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# Thematic Learning Model of Science, Environment, Technology and society in Improving Elementary Students' Science Literacy

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***Abstract***

*The purpose of this research was to develop a science thematic model of science, environment, technology and its validity so that it can be used to improve the literacy of science of elementary school students. This was a research and development. The data collected in this research consisted of model validity data, students' science literacy, students' activity, students' and teachers' response to the developed learning model. The data collection techniques used was questionnaires, observations and tests. The data were analyzed by descriptive analysis. The result of the research showed that the developed thematic learning model of science, environment, technology and societies got an average score of 4.11 falling into the valid category. The ability of science literacy increased from the previous 41.71 at a very low level (<54) to 62.91 at a moderate level (60-75). The average score of student activity during the learning was in a good category. Students' and teachers' responses to the developed learning model were positive.*

***Keywords****: learning model, vision of science, environment, technology and society, science literacy*

## 1. Introduction

At the break of the Asean Economic Society (MEA), national and international quality and standard improvement are required. The standardization is not only applied to goods, industrial products and service but also the field of education especially to the educator and the process. This process standard will determine the outcome. A process is good when various inputs can be processed into heterogeneous outputs with above-average ability. Based on international organizations' assessment, the ability of Indonesian students is at a lower rank. One of the issues assessed by an international organization is science literacy. The assessment result of the *Programme for International Student Assessment* (PISA) shows that Indonesian students' science literacy is at the critical level. In 2012, it was in the position of 64 from 65 observed countries.

The students' poor science literacy is due to several factors, including curriculum, education system, education method, learning model, learning aid facility, media usage, the ease of information access and its frequency (Minart et. al, 2012). From those various factors, the method used and the learning model become important and need to be improved in the learning to facilitate and improve the students' science literacy. Based on the measurement, a tangible step is needed to improve the result. One of them is by improving the learning process which by far is running inside the classroom setting to improve the Indonesian students' rank in the international level as it has been released by an international assessment organization. The learning method and model has an important role in creating a more meaningful learning process which helps students acquire knowledge that can be stored in their long-term memory and applied in a real, new, and different condition (Astuti, Prasetyo, & Rahayu, 2012).

The improved learning method and model are generally aimed to improve the students' conceptual knowledge and their motivation. The developed method and model of this research have the purpose to facilitate and to improve the students' science literacy in the domains of the context, competence and knowledge of science. Based on those matters, the learning method and model were designed by paying attention to PISA 2015 framework, dealing with the context, competence and knowledge of science. To be able to accommodate the context, competence and knowledge of science, a different learning method is needed. One of the learning methods which involves the elements of science, environment and society is the *Science*, *Environment*, *Technology and Society* (SETS)

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based thematic learning**.** This SETS based learning is expected to improve the students' science literacy for it involves the context, competence and knowledge of science.

This research was aimed to reveal how the model of SETS based thematic learning could improve the elementary student's science learning literacy. The model was developed in the form of the syntax of effective SETS based thematic learning in improving the elementary students' science literacy. The purpose of this research was to develop SETS based thematic learning model to improve elementary students' science literacy. Elementary students were selected to be the subjects of this research because they have better ability in acquiring and understanding science concepts that it will last longer in their memory as better retention. With better understanding, retention and learning process which accommodates the context, competence and knowledge of science in SETS based thematic learning; the delivery of science literacy will surely be different from non-science literacy delivery. Science literacy can only be comprehended optimally when the students are learning and doing, finding the concepts, and practicing theme, also by relating them to the elements of *Science, Environment, Technology and Society*.

SETS based thematic learning will give a complete the experience of science learning to the students (Nugraheni, Mulyani, & Ariani, 2013). Besides giving experience of science learning it will also train the students to work in a natural way to make them understand more the concept of science. Thus, the students will get a complete understanding as to the result of optimal science learning which accommodates the context, competence and knowledge of science. By understanding science, having knowledge in the science context, competence and knowledge, they will be able to improve their science literacy which is expected to have an impact in the improvement of Indonesian students science literacy rank in the international level as it has been released by *Programme for International Student Assessment* (PISA).

Science literacy is one of PISA's domains of study. Science literacy is defined as the ability to use the knowledge of science, identify questions and draw conclusions based on proofs in the effort at understanding and making decisions related to nature and the changes done to nature by human hand (Johar, R., 2013). This definition views science literacy as multidimensional, not merely about understanding science knowledge but more than that. PISA 2000 and 2003 determined three major dimensions of science literacy in their measurement, competence/science process, content/science knowledge, and science application context. PISA 2006 developed four science literacy dimensions with the additional students' attitude towards science aspect (OECD, 2007).

## 2. Methods

This method of this research belongs to *research and development*. The development is conducted to SETS based thematic learning model in improving elementary school student's science literacy. This research was conducted in a school applying the K-13 curriculum. The location of the research was fixed for 10 students determined by the purposive sampling technique. This technique is used when the researcher has particular considerations in determining the samples based on the purpose of the research (Suharsimi, 2006). Based on the same consideration, a more massive scale trial is conducted to 5 graders of Kadipiro 1 Elementary School Yogyakarta. The class categorization was based on the observation conducted by the researcher. The research was conducted in two phases. The development phase was in February - July 2017 while the limited trial was conducted in August - October 2017.

Research and development approach was used during this research. Following S. Thiagarajan, Dorothy S. Semmel, and Melvyn I. Semmel (1974), the research steps implementation in this type of research is modified into three phases as follows in Figure 1.

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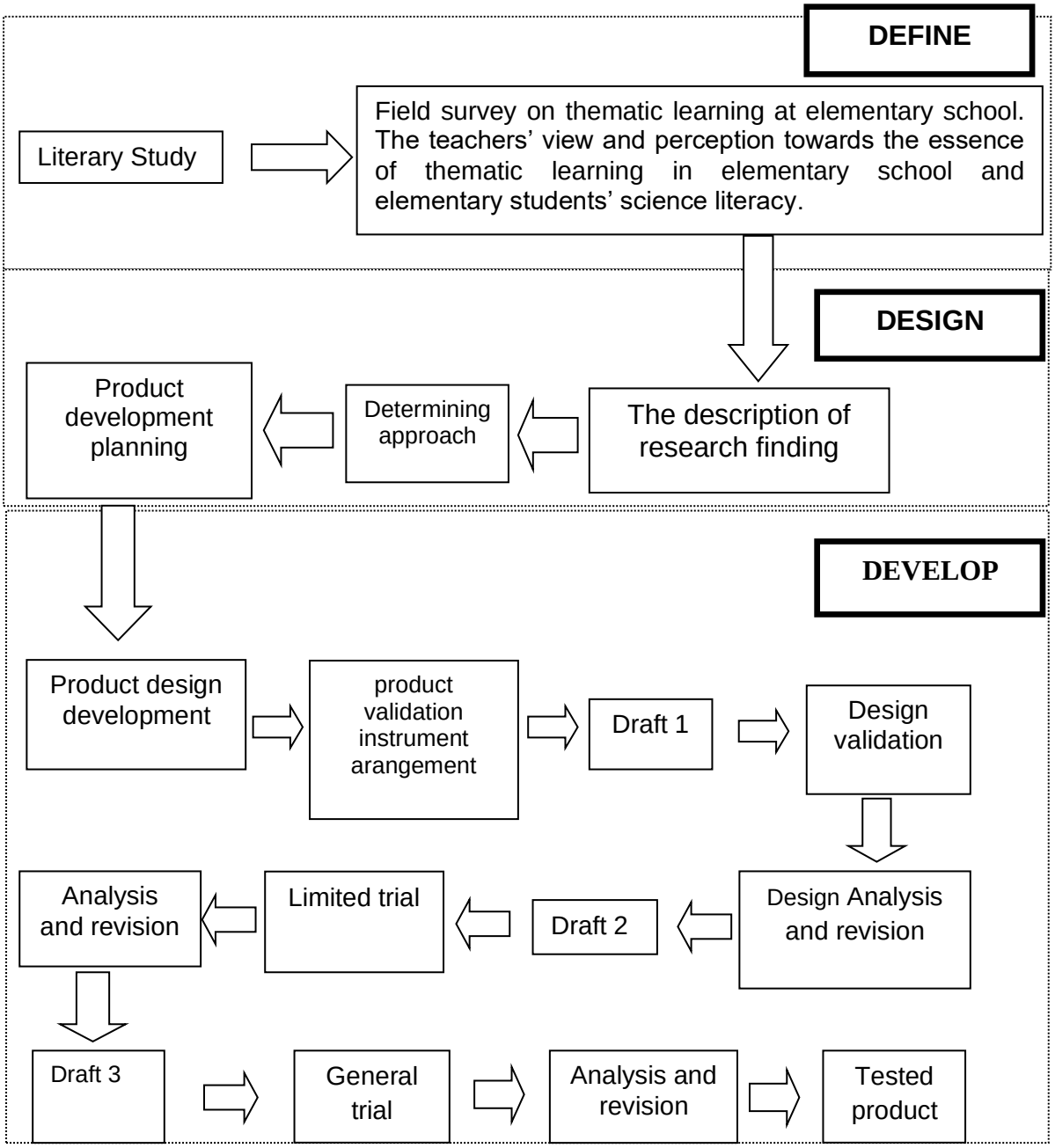


**Figure 1.** The diagram of research development and procedure (adapted from Thiagarajan 1974)

Data type, data collection technique, data analysis technique and instruments can been in the following Table 1.

**Table 1.** Types, collection techniques, instrument and analysis of the data

| No | Types of Data | Data Collection Technique | Data Collection Instrument | Data Analysis |
|---|---|---|---|---|
| 1 | Product Validity (Model) | Validation Questionnaires | Validation Sheets | Descriptive percentage |
| 2 | Science Literacy | Test | Students Questionnairs Sheets | Descriptive percentage |
| 3 | Students' Activity | Observation | Observation Manual | Descriptive percentage |
| 4 | Students' | Questionnaires | Questionnaire Sheets | Descriptive percentage |

| No | Types of Data | Data Collection Technique | Data Collection Instrument | Data Analysis |
|---|---|---|---|---|
| | Response | | | |
| 5 | Teachers' Response | Interview | Interview Manual | Descriptive percentage |

## 3. Results and Disscusions

*3.1 Model Development*

This SETS based thematic learning method is based on elementary thematic and science discussion. The essence of this model was to involve the students in genuine thematic learning matters by observing and understanding the learning concepts integrated through SETS based thematic learning, observation at the investigation spot, and to invite the students to design ways in dealing with environmental problems as a whole. Thus the students will be able to have a view of the concept of the learning from the science, environment, technology and society points of view. This effort can be done by a group of students. Schaubel, Kopfer, dan Raghafen (Joyce & Weil, 2000) expressed that at the same time, the students get positive respect considering science and they will possibly learn about the recent knowledge boundaries which can be trusted and reliable. The activity which had been planned and conducted also suits the learning activity in improving elementary students science literacy. The Syntax of this model is explained in the following figure 2.

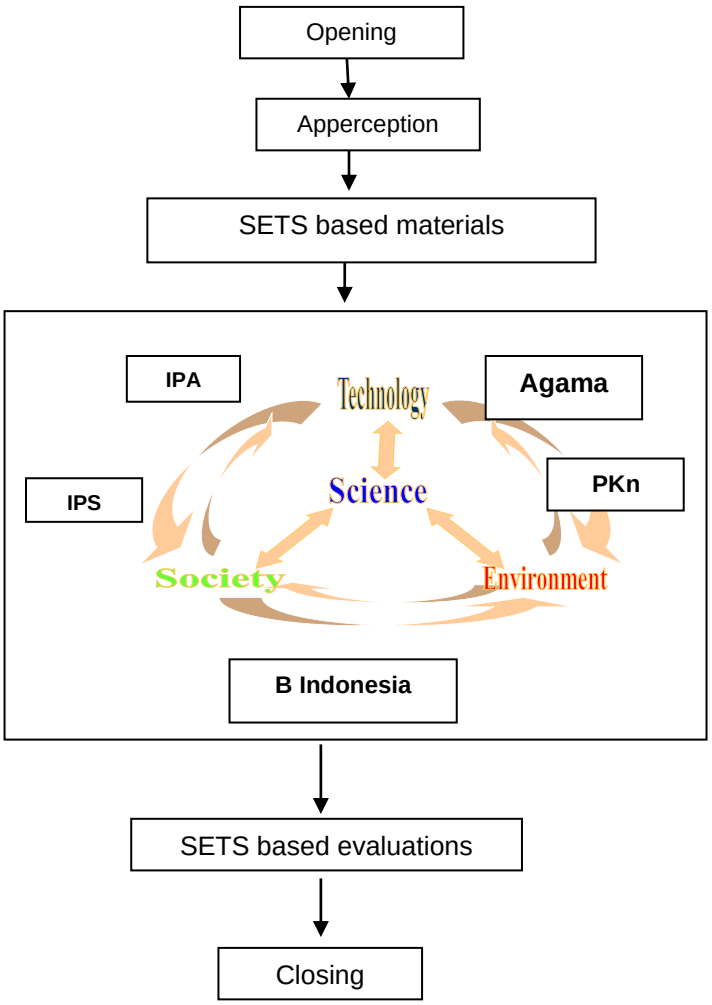


**Figure 2.** *Science, Environment, Technology and Society based thematic learning model syntax.*

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*3.2 Social System*

To implement this model, a certain atmosphere is required to make the students be able to run the activity in the SETS based learning by collaborating the concept of the material and the material itself thematically with each of SETS elements. The students have to cooperate carefully and thoroughly. It is necessary for they will be in the same community as a person who applies the best techniques in learning and understanding the science concepts to do some important things related to the student's science literacy. The students must draw hypotheses accurately dispute the facts; propose some design of technology, environment, social and society and other matters.

*3.3 Reaction Principle*

In this model, the teacher has to create and maintain a scientific atmosphere by emphasizing the process of invention, also to invite the students to make some reflections of their inventions. The teachers need to be careful that the identification of the facts is not the one to be the main issue and they have to encourage the students to be in the high level of detail in collaborating the elements of SETS and viewing the thematic learning concept from the four SETS elements. The teachers have to develop/invite the students to express their ideas and develop the concept of SETS in improving the elementary students' science literacy.

*3.4 Additional System*

To implement this model, a flexible and skillful manual and instruction are needed to support the learning process. Thematical learning concept understanding, scientific, environmental, technological and society concept point of view is essential to be deeply considered. Additional sources, system, tools and places are needed to run the SETS based thematic learning in improving the elementary student's science literacy.

*3.5 Instructional and Additional Impacts*

This SETS base thematic learning model is designed to teach the learning concept thematically by viewing the learning concepts through the point of view of science, environment, technology and society. Thus the instructional impacts are scientific knowledge and science literacy of elementary students. Along with it, this model also has some additional impacts: the student's commitment towards their learning and science literacy.

This model consists of a syntax of learning steps and learning tools (lesson plans, materials, and evaluation tests) which then takes the validity test by requesting validation from the lecturer who has accountability in terms of model and learning tools development.in this validation phase, there will be some feedbacks and suggestions concerning the model. The feedbacks and suggestions will be used as an input to improve and revise the model. Based on the validator measurement, it was known that the average validity of the learning model of all validators (Va) is 4.11i n the valid criterion of ($4 \leq Va < 5$), thus the learning model could be implemented to test the effectiveness of the developed model.

The learning model effectiveness test was conducted twice, consisting of a limited test with SD N Kasihan Bantul and field test with the 5$^{th}$ graders of SD 1 Kadipiro Yogyakarta. Based on the result of the test, it can be drawn that the manual of the model for the teachers is not yet clear enough and the students still found some difficulties in filling in the SETS based evaluation sheets. Thus, it required further revision and improvement. The result of the revision and improvement was then implemented in the field test to the 5$^{th}$ graders of SD Kadipiro Yogyakarta. The test was aimed to find out whether the learning model has the ability to improve the 5th grader science literacy and also to find out the students' response activity and the teachers' response to the developed model.

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*3.6 Students Science Literacy Level*

The measurement of the students' science literacy during the activity in the SETS based thematic learning model yielded the results as shown in table 3.

**Tabel 3.** The average of Students' Science Literacy Level

| Science Literacy Aspects | Indicator | Students Science Literacy Level Average | | | |
|---|---|---|---|---|---|
| | | Measurement 1 | Measurement 2 | Measurement 3 | Measurement 4 |
| Contextual Aspect | Recognizing Science and Technology related life situation | 44.25 | 52.75 | 56.50 | 60.25 |
| Knowledge Aspect | Understanding nature based on scientific knowledge | 44.50 | 55.75 | 55.56 | 61.76 |
| Competence Aspect | Identifying scientific issues | 45.75 | 55.88 | 58.33 | 62.76 |
| | Explaining scientific phenomenon | 42.25 | 57.65 | 55.56 | 64.71 |
| | Applying scientific proves | 34.25 | 52.75 | 61.45 | 65.25 |
| Science attitude aspect | Supporting science inquiry | 30.75 | 42.75 | 51.55 | 60.05 |
| | Interest in science | 47.25 | 52.75 | 61.35 | 66.25 |
| | Responsibility for natural resources | 44.75 | 56.75 | 58.5 | 62.25 |
| Average | | 41.71 | 53.37 | 57.35 | 62`91 |

Based on table 3 we can see that the average students' science literacy from the 1st – 4th measurement has shown an improvement though it was not a significant one at the first measurement, The literacy was still at the low level, and it increased after they joined the SETS based thematic learning model to the medium level, though it was still at the lower medium level.

The medium achievement of science literacy was due to several factors. The first factor was that the students had not yet been used to thinking and solving problems during the learning. the second factor was the number of the students which was more than 20 students in the classroom that made the SETS based thematic learning model work less effectively. This is in line with Suyanti (2010) dan Sanjaya (2009) who said that learning will be effective if the learning process is conducted in a classroom setting with not too many students that it will be easier to control. According to Suyanti (2010), one of the causes of the less maximum result of a learning process was a big class. Besides, less effectiveness could also be the result of the characteristics of the subjects in the research. The subjects were the students of a less favorite school that made it require a longer time to train their thinking, problem-solving ability in the learning process.

Science literacy means the knowledge and understanding of scientific concepts and the process needed in making a personal decision, participating in the society of cultural matters, and economic productivity (Turiman et al., 2011). Improving science literacy through science education is by developing ability, creativity, employing the right knowledge based on scientific proves and skills, mainly, in relevance to the daily life and career, in solving a challenging scientific problem with every meaning in it and in making responsible socio-scientific decisions. However, we need to admit that improving science literacy also depends on the need to develop the right collective skill interaction, personal development, and

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communication approach to express the logic and persuasion in proposing socio-scientific arguments (Holbrook and Rannikmae, 2009).

For the research purpose, PISA science literacy definition can be characterized by four connected aspects, consisting of context, knowledge, competence and science attitude (OECD, 2007). The aspect of context drives the students to be able to recognize the situation in their life which involves science and technology. It is aimed that the students will be able to understand that science has a particular value in individual or community life in improving and maintaining the life quality and in developing public policy.

The aspect of knowledge drives the students to be able to understand the nature based on scientific knowledge consisting of natural science and the knowledge of science itself. The purpose is to describe how far the students are able to implement their knowledge in the relevant context with their daily life (Ekohariadi, 2009).

The aspect of competence in PISA science literacy gives the priority to several competencies: (1) identifying scientific issues, dealing with scientifically studied issues, identifying the keywords for scientific information, recognizing the characteristics of scientific studies; (2) explaining a scientific phenomenon, applying scientific knowledge in the situation given, describing and interpreting phenomenon and predicting the change, identifying the right description, explanation and prediction.; and (3) using the scientific proofs, interpreting scientific prove and drawing conclusions, giving arguments to support or to deny the conclusion, and identifying the assumption made in the process of drawing conclusion, delivering the conclusion based on proofs and logic behind it and making reflection based on social implication and scientific conclusion.

The aspect of scientific attitude shows the interest in science, the support to scientific study, and the motivation to act responsibly for natural resources, and environment. PISA's concern with science is based on the belief that someone's science literacy comprises certain attitude, belief, motivational orientation, self-efficacy, values, and main act. According to PISA 2006, science attitude in science literacy consists of 3 categories: (1) supporting science inquiry, (2) interested in science, and (3) being responsible for the natural resources.

The developed model has successfully improved the previous students' science literacy of 41.71 in the very low level (< 54) to 62,91 at the medium level (60-75). The improvement was due to the fact that learning through the model trains the students to take the lessons by collaborating the aspects of science, environment, technology and society themes that make them able to train their science literacy. This research result is in line with other research results about science literacy which shows the medium level.

Some researches about science literacy which have been conducted before showing the improvement in the medium level are as follows: (1) Hastia's Research (2012) concluded that guided inquiry learning could improve the students' science literacy in the medium level with the N-Gain of 0,41; (2) Anwar's research (2012) concluded that video aided guided inquiry learning could improve the students' science literacy in the medium level with the N-Gain of 0.52;(3) Brickman, *et al*. (2009) also conducted a research showing that inquiry learning could improve college students science literacy. Based on the researches previously done, it can be concluded that the students' science literacy was at the medium level, so was the result of this research.

*3.7 Student Activity*

The observation result in the SETS based thematic learning model can be seen in the following table 4.

**Table 4**. Activeness Percentage on Every Aspect

| No | Activeness Aspects | Session 1 (%) | Session 2 (%) | Session 3 (%) | Session 4 (%) |
|---|---|---|---|---|---|
| 1 | Taking opinion/ideas from groupmates. | 70.69 | 73.43 | 69.34 | 70.49 |
| 2 | Giving opinion/ideas from groupmates | 68.65 | 67.75 | 74.00 | 67.65 |
| 3 | Asking groupmates for unclear maters. | 42.28 | 55.78 | 55.00 | 50.50 |
| 4 | Responding other groups' questions | 52.84 | 54.88 | 63.79 | 52.84 |

| No | Activeness Aspects | Session 1 (%) | Session 2 (%) | Session 3 (%) | Session 4 (%) |
|---|---|---|---|---|---|
| 5 | Giving questions towards other groups' presentation | 42.18 | 45.12 | 52.88 | 45`12 |
| 6 | Getting involved in revising presentation result | 97.05 | 100.00 | 98.25 | 100.00 |
| 7 | Responding teachers' question. | 64.81 | 63.75 | 55.76 | 64.75 |
| 8 | Taking notes from teachers' explanation | 96.06 | 100.00 | 97.32 | 100.00 |
| 9 | Paying attention to teachers' explanation | 96.26 | 100.00 | 100.00 | 100.00 |
| 10 | Reading relevant books related to the learning | 74.47 | 75.41 | 77.22 | 79.47 |

Based on the table above we can see that the activity mostly done by the students by the time they were getting involved in revising their presentation result. Noting the teacher's explanation, and listening to the teacher's explanation. The three aspects of activeness are shown by all of the students in measurement 2 and 4, while in measurement 3, only the aspect of listening to the teacher's explanation shown by the whole students in the class. The lowest activity aspect was asking the group member if there was something not yet understood and giving question-related to the result of the presentation of other groups which is only shown by 42.18 % of the students in measurement 1. To see the students' activity percentage average in a class on each measurement, we can check the following figure 3.

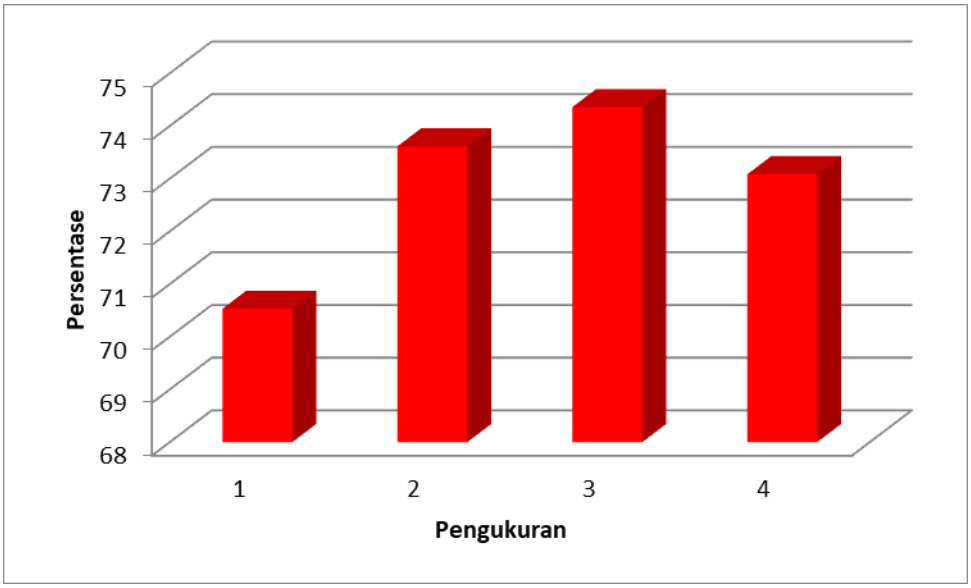


**Figure 3.** The average of students' activeness percentage

Based on figure 3 we know that the averages of students' activeness on the 1st, 2nd, 3rd, and 4th measurements were 70.52 %, 73.61 % , 74.35% and 73.08% respectively, all falling into the good category. It shows that the averages of the students' activeness percentages fell into agood level. Thus, SETS based thematic learning is effective to be implemented for the averagely > 70 % of the students were active during the learning process.

*3.8 Students Respons towards the Learning*

To know whether SETS based learning is appropriate to be implemented; learning appropriateness questionnaires are distributed to the 5 grades of the elementary school. Interviews are also conducted towards the 5th grade teacher. The questionnaires calculation is presented in the following Table 5.

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**Table 5.** Learning accuracy questionnaires result

| No | Scores | Criteria | Percentage (%) |
|---|---|---|---|
| 1 | 17-20 | Highly Accurate | 55.48 |
| 2 | 13-16 | Accurate | 26.84 |
| 3 | 9-12 | Less Accurate | 17.64 |
| 4 | 5-8 | Not accurate | 0 |
| | **Total** | | **100** |

It is shown in table 5 that 82.32 % of the 5th graders at SD Kadipiro 1 Yogyakarta stated that the SETS based thematic learning model was appropriate to be implemented in the learning process of 5th graders of elementary school. Based on the calculation, the science, environment, technology and *society* based thematic learning model has a high level of relevance to be implemented with more than 80 % of the students giving a positive response. The following Table 6 shows the result of the interview between the researcher and the teachers.

**Table 6.** Results of an Interview with Teachers about the thematic learning model with the Vision of i *Science, Environment, Technology and Society*

| No | Questions | Answers |
|---|---|---|
| 1 | The ease in the implementation of learning tools | It is easy, but it will be more optimum if the learning tools is given a week earlier so that the students can get along with it in advance |
| 2 | The practicality in the implementation during the learning process | I think this material is practical to be implemented in classroom settings |
| 3 | The impact on learning result | It has the ability to improve the students' learning result for it will last longer in their memory. |
| 4 | The impact on the students' science literacy | It improves the science literacy because it encourages them to learn the aspect of science literacy |
| 5 | The suitability with the competence to be achieved | It is in line with the competence and purpose to be achieved |
| 6 | Learning order | It has a good order, starting from observation, discussion, presentation, and practicum. |
| 7 | The obstacles in implementing the model | The students found it hard at the beginning for they were not familiar yet with the learning method, but in the progress, they could finally cope with the learning well. |
| 8 | The students' condition during the lesson | The students found it hard at the beginning for they were not familiar yet with the learning method, but in the progress they could finally cope with the learning well and they found the learning interesting. |

The interview results in table 6 show that the teachers thought that the teaching was relevant to the goal and suited the students' characteristics. It was also designed in good order, easy to apply in the lesson, practical and able to improve the student's activeness and their science literacy.

In implementing the learning model and applying the teaching materials, the teachers didn't find any significant obstacles. The main obstacle was in fact faced by the students who were not yet familiar with this kind of learning method. The obstacle occurred only at the beginning of the teaching. Then the students gradually comprehended and could follow the lesson well so that the learning became more interesting and the students became more active in the process.

## 4. Conclusion

The conclusion of the research is that the validity of SETS based thematic learning model gains the average score of 4.11 which belong to the category of valid, according to

the experts. The previously low level of science literacy of 41.71 (< 54) had improved to 62.91 in the medium level (60-75). The average of students' activeness during the lesson is improving into > 70. The students and teachers' responses towards the developed model are good. SETS based thematic learning model needs to be further developed to maximize the improvement of the students' science literacy. The greatest gratitude is addressed to Research and Society Service Directory of Education Ministry who had funded this research through 2017 Beginner Lecturer Research Fund.

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