

Efforts to Increase Scientific Literacy and Thinking Process by Higher Order Thinking Skills

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Abstract

The research objective is to develop thematic teaching materials to improve scientific literacy skills and the thinking process of higher order thinking skills. This research uses the R & D (Research and Development) method with the design of Borg & Gall. The products resulted in this research is thematic teaching material oriented to scientific literacy and higher order thinking skills. Data analysis techniques used in this research include analysis of quantitative descriptive data related to validity and legibility of teaching materials. To determine the effectiveness of teaching material used normalized gain test. The results of this study indicate that the instructional material developed is valid and contains all the components of scientific literacy which include science as the body of knowledge, science as a way of investigating, science as a way of thinking, and the interaction between technology science and society in a balanced curriculum-oriented 2013. Learning by using the developed teaching material increase the students' scientific literacy, namely the students' ability to apply science to solve a problem. After learning with developed teaching material, the higher order thinking process is improved. Students' thinking skills enable them to work on problems with operational analysis, evaluation, and creation work. Based on data analysis it can be concluded that the development thematic teaching material oriented to scientific literacy and higher order thinking skills is effective in improving scientific literacy and the thinking process of students of higher order thinking skills.

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INTRODUCTION

In the 2013 curriculum the government expected students to have scientific literacy skills and higher order thinking skills. This was showed in the basic competencies provided by the government at present learning which is more focused on the surrounding environment phenomenon analysis and problem solving abilities. In addition to the 2013 curriculum implementation seminars carried out by the government, the tutors always reminded teachers to construct evaluation questions that were oriented towards HOTS (Higher Order Thinking Skills). It is considered by the government due to international relations need, that the progress and retreat of a nation is determined by three main parameters, one of which is Literacy of Science (Permanasari, Islami & Nahadi, 2015). Once scientific literacy is applied, children automatically learn critical thinking and high order thinking, because scientific literacy with high order thinking skills has a very strong correlation (Rahayuni, 2016). Implementing scientific literacy can be improved by incorporating elements of scientific literacy into teaching materials that are equipped with evaluation questions of higher order thinking skills.

Teaching material is an important part of learning activities. Teaching material is a set of learning tools or tools that contain teaching material, methods, boundaries and ways to evaluate that are designed systematically and attractively in order to achieve the expected competencies (Widodo, 2008). In the teaching material there are learning messages, both specific and general that can be used for the benefit of learning (Mulyasa, 2006). Teaching material can be used by teachers to convey the messages to their students so that learning objectives are achieved (Dick & Carey, 2009). If the teacher uses good teaching material then the learning that goes on in the classroom also runs more optimally and if learning takes place maximally, the learning objectives become easier to be achieved. The teaching material, can be in

the form of printed teaching materials or other forms according to the needs in the classroom.

However, when observations were made at several elementary schools that had implemented the 2013 curriculum in Sumowono Subdistrict, it was known that the teacher only used makeshift teaching materials to be used as a companion to the theme book at school. In the instructional materials the information sources that are poured sometimes do not corresponded to the Basic Competencies to be achieved. The teaching material is not oriented on scientific literacy. Colour of the book is not interesting for students. The teaching material was chosen by the teacher as a companion to the theme book because the price was cheap, easy to obtain and contained many practice questions. The teacher uses the teaching material without considering the content and types of questions that are not in accordance with the objectives of the 2013 curriculum. If it is allowed to drag on, students' scientific literacy and higher order thinking skills will not be achieved in the implementation of the 2013 curriculum.

From the background described, it is necessary to develop a teaching material that is appropriate to the characteristics of students and is guided by the 2013 curriculum goals. The instructional material developed must be able to be a companion of existing student books, and can also be used independently. Teaching materials must be read well by students so that information can be understood easily. The information displayed must be oriented towards scientific literacy and the practice questions developed showed also increase the students higher order thinking skills. Therefore development of thematic teaching material that is oriented to scientific literacy and higher order thinking skills of students in elementary school is very important.

In line with the research conducted by Budiningsih, Rusilowati, & Marwoto. (2015), it is found that teaching materials which contain aspects of scientific literacy must have a ratio of 2: 1: 1: 1, namely the 40% category for knowledge as the body of science, 20% for the investigation of the nature of science, 20% for the science

category as a way of thinking, and 20% for the interaction of science, technology, and society according to what was set by Chiapetta.

Thematic teaching materials developed in this study are based on the 9 theme book of “The Rich of My Country” which consists of 3 sub-themes. Each sub-theme consists of 6 lessons. The total learning in this teaching material is 18 learning activities.

METHODS

This type of research is research and development elaborated by Borg & Gall's model (2003). Ten steps developed by Borg and Gall, are only arrived at step seven (7) due to limitations, both in terms of time and cost in this study. According to Sukmadinata as stated in Abdurrahim (2011), for thesis or dissertation which have research purposes for a small-scale subject can stop the research in step seven (7), because for step eight, nine and ten requires expensive costs and coverage very wide in a long time. According to him also in research and development can be stopped until the final draft is produced, without testing the results. The results or impact of the implementation of the model already exists, both on limited testing and wider trials because during the implementation of learning there are tasks performed by students as well as a final test of each subject. The results of the final assignment and test assessment of each subject can be seen as the result or impact of the application of the product. The research steps can be seen in Figure 1.

The study was conducted in two schools, namely Lanjan 01 elementary school and Piyanggang 02 elementary school, Subdistrict Sumowono, Central Java. Phase 1 trials were carried out on a small scale, including one on one trials with class V Lanjan 01 elementary school, small group trials in class V Lanjan 01 elementary school, and class trials conducted in class IV outside the sample class, namely Sumowono Elementary School.

Field trials were conducted in class IV SDN Lanjan 01 and SDN Piyanggang 02 with a

total of 50 students as an experimental class. Field trials using one group pretest - posttest.

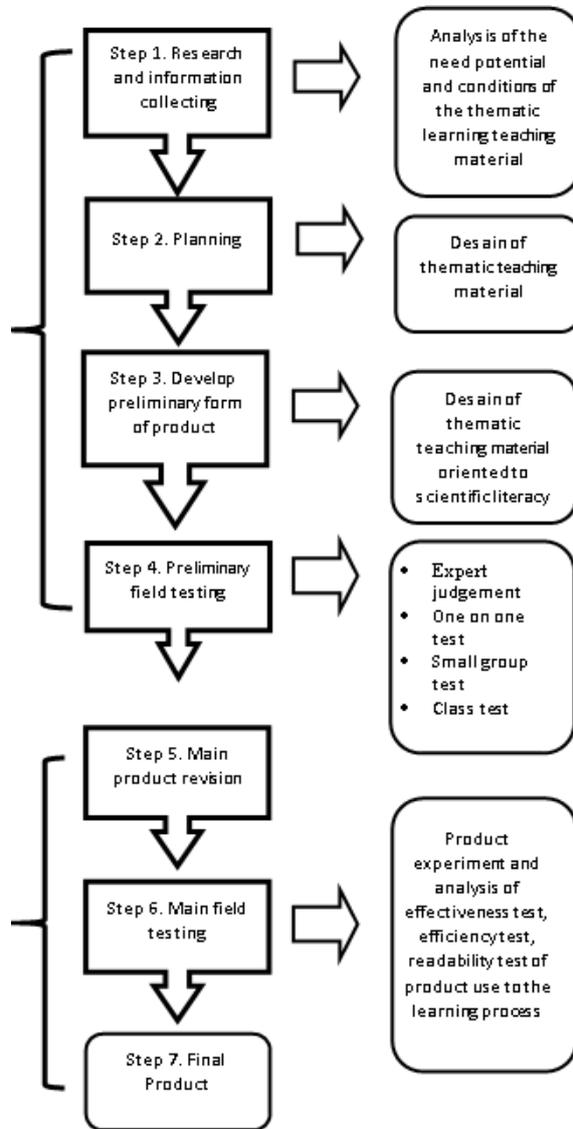


Figure 1. Steps in Research on the Development of Thematic Oriented Teaching Materials for Scientific Literacy and Higher Order Thinking Skills for students.

RESULTS AND DISCUSSION

Teaching Material Characteristics

Teaching material developed refer to the 2013 curriculum grade IV semester 2 theme 9 My Rich Country. This teaching material is developed in accordance with the characteristic of scientific literacy, that is in each learning contains

four components. The first component of scientific literacy is science as the body of knowledge. The scientific literacy aspect as the body of knowledge has a percentage of 40% of all learning indicators. This aspect displays information content or content of science that contains various types of knowledge, namely facts, concepts, theories, laws, principles, and information. The aspect of scientific literacy as the body of knowledge is reflected in the section "Let's Learning", where in this section the lesson invites students to remember and understand the information conveyed. This knowledge can be used as knowledge to explore other phenomena in daily life.

The second component of scientific literacy is science as an investigation process. The aspect of scientific literacy as an investigation process has a percentage of 20% of all learning indicators. This aspect includes student activities in carrying out an activity to find information from various sources. Activities can be in the form of experiments or observations. The point is that in this aspect students associate the knowledge and concepts they possess into the science process. The aspect of scientific literacy as an investigation process is reflected in the sub-chapter "Let's Find Out".

The third component of scientific literacy is science as a way of thinking. The aspect of scientific literacy as a way of thinking has a percentage of 20% of all learning indicators. This aspect gives an overview of scientists in conducting scientific investigations. Student activities in the process of thinking, reasoning, reasoning, and reflecting on the ongoing scientific activities in a learning. This aspect of scientific literacy is reflected in the section "Let's do Scientific Thinking".

The fourth component of scientific literacy is the interaction of technological science and society. This aspect has a percentage of 20% of all learning indicators. This aspect provides an overview of the application of science in human life and provides an overview of how technology has a positive and negative impact on society. The aspect of interaction of science, technology, and society is reflected in the section "Science and

Life", which contains how technology works, the use of technology in daily life, and mentions of jobs in the field of science and technology.

Science literacy oriented thematic teaching materials and higher order thinking skills have fulfilled the characteristics of scientific literacy teaching materials. This teaching material support students to be more active, creative and facilitates students to have high order thinking skills. In the development process, several assessment processes were conducted so that teaching material always go to a better stage.

A high order thinking ability is characterized by the ability to use the mind to search for meaning and understanding in exploring ideas, making decisions, thinking about solutions with the best consideration and revising the problems in the previous thinking process (Arifin, 2017). The ability to make decisions using the knowledge that has been acquired is commonly referred to as scientific literacy (Nisa', Rusilowati, & Wardani, 2018). To improve these two aspects, it is important to develop science literacy oriented thematic teaching materials and higher order thinking skills.

The development of science teaching materials like this has also been done by Nailiyah, Subiki, & Wahyuni (2016) which resulted the needs to contribute in instilling student character education through the local culture thematically integrated with the concept of science learned, so students can think scientifically against a phenomenon that exists in the their environment. It states that in education students must be directed to analyze natural phenomena that occur around them, and if they meet a problem they must try to solve the problem. This usually called as scientific literacy.

Similar research was also carried out by Islami, Nahadi, & Permanasari (2015) which in their research found that future science learning would be oriented towards developing scientific attitudes, scientific skills, reasoning abilities, students' ability to conduct scientific investigations, science process skills, and beliefs. self. The things mentioned above are very suitable with indicators of scientific literacy.

The Validity of Teaching Materials

The validity test of teaching material which is oriented to scientific literacy and higher order thinking skills has been done by 10 validators , they are 3 lecturers from the faculty of Mathematic and Science as a scientific experts,1 lecturer from Elementary School Teacher Education program,2 supervisors of Elementary school who acts as tutor of curriculum 2013 in Semarang region, 1 principal of Elementary school, and 3 teachers as the teching learning holder. The result of validity test for teaching material is presented by Table 1.

Table 1. The Result of Validity Test for Teaching Materials of Scientific Literacy and Higher Order Thinking Skills

Validator	Result	Category
Validator 1	93	Totally valid
Validator 2	94	Totally valid
Validator 3	91	Totally valid
Validator 4	97	Totally valid
Validator 5	93	Totally valid
Validator 6	96	Totally valid
Validator 7	91	Totally valid
Validator 8	96	Totally valid
Validator 9	97	Totally valid
Validator 10	96	Totally valid
Average	94.4	Totally valid

Based on Table 1, the average score is 94.4 and meets the totally valid criteria. The validity of teaching materials reflects the content regulation, presentation feasibility, language feasibility, graphic feasibility, and the feasibility of the scientific literacy component and high-level thinking skills. Compared to the average category of values obtained, this means that thematic literacy-oriented teaching materials and high-level thinking skills can be applied.

This teaching material is valid because it contains material that is in line with Core Competencies, Basic Competencies and also indicators of scientific literacy. The material developed also explains concepts or theories in daily life. To make it easier for students to understand the material in teaching materials, students are invited to do an observation that will certainly increase students' memory and understanding. This teaching material is also a

form of phenomena that exist in daily life, this allows students to imagine real conditions in a certain state (not abstract).

At the end of the theme there is also an evaluation problem that honors students' higher order thinking skills. Mustofa, Kuswanti, & Hidayati (2017) stated that in the matter of scientific literacy must contain scientific questions, explain phenomena scientifically, and use scientific evidence. These evaluation questions are presented so that students can solve problems in everyday life. The validity of the substance of the material is also worthy, clear, and true. The material presented is interesting because it has a harmonious image illustration, the scratches used are clear and firm, and of course the illustrations presented can add depth to understanding. Review of the material presented and the science information provided in the actual teaching material in accordance with the development of science and technology, so it is not out of dated.

Interest and Readability of Teaching Materials

Readability test using a legibility questionnaire on 54 students from grade fourth and fifth who have already take the course. Grade Five students from Lanjan 01 elementary school who were the subjects of small-scale trials and fourth-grade students from Sumowono Elementary School who were the subjects of limited trials were asked to fill out the readability readout questionnaire. Details of the results of the calculation of the readability questionnaire for teaching materials is presented in Table 2.

Tabel 2. Results of the Questionnaire on Interest and Readability of Teaching Materials

Indicators	Percentase Avarange (%)			
	D	LA	A	SA
Interest	-	-	19	81
Material	-	-	20	80
Clearance	-	-	-	-
Readability	-	-	10	90

Information :

- D : Disagree
- LA : Less Agree
- A : Agree
- SA : Strongly Agree

Judging from Table 2, it is known that 81% of students strongly agree that the teaching

material that has been developed by this researcher is interesting. They can state that this teaching material is interesting because the teaching material has an attractive overall appearance. Teaching material is equipped with attractive colors and images so that students become more enthusiastic in learning. In terms of material clarity, 80% of students strongly agree that the instructional material developed by researchers has a very clear and systematically structure of material. Submission of material in this teaching material is related to daily life, making it easier for students to provide a direct picture related to daily life phenomenon. In terms of readability of teaching materials, as many as 90% of students strongly agree that the teaching material developed is easy to read. Students can say so because the teaching material has the size and type of letters that correspond to the level of development of students, namely Arial 12. This was in accordance with the rules for writing teaching material regulated in the BSNP (2007). The use of sentences in teaching materials is not too long so that it is easily understood by students.

Teaching Material Effectiveness

The effectiveness of the instructional materials developed was measured using a comparison of the increase in the results of scientific literacy learning given before (pretest) and after (posttest) using teaching materials. The questions used are questions about higher order-oriented thinking skills. The number of questions used is 20 questions. Of the 20 questions there are three categories of difficulty levels, namely 6 questions in the easy category, 12 questions in the medium category, and 2 questions in the difficult category. The validity of the questions was measured using expert judgment from 10 experts, and stated that the questions were valid for use. The reliability of the problem was measured using the Alpha Cronbach formula with the acquisition of an alpha indicator of 0.832 which means that the reliability of the question coefficient is very high.

The results of the calculation of the normality of the posttest data about scientific

literacy evaluation and higher order thinking thinking skills in the experimental class are presented in Table 3.

Tabel 3. The Result of Normality Test

		Posttest
N		50
Normal parameters ^{a,b}	Mean	84.64
	Std. deviation	11.925
Most extreme differences	Absolute	.124
	Positive	.099
	Negative	-.124
Test statistic		.124
Asymp. sig. (2-tailed)		.054 ^c

a. Test distribution is Normal

b. Calculated from data

c. Lilliefors significance correction

Based on Table 3 obtained a significance value = 0.054. When compared to $\alpha = 0.05$ then the value of $\text{Sig} > \alpha$ so it can be concluded that the results of scientific literacy learning and higher order thinking skills of experimental class students come from populations that are normally distributed.

The average increase in scientific literacy of students in the experimental class can be seen from the difference between pretest and posttest results. The results of the increase are measured using a normalized gain test. Details of individual improvement results can be seen in Table 4.

Tabel 4. Normalized Gain Index Increase

Increasing category	Increasing average	Number of students
High	0.90	31
Intermediate	0.70	16
Low	0.30	3
Overall average	0.63 (Intermediate category)	

From the results presented in Table 4 it can be said that 31 students experienced an increase in the high category, named an increase in value of more than 0.70 which means that the teaching material is very effective. Then 16 students experienced an increase in the medium category with an increase in value between 0.30 to 0.70, which means effective teaching materials to be used. But 3 students experienced an increase in the low category of less than 0.30 which means that the teaching material was less effective for the three students. From the overall data can be taken the average increase in learning outcomes

is 0.63 which means that the instructional material developed effectively can improve scientific literacy and higher order thinking skills of students. Based on interviews conducted with several teachers, they said that the scientific literacy teaching material was effective in learning. The learning was student centered and was not monotonous and boring.

These results are consistent with the research conducted by Cristina, Rusilowati, & Sunarno (2016) entitled Development of Integrated Science Teaching Materials Based on Literacy Themed Science Application of the Concept of Energy in Life. The study concluded that the development of teaching materials can improve students' scientific literacy skills. Similar research was also carried out by Safitri, Rusilowati, & Sunarno (2015) with the title Development of Integrated Natural Science Teaching Materials Based on Natural Symptoms Themed Literacy. In this research concluded that the development of science literacy teaching materials effectively improves students' scientific literacy.

This increase in learning outcomes is inseparable from the creation of scientific literacy-oriented types of questions and higher order thinking skills, such as research conducted by Hartono, Hanif, & Rusilowati (2017) which states students must be able to master scientific literacy skills including science as a body of knowledge, science as a way of thinking, science as a way of investigating, and the interaction of science, technology, and society.

CONCLUSION

The conclusion of this research is the instructional material developed has an integrated and equitable scientific literacy learning component. The content of teaching materials was written based on the 2013 curriculum by developing scientific literacy in students, namely science as a body of knowledge, science as a way of thinking, science as a way of investigating, as well as technological science interactions and society. The teaching material

also contains evaluation questions with the type of higher order thinking skills.

Teaching materials developed are effective in improving students' scientific literacy. This is evidenced by the students' ability to solve a problem that exists in the surrounding environment by using the science they have learned.

Teaching materials developed are effective in increasing higher order thinking skills of students. This is evidenced by the increase of student learning outcomes in working on evaluation questions of higher order thinking skills (questions with operational verbs analysis, evaluation, and creation).

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