class consisted of 15 five-year-olds. Data was collected three times a week for four weeks. Role-playing happened during the free-choice activity and it took about 50-60 minutes each time. I collected the data in three different ways: field notes, audio recordings, and video recordings. Data was analyzed according to five mathematical concepts: number and operation, space and shape, measurement, pattern and data analysis and probability. Based on the results of this study, children mainly experienced and developed mathematical concepts of 'number and operation', 'space and shape' and 'measurement' while role-playing in a spaceship and a fruit store.

Keywords : mathematics education, mathematical experience, role-playing

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Introduction

Lots of new knowledge and information are pouring in every day and it is so easy to access them nowadays thanks to scientific and technological development (Lee, 2009). As the number of people who are using a computer and the internet is dramatically increasing due to the development of science and technology, they are required to learn mathematics more than before to be knowledgeable enough to be able to deal with lots of information. People who have mathematical competence will lead their lives successfully and productively, because thinking mathematically helps them to solve the problems that happen in their everyday lives critically and reasonably (NCTM, 2000).

In fact, human beings have mathematical ability as soon as they are born and the foundation of this ability is formed during young childhood (Baroody, 2000; Ginsburg, Klein, & Starkey, 2001). Therefore, early mathematics education is emphasized these days. In Korea many professionals realize the importance of mathematics and they have researched mathematics education for young children and developed a lot of programs and materials since 2000 (Lee, Noh, & Kim, 2007).

The content and methods of mathematics education have been affected by Piaget's constructivist theory until recently (Lee, 1999; Young-Loveridge, 1987). He asserted that understanding and using numbers could be possible when children have the capacity of conservation. Young children in the pre-operational period do not have this capacity, because they cannot conserve number; that is, they appear to think that a quantity is different if its appearance is transformed. Piaget suggested that young children during the pre-operational period have to develop the foundation of logical and mathematical thought through early math activities with concrete materials like sorting, ordering, matching, and pattern making (Bjorklund, 1995; Devries & Kohlberg, 1987; Kamii, 1982). Therefore, most kindergarten teachers in Korea have emphasized and provided these kinds of activities.

However, several researchers have discovered that young children have much more mathematical knowledge than the Piagetians claim. For example, they

sometimes check the time and press the number buttons to watch a TV program that they like, ask their friends for telephone numbers in order to contact them later, and enjoy finding and describing the shapes of objects around them (Clements & Sarama, 2005). They also experience measurement while comparing the different lengths of two pieces of celery during snack time, and have lots of opportunities for classifying, measuring, ordering, counting, and operating while they are playing with blocks or other objects (Maxim, 1989; Wolfgang, Stannard, & Jones, 2001).

These results show that young children already develop many fields of mathematical concepts from the experiences of their daily lives in an informal way. It means that they have enough ability to do mathematics through experiences based on the context and culture that they are involved in (Lee, 1999). It is clear that young children interact with others and use their informal mathematical knowledge at the same time, while having meaningful experiences in everyday life. As these experiences are accumulated, children will gradually develop the mathematical abilities and construct the knowledge that society requires of them (Lee, 1999).

It is widely accepted that children's life is often focused on play (Hoorn, Nourot, Scales, & Alward, 2007). In particular, role-playing is a kind of play that is very appropriate for young children. Role-playing can be a very effective way to teach mathematics to young children (Lee, 2010; Lee, Lee, & Kim, 1998; Park, 2008). This is because it gives them many chances to discover and experience mathematics that exists in their real lives, and also to apply mathematics naturally while playing. Moreover, mathematical knowledge, skills and attitudes acquired through role-playing help them to solve problems related to their daily lives and to figure out situations or events while living in the world (Lee, Kim, & Jeon, 2008).

There have been several studies on the mathematical education related to role-playing for young children. After review, it has been shown that role-playing is an efficient way for teaching mathematics. But most role-playing activities that have been studied are those in which children have to use money to buy things from a shop, such as a flower shop, an ice-cream store, a market, and so on. They have the limitation of being mostly related to numbers and operations concepts. However,

Kim (2006) found that children's mathematical experiences during role-playing were affected by the theme of the role-playing.

After reviewing the literature and research I chose two different role-playing activities. One was a spaceship (without money), and the other was a fruit store (with money). I analyzed the mathematical experiences that children had during each role-playing activity. The results of this research indicate the kinds of role-playing that kindergarten teachers could provide and what roles teachers can take when they teach mathematics to children through role-playing.

In order to achieve this purpose, I set the following research questions :

1. What are the mathematical experiences of children while they are role-playing in a spaceship context?
2. What are the mathematical experiences of children while they are role-playing in a fruit store context?

Method

Subjects

The kindergarten was located in Seoul, Korea and the class consisted of 15 five-year-olds. However, the subjects of this study were limited to the children involved in a role-playing area during free-choice activity time. The maximum number of subjects who were able to play in the role-playing area at once was six. The children active in the role-playing area sometimes changed during play time. The teacher who taught them was enrolled in a master's course for the MA degree and had worked as a kindergarten teacher for five years.

Data Collection

Data was collected three times a week for four weeks from Nov. 3rd to Nov. 28th, 2008. Role-playing took place during the free-choice activity period and each free-choice activity period lasted about 50-60 minutes. I observed the children's mathematical experiences in the role-playing area without participating in the children's play. While observing, I wrote field notes and placed a voice recorder and

a camcorder to document and record the children's interactions, behaviors, gestures and so on. The spaceship activity was available for two weeks from Nov. 3rd to Nov. 14th, and the fruit store activity was available also for the two following weeks, from Nov. 17th to Nov. 28th. The environment and the materials that the teacher provided for each role play are shown in Table 1.

Table 1. *The Environment and the Materials for Each Role-Playing Activity*

Theme of role play	Environment and materials for each role-playing activity
Spaceship Role-playing	space pictures, many kinds of small stones, hats, clothes, gloves for spaceman, keyboard and computer, oxygen tanks, many kinds of blocks, chairs, small desk, magnifying glasses, etc.
Fruit store Role-playing	name board, a price list, many kinds of fruit models, paper boxes, several plastic baskets, calculator, play money (1,000 won, 5,000 won, 10,000 won, 50,000 won) and coins(100 won, 500 won), chairs, small desks, aprons, etc.

Data Analysis

I collected the data in three different ways: field notes, audio recordings, and video recordings. Before I analyzed the data, I had set the criteria after reviewing *the Kindergarten Curriculum of the Republic of Korea* (Ministry of Education, Science and Technology, 2008), *Principles and Standards for School Mathematics for Pre-K-Grade 2* published by NCTM in 2000, and *Early Childhood Mathematics: Promoting Good Beginnings* published by NAEYC and NCTM in 2002. Based on these documents, mathematical contents for young children were related to five mathematical concepts; number and operation, space and shape, measurement, patterns, and data analysis and probability. The criteria for the five mathematical concepts and content are shown in Table 2. All data codings were verified by two professionals who were in their doctoral courses and have experience of teaching mathematics education at college. The reliability of all data was confirmed by the researcher and two other professionals.

Table 2. *The Criteria of Five Mathematical Concepts and Contents*

Mathematical concepts	Mathematical contents
Number and Operation	• understanding and representing numbers • understanding and using numbers in daily life • counting numbers in various ways • exploring the familiar large numbers • operating numbers with the concrete materials • understanding the relationship with numbers • understanding and using ordinal numbers
Space and Shape	• exploring various locations, directions, and distance around them • understanding and using vocabularies related to location, direction and distance • constructing the limited space • exploring the shapes of objects around them • recognizing and using the two- and three-dimensional shapes • constructing objects with two- and three-dimensional shapes
Measurement	• exploring the measurable attributes of objects • understanding and using the vocabularies and units related to measurement • ordering objects according to various measurable attributes • measuring using a rough estimate • measuring using nonstandard units • measuring using standard units
Pattern	• finding the patterns of objects around them • recognizing and extending patterns • making various patterns
Data analysis and Probability	• collecting data • recognizing the similarity and the difference among the objects • classifying the objects according to one or more criteria • representing data using tables, pictures, graphs, etc. • understanding and using the vocabulary related to probability • predicting and reasoning about probability based on the data

Results

These are the results of children's mathematical experiences during the 'spaceship' role playing and the 'fruit store' role playing in the role-playing area. Each chosen case was representative of a large number of mathematics-related plays observed.

Children's Mathematical Experiences in the 'Spaceship' Role Playing

During the 'spaceship' role playing, children repeatedly built a spaceship with paper blocks and operated it. Using magnifying glasses, they observed small pebbles that the teacher placed around the spaceship. They also filled the spaceship with fuel or the tanks with oxygen. Children's mathematical experiences in the 'spaceship' role-playing were as follows:

Case 1

Child 1: (standing the oxygen bottle upright)

Don't put the oxygen tank upside down. The amount of oxygen is decreasing.

Child 2: (checking his own oxygen tank) I used only 20.

Child 3: I can't go out (from spaceship).

(Putting down the oxygen tank) Fill it up to 100.

Child 4: (pretending to fill the tank) It is full.

Child 3: You should fill it up to 100. Fill it more.

In the above case, children knew that they had to be supplied with oxygen when they went outside of the spaceship for a long time. While playing, they repeatedly came back to the spaceship and filled the tanks up with oxygen. Even though they could not see the oxygen, they were talking about how much oxygen remained, or needed to be added, using numbers (10, 20, 30... 80, 100) that are marked on the tanks. From this case, it was obvious that children were doing measurement activities that related to the concept of amount.

Case 2

Child 1: By the way, how large is the international space station...

Child 2: It's almost over 100 pyeong (a Korean unit of area).

Child 3: Go to the sun. Go to the sun within one second.

Child 5: How long does it take to get there?

Child 3: Just one second!!

In the second case, children were pretending to be in the spaceship and to operate it. In this case, Child 2 was using the term 'pyeong' which is used only in Korea to describe area. And Children 3 and 5 used 'seconds' to explain the time needed to get to the sun. These cases show that 'spaceship' play lets children use words related to measurement concepts such as area and time etc.

Case 3

Child 6: (holding a magnifying glass) Convex lenses are bulging.

Child 6: (observing small stones through the lens) Convex lenses make things look larger.

In Case 3, Child 6 pretended to be an astronaut while observing small stones. This case shows the child doing measurement related to the concept of size, because he was comparing the sizes of things that looked different when observed with the naked eye, and through a magnifying glass, respectively.

In addition to these three cases, children tended to divide the role-playing area into two parts at the beginning of play, the inner and outer areas, by making the spaceship with paper blocks. As the area was divided into two parts, role-playing was also separated into two types: one was inside the spaceship (e.g. piloting the spaceship and filling the oxygen bottle), and the other was outside of the spaceship (e.g. collecting space rocks, walking like a spaceman). Dividing the area for the two

different kinds of role playing leads children to naturally use terms for spatial concepts like 'in', 'out', 'side' and so on.

Children's Mathematical Experiences in the 'Fruit Store' Role Playing

During the 'fruit store' role-playing, Children repeatedly bought and sold a lot of fruit using play money and a calculator. Children's mathematical experiences in the 'fruit store' role-playing were as follows:

Case 4

Child 6: (choosing two bananas from the basket) Two bananas, please.

Child 7: (checking the banana price on the list) 2,000 won. Is that right?

Child 6: Two bananas... It's 1,000 won for one banana.

You're right. 2,000 won. 2,000 won.

Child 7: 2,000 won is right. (giving money to child 6) Take them.

In Case 4, Child 6 was a customer and Child 7 was the shop owner. The teacher provided a written price list for all the fruit. Confirming the banana price on the list, the children exchanged fruit and money with the 'shopkeeper'. From the above case, it is clear that children were doing mathematical activities related to numbers and operations concepts such as reading numbers, counting things, and adding numbers.

Case 5

Child 8: Watermelon! 10,000 won for a watermelon!

Child 9: (giving a 10,000 won bill to child 8) Here you are. 10,000 won.

Child 10: Me too! This one.

This watermelon! (handing over two 5,000 won bills to child 8)

Customers, Children 9 and 10, were each buying watermelon. They paid the money to the shopkeeper, Child 8. The situation of Case 5 is the same as Case 4.

These cases show that fruit store role-playing consisted of buying and selling fruit. Because there are four different kinds of banknotes in Korea(1,000, 5,000, 10,000 and 50,000 wonbills), the children could pay 10,000 won in four different ways: ten 1,000 won bills, one 5,000 won bill and five 1,000 won bills, two 5,000 won bills or one 10,000 won bill. In Case 5, Child 9 paid one 10,000 won bill and Child 10 paid two 5,000 won bills. These kinds of experience are related to part-part-whole concepts of numbers and operations.

Case 6

Child 11: Strawberries are..... (after checking the price of strawberries) 200 won.

(taking one strawberry out of the basket) Hey! Buy just a little.

Child 12: Why?

Child 11: It's too difficult. I mean it's too hard to calculate the whole price.

In the case 6, shop owner child 11 was calculating how price of the strawberries that child 12 chose. Then child 11 suddenly asked him not to buy a lot of fruit because it was quite difficult for him to calculate. This case shows that preschool teachers have to consider children's ability of operation when they provide many kinds of store role playing to children. It means that the prices of all the things to sell should not be expensive or complicated to calculate. The main problem is that in Korean currency the amounts are very large for children of this age to understand properly. Therefore if there are various kinds of fruit, teachers can suggest simple prices or the same price in order to make it easier for children to calculate. Also, if they can learn how to use a calculator, it will be helpful.

As well as these three cases mentioned above, I observed that children experienced classification activities by putting the same fruit in each box, and arranging the money by denominations at the counter.

Conclusion and Discussion

According to the results of this study, I reached the conclusion that children mainly experienced and developed mathematical concepts such as ‘number and operations’, ‘space and shape’ and ‘measurement’.

First, children experienced and developed number, space and measurement concepts in the ‘Spaceship’ role-playing. They especially did a lot of measurement activities while they played with oxygen tanks, explained how large the space station was and how long it took to get from one planet to another. These cases were related to amount, area and time concepts. Moreover, the results indicated that children understood the measurable attributes of objects and could use the vocabularies and standard units related to measurement appropriately. They sometimes read the actual numbers written on oxygen tanks during spaceship play. This case was an example of number counting related to number concepts. These results support the results of Kim’s (2006) and Lee et Al’s (2008) research, which found that young children developed number, space, and measurement concepts while role-playing.

Second, children mainly experienced and developed number and operation concepts in the ‘Fruit store’ role-play. When they bought and sold lots of fruit using play money and a calculator, they naturally read, counted and added numbers. They also explored the familiar large numbers easily; nevertheless, the quantities involved in the Korean money system are very large. This definitely helps children to improve their number and operation concepts. These results support the results of Choi’s (2007) and Hwang’s (2005) research, which found that role play using money can develop children’s number and operations ability. It is also closely connected to Lee’s (2001) and Griffiths (2001) research. Lee (2001) found that children did mathematical activities related to number and operation concepts and Griffiths’ (2001) clarified his opinion that role-plays involving economic activities (as in a market) would be a very good way to improve children’s mathematical ability through role-playing. However, many experiences of number and operation concepts were observed in the fruit store role play. This is consistent with Choi (2007) and

Hwang (2005) who argued that role play using money can encourage children's number and operations ability.

According to the results of the research above, the theme of the role play had a significant effect on the types of mathematical concepts experienced by the children. In particular, mathematical concepts of space and measurement were frequently observed when they were doing the spaceship role play. However, when young children were doing the fruit store role play, they mainly experienced mathematical concepts related to number and operation. It appeared that children's mathematical experiences also were influenced by the role-playing theme and the materials that the teacher provided.

In conclusion, preschool teachers should offer children experiences with various role-playing themes and provide the materials in a role-play area that involves the various mathematical concepts, after considering the children's mathematical ability. Young-Loveridge (2009) also emphasized the importance of teacher's role for early mathematics education. So it will help children to encourage to use their informal mathematical knowledge and to develop their mathematical abilities through role-playing.

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