

Developing Mathematical Skills in First-Year Preschoolers with a Dough Modeling Activity in an International Kindergarten in Bangkok, Thailand

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Abstract

Through the use of a dough modeling activity, this study sought to determine the level of mathematical skills development of preschoolers. The sample group consisted of 17 first-year preschoolers from an international kindergarten in Bangkok. The research instruments were a set of tasks for developing mathematical skills through the dough modeling activity and a mathematical skills assessment form for early childhood children. The statistics used were percentage, mean, SD., and paired t-Test. The study's findings indicated that the dough modeling activity helped first-year preschoolers improve their mathematical abilities, with statistical significance at the .01 level, and develop important basic mathematical skills in each of the four skills: sequencing, counting, measuring, and categorizing. The children's mathematical skill levels were significantly higher than before the development at a statistical level of .01.

Keywords: Mathematics Skills Development, Early Childhood Skill Development, Game-Based Learning, Play-Based Learning

1. Introduction

Since children are the country's future, early childhood education is crucial to their development. Physically, emotionally, socially, and intellectually, this is the age of development. The brain develops and matures quickly, therefore it's important to provide age-appropriate learning support. Children will be able to develop their potential to the fullest (Puncreobutr and Kitratporn, 2017; Armai et al., 2020; De Chambrier et al., 2021).

One important part of early childhood education is the need to create a foundation in mathematics for learners to learn from direct experiences through many senses. This is due to

the fact that mathematical abilities serve as an important basis for the development of analytical, systematic, and creative thinking abilities all of which are essential for the advancement of human resources in the modern world (Puncreobutr and Rattanutumma, 2016; Mingmongkol et al., 2022).

Learning from direct experiences through various senses for children that are appropriate are play-based learning and game-based learning that encourage children to play naturally while providing them with activities that are relevant to the expected learning outcomes, meaningful play, and developmentally appropriate play-based learning goals. This allows children to learn and play simultaneously (Cojocariu and Boghian, 2014; Farooqi et al., 2024).

Play-based learning and game-based learning principles have been applied to develop basic mathematical skills and it was found that children develop mathematical skills rapidly (Cayang and Ursabia, 2024). In particular, the application to early childhood, which is an age of play and learning, can develop mathematical skills rapidly, both through play (Van and Duijkers, 2013; Weisberg et al., 2016; Vogt et al., 2018; Wickstrom et al., 2019; De Chambrier et al., 2021) and game-based learning (Cojocariu and Boghian, 2014; Vlassis et al., 2022; Farooqi et al., 2024).

In Thailand, young children can develop their mathematical skills through play-based learning and learning based on games. For example, kindergarten 1 students can participate in local folk games (Doungkeid et al., 2015), and early childhood students can use recycled materials for creative activities (Armai et al., 2020). However, the researchers found that dough is a type of material that parents and guardians use to mold and shape as a toy for young children that is popular in general households because it comes in a variety of colors, has a variety of molds for molding, and can be molded by hand without sticking to hands and is safe.

Thus, the researchers decided to carry out a study on "Developing mathematical skills in first-year preschoolers with a dough modeling activity" in an international kindergarten in Bangkok in order to ensure that young children's play is meaningful, learning-oriented, and develops mathematical skills. As part of teacher development activities, learning management experience development, and curriculum development, the findings of this study would be helpful to homeroom teachers, experience teachers, childcare teachers, and administrators of different kindergartens. They would also be helpful to instructors in charge of the curriculum, deans, and administrators of universities that teach early childhood education and mathematics.

2. Research objective

To analyze first-year preschoolers' level of mathematical skills development through a dough modeling activity at an international kindergarten in Bangkok, Thailand

3. Research Methodology

3.1 Scope of the Population and Sample

Seventeen preschoolers in their first-year of the second semester of the academic year 2024 at an international kindergarten in Bangkok made up the population and sample. They were chosen by purposive sampling. With young children in the learning phase, actively participating in the learning process to develop mathematical skills.

3.2 Scope of Contents

Following the first-year early childhood curriculum of an international kindergarten in Bangkok, which included sorting, counting, measuring, and classifying skills, the research's content was a dough modeling activity to develop mathematical skills. This curriculum included ten tasks: sorting from large to small, sorting from small to large, counting orally, and displaying objects according to the specified number, measuring objects from short to long,

measuring objects from high to low, categorizing by color, categorizing by size, and categorizing by shape.

3.3 Scope of variables

3.3.1 The independent variable used in the study was the dough modeling activity.

3.3.2 The dependent variable was the mathematical skills of first-year preschoolers.

3.4 Scope of the study period

Thirty hours of experience were gained during the ten-week study, which was conducted three days a week, on Monday, Wednesday, and Friday. Each day's activity lasted one hour, following a single experience plan.

3.5 Instruments used in the research

The research instruments

3.5.1 One hour was allotted to each of the ten plans for the international kindergartens' experience of dough modeling activity, for a total of thirty hours altogether. According to the 80/80 criterion, the school used the relationship between the process and the results (E1/E2) to measure the experience plan's efficiency. The overall efficiency was 84.56/87.21.

3.5.2 Activity sets for developing mathematical skills with dough modeling activity for the preschoolers, three sets per experience plan.

3.5.3 Ten copies of the preschool mathematics skills evaluation form with ten questions each.

3.6 Data Collection

3.6.1 The preschool mathematical skills evaluation was used to measure preschoolers' mathematical proficiency before they began learning (pre-test), and documented the results as a pre-development evaluation.

3.6.2 Complete the ten dough modeling activity experience plans while having the experience organizers and homeroom instructors present each day. After that, assess the actions both during and after the activities according to the experience plan.

3.6.3 Following the completion of the ten dough modeling activity experience plans, the students' mathematical skills were assessed using the same preschool mathematical skills evaluation (post-test). The results of the assessment were then recorded as a post-development assessment.

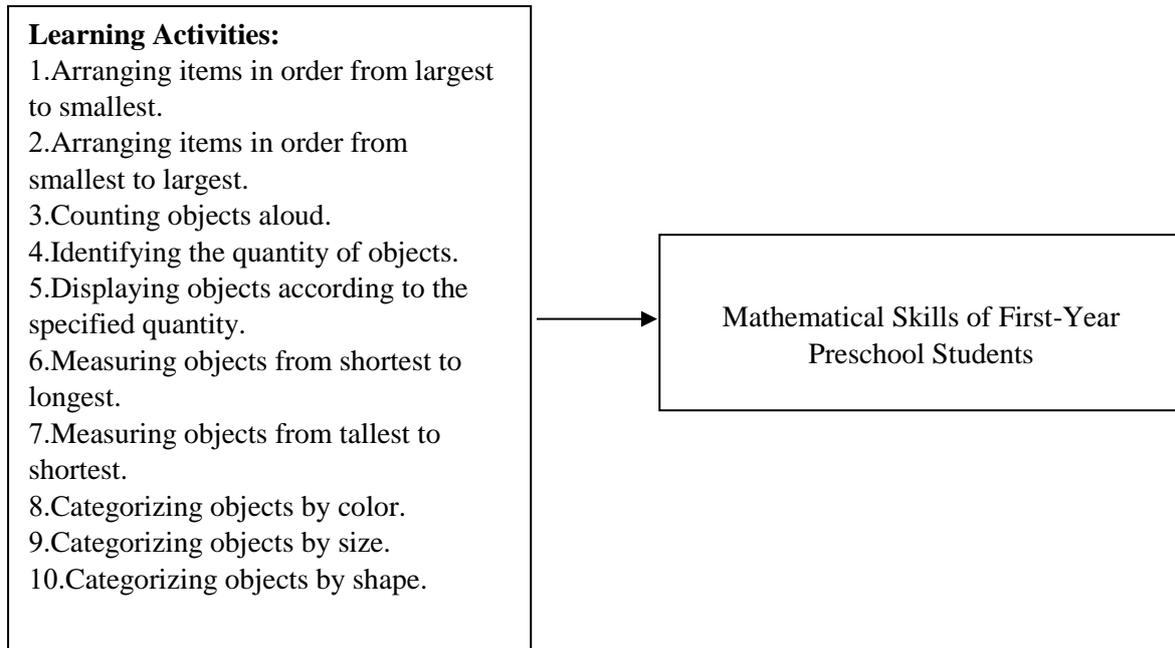
3.6.4 Grade the mathematical skills test by assigning one point for each right response and zero for any wrong or missing responses.

3.6.5 Provide a summary of the findings from each preschooler's assessment of their mathematical proficiency.

3.7 Statistics used in data analysis

Statistics used in data analysis were percentage, mean, SD., and pair t-Test.

4. Research Framework



5. Research Results

The following findings were from the study on preschoolers' dough modeling activity and their mathematical skills development.

5.1 Basic information

Basic information about year-one preschoolers in the international kindergarten under study, broken down by gender and ethnicity, is displayed in Table 1.

Table 1 - Basic information of first-year preschoolers (N=17).

	Category	Number	Percentage
Gender	Female	10	58.8
	Male	7	41.2
Ethnicity	Thai	9	52.9
	Non-Thai	8	47.1

Table 1 reveals that the majority of the students under study were female (58.8%) and were Thai students (52.9%).

The relationship between gender and ethnicity is shown in Table 2.

Table 2 - Gender and ethnicity of first-year preschoolers (N=17).

Ethnicity	Gender		Total
	Female	Male	
Thai	7	2	9
Non-Thai	3	5	8
Total	10	7	17

5.2 Preschoolers' mathematical skills

Comparison of year-one preschoolers' overall and individual mathematical skills assessment scores, before and after the dough modeling activity is shown in Table 3.

Table 3 - Comparison of mathematical skills assessment scores before and after development with dough modeling activity overall and in each skill (N=17)

Mathematical skills	Pre-development		Post-development		D	t	p
	mean	S.D.	mean	S.D.			
Sequencing	2.15	.580	7.82	.846	5.676	38.314**	.000
Counting	1.98	.606	7.76	.724	5.784	52.354**	.000
Measuring	1.94	.583	7.53	.874	5.588	45.419**	.000
Categorizing	1.88	.564	7.37	.725	5.490	35.596**	.000
Overall mathematical skills	1.97	.517	7.61	.688	5.635	49.973**	.000

* p< .05 ** p< .01

According to Table 3, the first-year preschoolers' overall mathematical skills as well as their abilities in all four skills sequencing, counting, measuring, and categorizing were significantly higher following the dough modeling activity than they were prior to the development at the statistical level of .01.

The following Tables 4 – 7 compare the first-year preschoolers' scores on the mathematical skills assessment for each task before and after the dough modeling activity.

Table 4 - Comparison of the assessment scores of sorting skills before and after the development with dough modeling activity in each task (N=17)

Skills development task	Pre-development		Post-development		D	t	p
	mean	S.D.	mean	S.D.			
Ranking from largest to smallest	2.00	.707	7.76	.970	5.764	31.588**	.000
Ranking from smallest to largest	2.29	.685	7.88	.857	5.588	28.975**	.000
Overall sorting skills	2.15	.580	7.82	.846	5.676	38.314**	.000

* p< .05 ** p< .01

Data in Table 4 demonstrates that following the dough modeling activity, the first-year preschoolers' overall sorting and mathematical skills that is, their ability to sort from largest to smallest and from smallest to largest were both higher than they were prior to the development, with statistical significance at the .01 level.

Table 5 - Comparison of the counting skill assessment scores before and after the development with the dough modeling activity in each task (N=17)

Skills development task	Pre-development		Post-development		D	t	p
	mean	S.D.	mean	S.D.			
Oral counting	1.94	.747	8.17	.808	6.235	30.923**	.000
Telling the quantity of things	1.94	.555	7.41	.618	5.470	43.841**	.000
Display of specified quantity of items	2.05	.826	7.70	1.159	5.647	38.400**	.000
Overall counting skills	1.98	.606	7.76	.724	5.784	52.354**	.000

* p< .05 ** p< .01

As shown in Table 5, following the dough modeling activity, the first-year preschoolers' overall counting and mathematical skills in all three tasks counting orally, stating the number of objects, and displaying objects in accordance with the specified number were higher than they were prior to the development, with statistical significance at the .01 level.

Table 6 - Comparison of assessment scores of measuring skills before and after development with dough modeling activity in each task (N=17)

Skill development activities	Pre-development		Post-development		D	t	p
	mean	S.D.	mean	S.D.			
Measuring objects from short to long	1.94	.658	7.47	.874	5.529	44.312**	.000
Measuring objects from high to low	1.94	.555	7.58	1.003	5.647	33.173**	.000
Overall measurement skills	1.94	.583	7.53	.874	5.588	45.419**	.000

* p< .05 ** p< .01

Table 6 reveals that following the dough modeling activity, the first-year preschoolers' general measurement and mathematical skills that is, their ability to measure objects from short to long and from high to low were higher than they were prior to the development, with statistical significance at the .01 level.

Table 7 - Comparison of assessment scores of classification skills before and after the dough modeling activity in each task (N=17)

Skills development task	Before development		After development		D	t	p
	mean	S.D.	mean	S.D.			
Classification by color	1.94	.555	7.52	.717	5.588	28.975**	.000
Classification by size	1.88	.600	7.29	.848	5.411	25.640**	.000
Classification by shape	1.82	.635	7.29	1.046	5.470	31.440**	.000
Overall classification skills	1.88	.564	7.37	.725	5.490	35.596**	.000

* p< .05 ** p< .01

Table 7 demonstrates that following the dough modeling activity, the first-year preschoolers' overall classification and mathematical skills in all three tasks color, size, and shape classification were higher than they were prior to the development, with statistical significance at the .01 level.

6. Summary of the research results

According to the study's findings,

6.1 The mathematical skills of first-year preschoolers could be enhanced by dough modeling activity, with statistical significance at the .01 level. Sequencing, counting, measuring, and classification were four crucial basic mathematical skills that they acquired. They were much more proficient in mathematics than before the development at the .01 level.

6.2 Dough modeling activity that could be used to develop sorting skills with statistical significance at the .01 level was the sorting skill from largest to smallest and sorting from smallest to largest.

6.3 The dough modeling activities that could be used to develop counting skills with statistical significance at the .01 level were counting orally, telling the number of objects, and displaying objects according to the specified numbers.

6.4 Activities involving dough modeling that could be utilized to develop measurement skills with statistical significance at the .01 level were the tasks of measuring objects from short to long and measuring objects from high to low.

6.5 The tasks involving dough modeling that could be utilized to develop categorization skills with statistical significance at the .01 level were sorting by size, shape, and color.

In summary, the Dough Modeling Activity effectively enhances the skills of first-year preschool students at an international kindergarten in Bangkok, Thailand. This activity stimulates the nervous system of young learners, helping them recognize and remember different shapes and colors of the dough. Additionally, it promotes the use of muscles, strengthening the coordination between vision and movement. As children use their hands to mold the dough into specific shapes or forms, repetitive actions help strengthen their muscles and improve their ability to control movements.

The study results indicate that the most effective activity for promoting development is color sorting. This activity effectively enhances the nervous system, allowing young children to distinguish between colors of dough. It is an activity that requires the coordination of multiple neurological systems, including vision, cognitive skills such as comparison, and memory.

7. Discussion

The results of the study showed that dough modeling activity can help young children improve their basic mathematical skills in both general and specific areas, such as counting, classification, measurement, and sequencing. This is due to the fact that activities involving dough modeling are compatible with the conduct of young children (Puncreobutr, 2015). It is a learning-based activity that enables children to play naturally by using games as a foundation (Game-Based Learning). Children can learn quickly and improve mathematical skills without even recognizing it when good play is crafted to be a meaningful game (Vlassis et al., 2022), which aligns with the idea of play-based learning to help young children build their mathematical skills (Wickstrom et al., 2019; De Chambrier et al., 2021); as a result, the learning that takes place is sustainable (Van and Duijkers, 2013; Weisberg et al., 2016; Vogt et al., 2018).

Additionally, this is in line with the findings of two studies: one by Doungeid et al. (2015), which found that planning activities involving local folk games could help kindergarten year-one students develop their basic mathematics skills, and another by Armai et al. (2020), which found that creative art projects made from recycled materials could help early childhood children develop their basic mathematics skills, and is consistent with the findings of Puncreobutr and Kitratporn's (2017) study, which showed that storytelling exercises, among other things, helped foster students' creativity.

8. Recommendations

8.1 Recommendations for applying the research results

According to the study, first-year preschoolers' mathematical skills could be developed by the dough modeling activity. Thus, kindergarten administrators, professional nannies, homeroom teachers, and experience teachers should encourage the use of dough in a variety of activities to foster mathematics skills in the classroom.

Furthermore, the study discovered that the dough modeling activity could be used to help first-year preschoolers improve their general mathematical skills as well as important

basic mathematical skills in all four areas: counting, sequencing, measurement, and categorization, at a statistical significance level of .01.

Therefore, lecturers responsible for the curriculum, deans, and administrators of universities that teach early childhood education and mathematics teaching programs should encourage students in the program to be able to develop a plan for organizing play dough activities for kindergarten, find the efficiency of the experience plan, create a set of activities for developing mathematics skills with play dough activities, and organize a mathematics skills assessment for preschoolers to be consistent with the needs of kindergartens.

8.2 Recommendations for future research

Based on the study's results, the dough modeling activity could help preschoolers improve their four fundamental mathematical skills: counting, categorizing, measuring, and sequencing. Thus, more research should be done to cover all of the fundamental mathematical abilities of young children.

According to the study, first-year preschoolers' fundamental mathematics skills could be enhanced by the dough modeling activity. Therefore, research on the development of fundamental mathematical skills should be conducted for preschoolers in all grade levels.

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