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Child Science Skill Improvement through Hands-On Learning Activities in Kindergarten with Limited Human Resources and Facilities

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Abstract The early childhood education (ECE) curriculum in Indonesia, either explicitly or implicitly, includes science skills as one of the basic competencies that children must achieve. However, under the pretext of lack availability of facilities, majority of educators have not carry out science learning appropriately. This study aimed to demonstrate and convince early childhood education practitioners that an interesting and effective learning to develop science process skills of children can be implemented even in a kindergarten with limited facilities. By using one-shot case study design, 17children of Group B (aged 5-6 years) at Srijaya Kindergarten of Palembang were exposed to hands-on activities including exploring materials that float or sink, dissolved or unsoluble, color mixing; making letters using play dough; and observing insects with magnifying glass. The child science skills were observed and assessed using observational forms and child worksheets. The results showed 9 (52.95%) subjects obtained scores range 80-100; 4 (23.5%) achieved score range of 66-79, 3 (17.6%) reached score range of 56-65, and 1 (5.9%) obtained score of 52. Thus, it can be concluded that science learning with a process skill approach proved to be effective for developing children's science skills, even in kindergartens with limited facilities such as in Srijaya Kindergarten of Palembang.

Keywords: *early childhood education, kindergarten curriculum, science process skill, science product skill, science skill, process skill approach*

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1. Introduction

Referring to UNESCO and UNICEF the so called early childhood education (ECE) is a range of processes and mechanisms that sustain and support development during the early years of life that encompasses education, physical, social and emotional care, intellectual stimulation, health care and nutrition [1,2]. In Indonesia, ECE has more or less definition as above that is a coaching effort aimed at the child from birth up to the age of 6 (six) years conducted through the provision of stimuli education to foster physical growth and development spiritually so that children have readiness in entering further education. Early childhood education is held before the level of basic education and can be conducted through formal, non-formal, and informal education paths. Kindergarten (children of 4 – 6 years) is an early childhood education in the path of formal [3,4].

As a formal form of education system, kindergartens have a planned intentional curriculum and appropriate teaching strategies that can lead children to achievement of the performance standards identified in the Regulation of the Minister of Education and Culture of the Republic of Indonesia Number 146 of 2014 on ECE Curriculum. The kindergarten’s curriculum contains four core competencies one of which reads as follows "recognizing self, family, friends, educators, the environment, religion, technology, art, and culture at home, playground and kindergarten units by: observing with senses (seeing, hearing, smelling, tasting, touching); ask; collect information; reasoning; and communicating through play activities”. This core competence is further elaborated into basic competencies that includes the scientific process skills. The scientific process skills include knowing the surrounding objects (names, colors, shapes, sizes, patterns, properties, sounds, textures, functions, and other characteristics); the natural environment (animals, plants, weather, soil, water, or rocks); and simple technology (home appliances, play equipment, or carpentry tools) [5].

Such basic competencies are depicting awareness and good intentions of educational policy makers about the importance of science process skills in early childhood education. As has been suggested, at least six reasons supporting the idea that even small children should be exposed to science. First, children naturally enjoy observing and thinking about nature. Second, exposing students to science develops positive attitudes towards science. Third, early exposure to scientific phenomena leads to better understanding of the scientific concepts studied later in a formal way. Fourth, the use of scientifically informed language at an early age influences the eventual development of scientific concepts. Fifth, children can understand scientific concepts and reason scientifically. Sixth, science is an efficient means for developing scientific thinking [6]. In short, especially in the context of ECE services, science process is not just useful in science, but in any situation that requires critical thinking [7].

However, in the Indonesian context, there are three main issues of ECE services including: lack of qualified educators; lack of infrastructure and facilities; and low awareness within the community and in local government. These weaknesses ultimately lead to inadequate learning outcomes as set out in the curriculum and expected by the parents who want their children's intelligence is developed and their attitudes improve [8]. Various studies, either aimed at improving educational policies or services, found that the majority of educators in most educational unit of all levels are less skilled in demonstrating an effective and interesting science learning process [9,10]. Based on the preliminary survey prior to this study, such a trend is also found in Srijaya Kindergarten of Palembang. As a note, Palembang is the second largest city on the island of Sumatra, Indonesia.

The limited availability of infrastructure and facilities on the one hand, and the lack ability of educators on the other hand, raises the question how can science process skills be achieved by children? This study intended to demonstrate as well as to convince early childhood education practitioners in developing countries like Indonesia that even in a limited availability of facilities, an interesting and effective science learning trough process skill approach can be provided.

2. Methods

2.1. Research Subjects

The study was conducted during the period of September 2016 at the Kindergarten Srijaya of Palembang. The kindergarten provide services to two groups of children, A (aged 4-5 years) and B (aged 5-6 years). Children of group B, consisted of ten boys and seven girls, were selected purposively as the research subjects.

2.2. Research Design

By using one-shot case study design the subjects were exposed to the classroom activities as follows: water play, dough play and observing insects as the independent variables. The science process skills and degree of changes achieved by children were observed and measured as the dependent variables of research.

2.3. Treatments

2.3.1. Teacher Training

One week before classroom learning implementation, the researcher provides teacher a brief training on science learning using process skill approach, especially about water play, dough play and insect observation.

2.3.2. Classroom Implementation

In this study there were three classroom teaching activities asked to be implemented by teacher once a week for three weeks. The themes, activities and materials of each classroom lesson are indicated in Table 1.

2.4. Observation and Assessment

2.4.1. Science Process Skills

During classroom learning took place, researchers observed the activities of children and made video recordings. Science process skills of each child were scored in an observation sheet as shown in Table 2.

The children science process skill was expressed as a mark determined by **Equation 1** bellow.

$$Pc = \frac{Process\ Score}{Maximum\ Score} x100\% \quad (1)$$

where

- Pc is the science process skill mark;
- Process score is the score obtained by children as described in Table 2;
- Maximum score is 4.

2.4.2. Science Product Skills

To assess science product skills achieved by children, at the end of each classroom learning, researchers asked teacher to deliver a post test using instrumens/methods as shown in Table 3.

Table 1. The themes, activities and materials used in science classroom learning conducted by the teacher

Subtheme	Activity	Description	Material used
Water	Water play	Exploring object that float or sink	• styrofoam blocks • pebbles • pieces of wood
		Exploring materials that dissolve in water	• sand • sugar • table salt
		Mixing primary color	• food coloring blue, yellow and red
Self-identity	Play with dough	Forming letters and words on workmats using playdough 'snake'	• plasticine clay • letter mats
Insect	Observing crickets	Using magnifier to explore crickets body parts	• magnifying glasses • crickets • clear containers for crickets

Table 2. Science process skills scoring rubric

No	Process Skills	Score	Description
1	Observing	1	Child do not observe materials provided by teacher
		2	Child observed a part of the materials but did not use all senses
		3	Child observe a part of the materials but has used all senses
		4	Child observe all materials provided using all of his/her senses
2	Questioning	1	Child was not motivated to raise question
		2	Child raised question but only once.
		3	Child raised question two to three times
		4	Child raised question repeatedly
3	Gathering information/experimenting/ exploring	1	Child did not do experiment
		2	Child does experiment with teacher and friend helps
		3	Child does experiment with teacher help
		4	Child does correct experiment without teacher and friend help
4	Associating/reasoning/data processing/ concluding	1	Child did not able to make conclusion of activities done
		2	Child able to conclude a part of the activities
		3	Child conclude all activities but there was still mistake
		4	Child conclude all of the activities correctly
5	Communicating	1	Child did not able to communicate activities done
		2	Child communicate a part of the activities done
		3	Child communicate all activities but there was still mistake
		4	Child communicate all of the activities correctly

Table 3.

Product skills	**Instruments of Assessment**	**Children tasks**	**Score range**
Differentiating float and sink	Worksheet containing picture (photographs) of styrofoam blocks, pieces of wood, and pebbles	Circling picture of objects that sink	0 -100
Differentiating dissolved and undissolved	Worksheet containing pictures (photographs) of sugar, table salt, and table sands	Circling picture of materials that dissolved in water	0 -100
Predicting result of color mixing	Worksheet containing pair of primary color circles	Coloring blank circles with colors that match the primary color pair	0 -100
Interpreting observations	Cards containing two letters (A and S) and two numbers (4 and 8)	Creating the clone of letters and numbers shown on the card using dough "snake" prepared by teacher on a work mats.	0 -100
Data processing	Worksheet showing squares containing pictures of crickets of vary in numbers (1,2,3 and 4)	Drawing a line to match the pictures of cricket to the appropriate number symbols	0 -100

The children science product skill was expressed as a mark determined by **Equation 2** bellow.

$$\text{Pd} = \frac{ProductScore}{MaximumScore} x100\% \qquad (2)$$

where

- Pd is the science product skill mark;
- Product score is the score of post test obtained by children as describe in Table 3;
- Maximum score is 100.

2.4.3. Science Skills

The children science skill was expressed as a grade determined by summing the marks of science process skills (Formula 1) and science product skills (Formula 2) by **Equation 3** bellow.

$$\text{G} = (Pc\ x\ 60\%) + (Pd\ x\ 40\%) \qquad (3)$$

where

- G is the final grade of children science skill;
- Pc is the science process skill mark;
- Pd is the science product skill mark.

2.5. Statistical Analysis

The data of children science skills obtained from the study were presented as frequency distribution. The normality of data distribution was tested using *Shapiro-Wilk* method, whereas the hypothesis reliability was tested using *One Sample Test* using *t*-distribution table at the *degree of freedom* (df) n-1. The statistical application used in the analyis was SPSS program type 20.

3. Results

The results of observation and assesment of the science process skill, science product skill, and scientific skill of each individual child after attend the three science classroom lessons are presented in Table 4. The histogram for the frequency distribution of the grade scale describing children's scientific skills are depicted in Figure 1. The results of normality test for the frequency distribution of the data in Figure 1 are presented in Table 5, and the results of test of hypotheses for children's scientific skills grade scales are presented in Table 6.

Table 4. Description of the children's science process, science product and science skills after attending classroom science learning by process skill approach

Child No.	Process skill marks (Pc)	Product skill marks (Pd)	Science Skill	
			Grade (0.6Pc + 0.4Pd)	Criteria
1	95	91,67	94	Very good
2	70	91,67	79	Good
3	90	91,67	91	Very good
4	75	100	85	Very good
5	100	100	100	Very good
6	85	100	91	Very good
7	50	66,67	57	Fair
8	60	83,33	69	Good
9	85	100	91	Very good
10	75	100	85	Very good
11	68,33	100	81	Very good
12	41,67	66,67	52	Poor
13	65	91,67	76	Good
14	80	100	88	Very good
15	53,33	66,67	59	Fair
16	58,33	66,67	62	Fair
17	75	83,33	78	Good

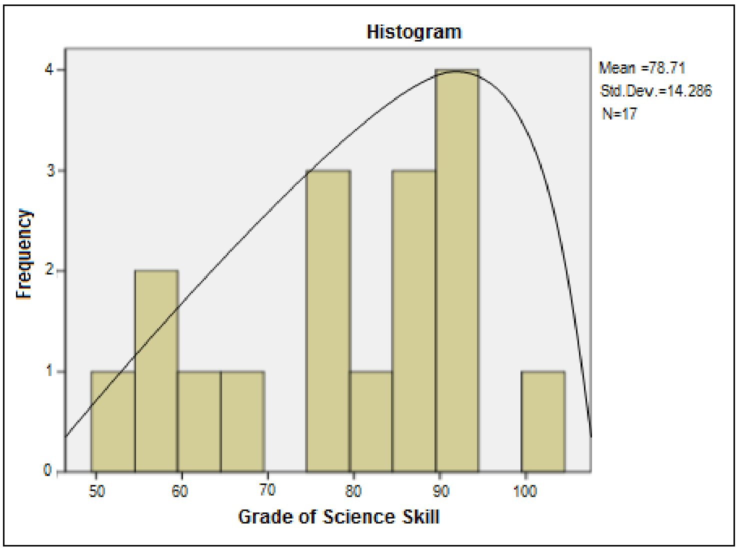

Figure 1. Frequency distribution of grade depicting children science skills after treatments

Table 5. Results of test of normality for grade depicting children science skill

	Kolmogorov-Smirnov[a]			Shapio-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Data	.141	17	.200*	.935	17	.262

*.This is a lower bound of the true siginificance
[a]. Lilliefors Significance Correction

Table 6. Results of test of hypotheses for children's scientific skills grade scales

	Test Value=17					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence interval of the Difference	
					Lower	Upper
Data	17.809	16	.000	61.706	54.36	69.05

Table 7. The science skill grade achieved by children (research subjects) at the end of research treatments

Grade scale	Criteria	Frequency (%)
80-100	Very Good	9 (52.9)
66-79	Good	4 (23.5)
56-65	Fair	3 (17.6)
40-55	Poor	1 (5.90)
30-39	Fail	0

Given the asymptotic significance value of children's scientific skills grade (0.935) that much higher than α=0.05, it suggests that the frequency of children's scientific skills grade was distributed normally. Next, test of hypotheses for children science skill grades resulted in t-value of the data (17.809) that much higher than that of t-crit (1.74) so it can be stated that the treatments positively contribute in changing children science skill.

Overall, the science skill changes achieved by children of group B at the Srijaya Kindergarten of Palembang at the end of research treatments, the science learning by process skill approach, summarized in Table 7. Based on the table, none of the 17 subjects falling into the category failed, only one was poor, only 3 were sufficient (fair), while the rest are good and very good.

4. Discussion

The data of this study indicate, among 17 research subjects, there are three children who achieve learning outcomes in the category of sufficient (fair) and one child with low (poor) learning outcomes.What was wrong with these four children? From Table 5 it was found that participant who achieved poor outcome is child number 12, while three children who achieved sufficient changes were children number 7, 15 and 16. Re-checking on the observation sheets of child's learning activities and the child worksheets (postest) results in the following facts. Child number 7 did not attend the first lesson (water play), child number 12 was absent in the third lesson (using magnifier to observe cricket), child number 15 was absent in the second lesson (play with dough), while child number 16 did not attend the third lesson. It seems that the lower achievement of the four children is not necessarily related to technical aspects of the method/approach of the science lesson applied, but more related to statistical data gap. The absence of such children leads to a lack of observational and posttest data so that the child's average score is low. Thus, it can be suggested that the science skills grade achieved by 75% of participants, good and very good categories, are the true picture of the impact of science learning applied in this study.

The results of this study are not surprising, but merely confirm and verify the theories of benefit of the process skill approach in science learning. By its characteristics, the learning applied in this study is a hands-on learning model, which by Haury and Rillero [11] defined as any instructional approach involving activity and direct experience with natural phenomena or any educational experience that actively involve children in manipulating objects to gain knowledge or understanding. By involving children in an enjoyable "hands-on" science activities, they have chance to develop their skills in both inquiry and mathematics. As suggested, children begin to construct scientific concepts during their preschool years [12]. Like scientists, even four-year-old children observe, pose questions, hypothesize, and have some understanding of cause and effect [13,14].

All three classroom learning implemented in this study, giving students opportunities to learn through play, play with water, dough, and insects. Water play is one among well known teaching practice adopted by early childhood education practitioner all over the world to approach sinking/floating concepts, due to the effectiveness in facilitating child's curiousity [15] and allowing children to develop their science concept and problem solving skills [16,17]. Through the dough play and observing insect, the child has experience in comparing caharacteristics of objects to discover similarities and differences as a fundamental process skill [18]. Through a playful science learning children do not necessarily reach an understanding of the concepts of natural sciences, but through play, children get on better science skills than those learn sicence trough minds-on [19,20].

Figure 2. Classroom atmosphere of science learning conducted in the research. A) An engrossed little girl in the color mixing experiment. B) The children eagerly filled out the worksheets followed the teacher's instructions

Apart from the effectiveness of the learning approaches applied in this one-shot case study, researchers are very proud to hear the testimony of teachers implementing the learning applied in this research. Ms Widiami, the implementing teacher, said “Frankly, I was deeply touched to see the children so enthusiastic and happy to follow the classroom learning such as implemented in these three weeks. These experiences has make me aware that there are many things we could do in a limited availability of facilities to educate our children appropriately.” The depiction of the classroom atmosphere and the enthusiasm of the child following the lesson as revealed by the implementing teacher can be seen in Figure 2.

Based on the children process skill, product skill and science skill achieved by children during and upon classroom learning and the testimonies of the implementing teachers it can be concluded as follows. Science learning with a process skill approach proves to be effective for developing children's science skills, even in kindergartens with limited facilities such as in Srijaya Kindergarten of Palembang. Given Palembang is a big city in Indonesia, while in it is still a kindergarten with teachers who unfamilar with learning using process skill approach it can be imagined what kind of early childhood learning in small towns and villages of this country. It is therefore the regular teacher training important to be considered.

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