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Movable Book Development To Improve Students' Science Process Skills

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Abstract

Books become a source of student activity and experience, serve as a guide for exploration, and experiment with concrete materials, directing students to be involved in the process and method of inquiry. The book provides direction for directing science experiences. This study aims to develop a feasible and effective movable book to improve students' science process skills. This study was a development research through Borg and Gall development model. The subjects were students and teachers of grade IV elementary school in Ngaglik sub-district Yogyakarta. Data collection was carried out through questionnaires and tests. Validation of products was carried out by media experts, and material experts. Teachers and students' responses were asked to see the practicality of using the product. Based on the validation, it was known that the movable book was feasible to use. Feasibility in the media aspect obtained a score of 255 with the category "feasible", the material aspect obtained a score of 95 with the category "feasible". The acquisition of teachers' response scores from 109 to 116 with the category "very feasible", the acquisition of student' response scores from 35 to 37.95 with the category "very feasible". The product that was developed effectively improved the science process skills based on the results of independent sample t-test showed a significance level of 0.03 which means <0.05. These results indicate that the movable book was feasible and effective to be used as a learning supplement to improve students' science process skills.

Keywords: *movable book, keterampilan, proses sains*

1. Introduction

Book becomes reference for the implementation of teaching and learning process for teachers and students. In addition, book becomes a mean for knowledge transfer to students and sources of activities for students' experiences. Book does not only provide subject materials, but also guide students in conducting exploration activities and scientific research. This means that a book supports the cognitive development of students and at the same time, plays a role in the development of student skills.

Book consists not only of knowledge, facts, concepts, principles, and procedures, but it also consists of the skills and attitudes that students must master in order to achieve the specified competencies (Daryanyo and Dwicahyono, 2014). Dick, Carey, and Carey (2015) explained that books as learning support must have five components; activities or materials to attract the attention and motivation of students, explain the purpose, explain and remind the prerequisite skills or knowledge; presentation of study materials in the form of elaboration of material or concepts and study instructions; student participation that includes practice activities and feedback; assessment that includes a specified competency test; and closing activities that improve memory, retention and transfer consideration in the form of reflection, evaluation, and capacity building. This statement showed that book plays an important role in the achievement of student learning goals. Thus, the contents of a book need to be well considered so that the fulfillment of students' needs and knowledge are balanced.

Curriculum 2013 has been applied in teaching and learning process; then teacher book used as a standard minimum to teach student. Meanwhile, students should be given students' activity books that provide subject materials and learning activities that students must do during the learning process. Students' activity books given are not reading books, but rather activity-based books (Ministry of Education and Culture, 2014). This means that teachers must be able to develop subject or study materials so that the students will be able

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to attain more in-depth knowledge, especially regarding concepts. Purnomo and Wilujeng (2016) revealed that there were deficiencies and discrepancies of assessment instruments for science learning in teacher's book and in fourth grade student activity books, in term of aspects of skills, knowledge, and attitudes compared to the expected goals.

The discrepancy of the books was found in the science process skill activities that did not provide appropriate instructions for students to carry out activities. In several books, it was also found misconception about the concept of science. In addition, some books did not include illustrations so that in experimental activities, students had difficulty in interpreting the instructions because students were still in concrete operational stage so that they needed coherent explanations and examples. This finding is one of the obstacles in developing students' science process skills.

The aspect of science skills refers to the science process skills that are prerequisite skills for students to obtain information during learning process. Science process skills allow students to process new information through real experience (Charlesworth and Lind, 2010). Raufl, Rasul, Mansor, et al. (2013: 47) suggested that the process skills describe the types of thinking and reasoning that are needed in learning activities. It means that, thinking and reasoning are very instrumental in successful learning process where students can use their skills in processing the information they receive, and vice versa. Learning activities should be able to encourage the development of the ability to think and reason optimally.

Science process skills are skills used in scientific research and decision making, so their existence in science learning must be rationalized by students' capabilities. Based on a study by Yumusak (2016), basic science process skills are the main skills introduced to students. The thinking skills of primary school students have not been able to coordinate the thoughts needed to perform integrated skills, which are a combination of various basic skills (Settlage and Southerland, 2012: 78). Therefore, this study will consider to students' basic science skills.

Basic science process skills, according to Settlage and Southerland, (2012: 55-103) consist of observing, inferring, classifying, measuring, predicting, and communicating. This study uses five basic science process skills, namely, observing, classifying, predicting, communicating, and concluding. Measurement of basic science process skills can be done using multiple choice questions. This refers to the study of Elmas, Bodner, Aydogdu, and Saban (2018) which revealed that multiple choice questions can be used to measure science process skills by paying attention to the quality of the questions and expected knowledge constructs.

Textbook, as a mean of learning science, must provide accurate science process content for student learning. The contents of the science process skills in the books are adjusted to the capabilities of the book's targets and science curriculum (Aslan, 2015). Based on previous findings in which there was a discrepancy between books based on the 2013 curriculum and science learning process, it is necessary to develop books that provide the contents of science process skills that are appropriate to students' capabilities.

Jean Piaget divided cognitive development into several stages. School children aged 7 to 11 years old belong to the stage of concrete operational thinking, which is a period in which the child's mental activities focus on real objects or events that have been experienced before. At this stage, students begin to think deductively, form the concepts of space and time, classify objects, do rather complex problem solving as long as the problem is concrete, and be able to use their experiences as a reference in understanding something (Hergenhan & Olson, 2008: 320; Hurlock, 1978: 39; and Schunk, 2012: 333). This explanation indicated that students have been able to master science process skills, as long as with concrete learning. Student learning can be presented by giving concrete or semi-concrete examples in the form of pictures or illustrations.

Regarding to this, movable book is one of the media that can help to deliver subject materials and science process skill contents. Movable book is a type of picture book that was first created in the 13th century in the form of volvelle or wheel chart, which was simple calendar used in medieval monasteries (Dyc & Hewitt, 2011: 5; Dales, 2007: 29; & Hiebert, 2014: 10). In the following century, movable books were used to harmonize data of star

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positions, church calendars, astrological signs, and the like (Marcus, 2013: 2). The development of this book grew rapidly until the 16th century when movable books for children were made. Later on movable books are used in various fields, such as medicine, astronomy, and education.

Movable book itself is three-dimensional book that describes material through writing, various mechanical elements and paper techniques. Klein, Gray, Zhbanova, and Rule (2015: 5) revealed that movable book is a book that has pages with mechanical motion when it is opened and flaps when the cover is lifted or the wheel is rotated. Sarlatto (2016: 89) revealed that a movable book is considered as an animated book that uses a paper mechanism to animate pictures by drawing certain parts so that the page can be lifted up and create a three-dimensional structure. This opinion emphasized that movable books are books with mechanical elements and have three-dimensional structures.

Movable books are published for children as a medium for learning and playing. Thus, movable books present something different compared to books in general. This type of book presents a sensation in enjoying the story so that it becomes more interesting. For fourth grade primary school students who are at the stage of concrete operational thinking, movable books can facilitate visualization of abstract concepts, such as day and night, or the structure of the Earth. Attractive design and the surprise sensation make children love books more and are eager to learn, as expressed by Dyc & Hewitt (2011: 9) that learning becomes fun and interactive when the illustration of the lesson moves and the page lifts.

Movable book has complex mechanical elements where pop-ups and lift the flap are a subset of movable book (Jackson, 1996: 8, Findlay & Rubin, 2005: 43; Hendrix, 2008: 41, & Reid-Walsh, 2016: 196). In more detail, the structure of movable book is explained by Crupi (2016: 25) who stated that movable book is three-dimensional book having mechanical or paratextual elements that can build interactions with readers. This book was interactive because the reader can move several elements of the book like they can move volvella, flap, scrolling picture, metamorphosis book, carousel book, or hidden picture (Brown, 2006: 359). The pictures in the book are joined together by a sequential tab and the pages of the book can be viewed in various ways (by peering or through tunnels). Readers can flip books quickly through page sequences, animate pictures through animation or illusion of movement (flip book) and additional decomposition by adding three-dimensional effects to illustrations using pop-ups, scenic books, stand-ups, V- folds, toys, and visual aids that use various folding devices, causing pictures to rise, surface, unfold, and open when a page is opened (Abrahamson & Stewart, 1982; Dyt & Hewitt, 2011; Jr., Le, Yu, & Low, 2014 & Klein, Gray, Zhbanova, & Rule, 2015).

According to Rubin (2010: 7), movable books can convey teaching material more clearly, make learning more meaningful, more interactive, and make it easier for students to memorize because of the visual elements in the books. Dyc and Hewitt (2011: 7-9) also explained some of the benefits of movable books in learning process, including; making it easy to explain an object; facilitating the teaching of primary-school-aged children; visualizing the world around us; and creating a more enjoyable, effective, interactive, and meaningful learning experience. The characteristics and benefits of movable books are expected to improve students' science process skills. Based on this context, the purpose of this study is to develop a movable book that is eligible and effective to improve students' science process skills.

2. Methods

This study was part of research and development and used development design from Borg and Gall (1983: 775-776), which consists of 10 steps, namely: 1) research and information collecting; 2) planning; 3) developing preliminary forms of product; 4) preliminary testing fields; 5) main product revision; 6) main field testing; 7) operational product revision; 8) operational field testing; 9) final product revision; and 10) dissemination and implementation. The trial subjects in this study were students and teachers from five primary schools in Ngaglik District, namely, Minomartani 6 Public Primary School, Dayuharjo Public

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Primary School, Gentan Public Primary School, Ngebelgede 1 Public Primary School, and Selomulyo Public Primary School. Details of the research subject are as follows:

Table 1. Trial Subjects

Trial	Number of Students	Number of Teachers	School
Initial trial	20	1	Minomartani 6 Public Primary School
Expanded trial	20	1	Class IV A of Dayuharjo Public Primary School
	20	1	Class IV B of Dayuharjo Public Primary School
Operational trial	19	1	Ngebelgede 1 Public Primary School (experimental class 1)
	26	1	Selomulyo Public Primary School (experimental class 2)
	27	1	Gentan Public Primary School (control class)

Data were collected using expert judgment questionnaires, student response questionnaires, teacher response questionnaires, and test. Expert judgment questionnaire was employed to determine the validity of the product from the viewpoint of media experts and subject-matter experts. Practical use of the product was assessed based on teacher responses and student responses. The effectiveness of the product was seen based on the results of operational tests using nonequivalent control group design, which is part of quasi-experimental research design. The design of this study was carried out by giving pretest and posttest to the experimental classes and the control class. The experimental method in this operational test is as follows:

Table 2. Nonequivalent Control Group Design

Group	*Pretest*	*Treatment*	*Posttest*
Experimental class (KE) 1	O_1	Xa	O_2
Experimental class (KE) 2	O_3	Xa	O_4
Control class (KK)	O_5	Xb	O_6

The data were analyzed using the independent samples t-test.

3. Results and Discussion

Research and Information Collecting

Preliminary studies that have been conducted by interviewing and distributing needs analysis questionnaires to teachers and fourth grade students in Ngaglik District indicated that students needed supplementary books. From the results, some schools still had not received the distribution of the 2013 curriculum (K-13) teacher books and student activity books. Another problem was that the K-13 books provide little subject materials so that other books were still needed in order to make students understand subject materials comprehensively. Some teachers interviewed also stated that students had difficulty in classifying, communicating, and concluding. These findings indicated that the development of science process skills in the school has not been optimal yet.

Planning

Based on the findings of the needs analysis and literature search on the type of movable book, the movable book design was planned. The design began with formulating objectives, analyzing the curriculum, identifying indicators of fourth grade students' science process skills, identifying the characteristics of fourth grade students, and gathering material resources. In this study, the material developed was the material in Chapter 7, "The Beauty of Diversity in My Country", with the sub-theme "The Beauty of Cultural Diversity in My Country" in Learning Section 1 and Learning Section 2.

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The next step was to create an instrument to evaluate the eligibility of the product and to measure the effectiveness of the product. The instrument for product eligibility was in the forms of product assessment questionnaire by media experts and subject-matter experts as well as questionnaires to obtain teacher responses and student responses to see the practicality of the product. Multiple choice questions were provided as instruments to measure students' science process skills.

Developing Preliminary Form of Product

This was the stage of making movable books, which consisted of making draft designs in the form of story boards, completing illustrations that were tailored to the material science process skills, printing, assembling movable book mechanical elements, and bringing together mechanical elements on each page and cover. After completing the production, the movable books were handed over to be assessed for validity by media experts and subject-matter experts before testing the books.

Figure 1. Pages in *Movable Book*

Preliminary Field Testing and Main Field Testing

The results of validation by media experts and subject-matter experts indicated that movable books were eligible and could be used for trials. The product is eligible by media experts if it scores a minimum of 207.4 with grade B in the "eligible" category. Media experts gave the movable book a score of 255 with grade B, categorized as "eligible". Meanwhile, according to subject-matter experts, the book category is be eligible if it reaches a minimum score of 78.2 with grade B in the "eligible" category. Movable book of this study scored 95 with grade B in the "eligible" category.

In the trial, the product is considered to be practical and eligible to use if the response of the teacher obtains a score of at least 85 with grade B in the "eligible" category and the response of students obtains a minimum score of 28 with grade B, also in the "eligible" category. The results of the responses of teachers and students in the initial trial and expanded trial are illustrated in the following diagram:

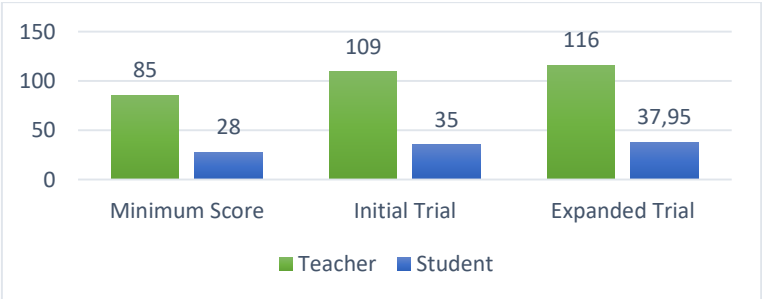

Diagram 1. Teacher Responses and Student Responses on Trials

Initial trial was conducted at Minomartani 6 Public Primary School with 20 students and one teacher of fourth grade as trial subjects. The teacher's response showed the final score of 109 with grade A in the "very eligible" category, exceeding the minimum score of 85

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with grade B in the "eligible" category. Student responses to the initial trial obtained a score of 35 with a grade A in the "very eligible" category, which exceeded a minimum score of 28 with grade B in the "eligible" category. Based on the scores, the product was considered to be eligible and could be passed on expanded trials.

The expanded trial was conducted in two classes at one school with a total of 40 students and 2 teachers from Dayuharjo State Primary School. The results of the responses of the two teachers showed a score of 116 with grade A in the "very eligible" category. This score exceeded the minimum score. Then, the students' responses also exceeded the minimum score, obtaining 37.95 with grade A in the "very eligible" category. Teachers and students also gave positive comments on the product. The teacher revealed that movable books were very good to be used in learning process. The books were interactive and made students active. The layouts were eye-catching and the subject materials were delivered completely and easily understood. Student comments for movable book were that the book was very interesting and easy to read. Students loved to learn using the book and wanted to have the kind of book.

The findings in this trial showed that learning process that was presented with interesting pictures was able to attract the attention of students to learn the contents of the book. Books that were presented with experimental instructions helped students to learn independently to explore the skills they have.

Product Revision

At this stage, the product was revised according to suggestions given by the teacher and students in the trial. Revisions were made so that the quality of the product became better and could be used for effectiveness testing. The revision of movable book products was about improving the quality of adhesive glue on mechanical elements so that it would not be easily torn when it was used by students. After product revision, the product was used for operational testing.

Operational Field Testing

Based on the expanded trial, the movable book was considered eligible and could be for operational testing, which aimed to find out the effectiveness of the product in improving students' science process skills. Operational testing was conducted through several stages. In the first stage, multiple choice questions were given as pretest to determine the initial skills of the students in the control class and the experimental classes. In the second stage, the learning process in experimental classes was carried out using movable books. Meanwhile, the control class used the 2013 curriculum teaching materials with the same time allocation as the experimental classes. In the third stage, posttest was given to students to know the final skills of students in the control class and the experimental classes.

To find out whether there were differences in the improvement of science process skills in the two classes, the independent samples t-test was conducted. Before the independent samples t-test, normality test and homogeneity test were conducted as prerequisite tests. The normality test results are shown in the following table:

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Table 4. The Results of One-sample Kolmogorov-Smirnov Test for Normality

		Pretest of Control Class	Posttest of Control Class	Pretest of Experimental Class 1	Posttest of Experimental Class 1	Pretest of Experimental Class 2	Posttest of Experimental Class 2
N		27	27	19	19	26	26
Normal Parameters[a]	Mean	62.3704	75.3333	66.0526	81.3684	65.6154	78.8077
	Std. Deviation	8.79313	8.71338	8.68891	9.57549	8.40037	8.61171
Most Extreme Differences	Absolute	.199	.185	.246	.177	.171	.175
	Positive	.199	.124	.246	.177	.171	.146
	Negative	-.143	-.185	-.228	-.143	-.142	-.175
Kolmogorov-Smirnov Z		1.033	.963	1.073	.773	.873	.895
Asymp. Sig. (2-tailed)		.236	.312	.200	.589	.431	.400

a. Test distribution was Normal.

Normality test was conducted using SPSS 16.0 at a significant level of 0.05. Decision making criteria was that if significance value > 0.05, then H_0 is accepted, meaning that the data is normally distributed. The normality test results of the control class, experimental class 1, and experimental class 2 in the table showed significance value greater than 0.05. Based on this data, H_0 was accepted, indicating that the data was normally distributed.

The next assumption test was homogeneity test, which aimed to find out that the data was from homogeneous classes. The hypothesis formulation in the homogeneity test is as follows:

H_0 = data derived from homogeneous population

H_a = data derived from inhomogeneous population

Homogeneity test was conducted with a significant level of 0.05. Decision making criteria was that if significance value > 0.05, H_0 is accepted, meaning that the data is homogeneous.

Table 5. Test of Homogeneity of Variances

	Levene Statistic	df1	df2	Sig.
Pretest of experimental class 1	2.430	3	15	.106
Pretest of experimental class 2	1.970	4	21	.136

Homogeneity test results of experimental class 1 and experimental class 2 toward the control class on science process skills showed a significance value greater than 0.05. Based on this data, H_0 was accepted, indicating homogeneous data. After that, independent samples t-test was conducted. The hypothesis was:

H_0 = There is no difference between the average science process skills of students in control class and those of students in experimental classes who used movable books.

H_a = There is a difference between the average science process skills of the students in control classroom and those of students in experimental classes who used movable books.

If the significance value sig (2-tailed)> 0.05, then H_0 is accepted and H_a is rejected. If the significance value sig (2-tailed) <0.05, then H_0 is rejected and H_a is accepted.

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Table 6. Independent Samples t-Test

		t-test for Equality of Means						
		t	**df**	**Sig. (2-tailed)**	**Mean Difference**	**Std. Error Difference**	**95% Confidence Interval of the Difference**	
							Lower	**Upper**
Posttest of class	Equal variances assumed	-2.102	70	.039	-4.55556	2.16767	-8.87884	-.23228
	Equal variances not assumed	-2.120	56.383	.038	-4.55556	2.14901	-8.85990	-.25121

The results of the independent samples t-test showed a significance value less than 0.05, which was 0.03. Based on this data, H_0 was rejected and H_a was accepted, meaning that there was a difference between the average science process skills of the students in control class and those of students in experimental classes who used movable books. In other words, movable books were effective for improving science process skills of fourth grade primary school students.

Dissemination and Implementation

Movable books did not go through the final revision because in operational trial, there were no obstacles in using the books so the books could be used for the dissemination and implementation stages. Dissemination was limited at the schools selected in this study because there were budgetary constraints and thus, dissemination could not be done in a wider scope.

This study showed that books have an important role in improving students' science process skills. Science learning activities that are presented through experimental or exploratory activities must be created in detail, but simple and attainable by students' capabilities. Learning activities presented using diction that is easily understood by children make it easy for them to understand the concept of learning. These results support a study by Jumanto and Zuhdan (2015: 9) which stated that the experimental activities presented in a science book should be within the reach of students' manipulative skills so that students do not have difficulty in conducting experiments presented in books.

Another factor that supported the improvement of students' science process skills in this study was the use of illustrations in movable books. Attractive colorful illustrations and mechanical elements became an attraction for students to learn and explore the skills they have. This finding is in line with the explanation of Dyc and Hewitt (2011: 7-9) which revealed that movable books can create a more enjoyable, effective, interactive, and meaningful learning experience. In addition, research by Suwandi and Masruri (2016: 88) also showed that picture books are able to attract interest and increase student concentration in learning process. Movable book has been able to be used as one of the teaching materials that is in accordance with the characteristics of students and can help students concentrate on understanding the lesson.

Science process skills of students who used movable books were proven to be better than those of students who used the 2013 curriculum student books. This was indicated by the result of t-test, which was 0.03. This finding was in line with the finding of Klein, Gray, Zhbanova, and Rula (2015) who used movable books in science learning about animal skulls. Their finding showed that movable books could facilitate students in learning science about animal skull, increase student motivation in learning, and create fun learning. Fun learning is one way to develop students' science process skills when students are given the opportunity to explore their ideas and carry out meaningful learning with play activities. Fun and meaningful learning can be presented using movable books as a means of modeling knowledge. Movable book is designed according to the concept of fun and meaningful learning. So, movable book does not only present subject materials, but also contains

educational games, interesting mechanical elements in the form of lift the flap, pop-ups, pull tabs, spinning, and light ups.

4. Conclusion

This study showed that movable books to improve the science process skills of fourth grade primary school students were declared in the "eligible" category by media experts with a score of 255 and also declared in the "eligible" category by subject-matter experts with a score of 95. Movable books based on effective multicultural education were used to improve science process skills and showed a significance value of 0.03 <0.05, which meant that the increase was significant. Based on the research findings, it can be concluded that movable book can be used as one of the supplementary books to the 2013 curriculum (K-13) student activity books; movable book can be used as an alternative to interactive and interesting teaching material; movable book can be used as one of the teaching materials to improve the science process skills of fourth grade primary school students.

During the activity that makes use of movable books, teachers are advised to control and pay attention to students so that students can stay focused on the subject material being discussed because students who have high levels of curiosity will tend to flip through the pages to find out the mechanical elements on other pages.

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