Analysis of scientific literacy-based junior high school physics teaching materials readability on students increasing scientific literacy skills

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Abstract. The background of this study was the lack of scientific literacy skills of Indonesian students according to the research that have done by PISA in 2012. The preliminary shows that the average score of scientific literacy skills is 56.2. The aim of this study is to know the readability of scientific literacy-based physics teaching materials. The readability of teaching materials is divided into four chapter which in each chapter consist of characteristics from the aspect of scientific literacy for example, science knowledge, investigation of the nature of science, science as a way of thinking, and interaction between science, technology and society. One shot experimental design has been used as the method of this study. The data is obtained through scientific literacy skill test and cloze procedure test of teaching materials on second year junior high school students. Narrow test shows that the percentage of teaching materials readability is 67.5% and wide test shows that the percentage of teaching materials readability is 71.87%. It is implied from this result that the scientific literacy-based physics teaching material has high level of readability.

1. Introduction
Survey was conducted in several school in Bandung. Result shows that 56.2% educator in Bandung didn’t build scientific literacy in their learning process. Table below shows score test of student’s scientific literacy.

Table 1. Score test of student’s scientific literacy

| School                  | Amount of Sample | Test Score |
|-------------------------|------------------|------------|
| SMP Negeri X Bandung    | 32               | 62.9       |
| SMP Negeri AB Bandung   | 31               | 51.2       |
| SMP Negeri CD Bandung   | 33               | 60.4       |
| Average                 |                  | 56.2       |

Result above is a representation that Indonesian student’s achievement in science is still not good so they still cannot compete with other students from abroad. Based on PISA’s study result (Program for International Students Assessment) taken from OECD (Organization for Economic Cooperation and Development) in 2012, shows that Indonesia is in second grade from the last of countries that involve
in that study, which is in 64th grade from 65 countries [1]. In 2015 Indonesia is in 69th grade from 76 countries that participate in PISA [2]. PISA is an international program that measure level of student’s literacy in terms of reading, mathematics, and science. From three subject that measured in PISA 2015 Indonesian students got 397 score for reading, 386 for mathematics, and 403 for science [3]. The participants of PISA’s test is secondary students with average age around 15 years old.

From PISA’s assessment we can conclude that Indonesian students still lack of science understanding. Overall, Indonesian students still cannot implement science knowledge in understanding and identifying natural phenomena. One of the factors that influence the poorness science literacy is education system that didn’t maximize scientific literacy implementation. One of factor that influence learning success is learning material, but the learning material content that utilized in learning process still do not explain science literacy. Harry Firman [4] state that science book in Indonesia more emphasize science content dimension not context dimension. Sari [5] state that content of science book in Bandung still emphasize only knowledge aspect, while another aspect like way of think and science interaction, society and technology literally ignored. Science text book have been become an object of interest and concern of science educator [6]. Learning material that cupping scientific literacy balance involve these categories: science knowledge, science as way of investigation, science as way of thinking, science interaction, technology and society. So that, text book has important role in science learning, especially in directing students to have scientific literacy skills.

Science text book that used should guide students to think critically, understanding science contextually and implement science in daily life and bring up problem solving strategy so that students can think scientifically. The purpose of this research is to analyze readability teaching materials based on scientific literacy to improve scientific literacy skill of junior high school students.

2. Methods

2.1. Research Design and Instrument
This research was designed according one-shot experimental design. The sample is eight grade students that taken randomly using purposive sampling technique from every junior high school in Bandung. The chosen school coming from high cluster, middle cluster and low cluster.

In the beginning of the research a pretest was conducted to know the student’s current scientific literacy ability. When information collected readability, test was conducted toward teaching material. Instrument that utilized to collect the data are:

- Literacy test that adapted from PISA 2006, 2009, and 2015 consist of 30 multiple choice problem. Picture bellow showing instrument test example.

![Figure 1. The example of PISA scientific literacy instrument test](image-url)
Figure 2. The example of PISA scientific literacy instrument test

- Cloze procedure is used to determine teaching material readability. Figure 3 bellow shows the example of cloze procedure.

Communication tool

Communication technology takes place on sound phenomena. Sounds appear because they are ...... (1) From the phenomenon of canned telephone vibrations occur in threads due to noise from sources that propagate. We know the vibrations that occur in the thread because of the waves ...... (2) Therefore with the concept of vibration, until the sound appears then propagates as a wave where human thought develops. Until finally the telephone technology found by ..... (3) The telephone is a communication tool used to deliver voice messages. The telephone continues to grow every time until the latest technological innovations from the telephone appear, namely cellular phones or mobile phones. The workings of cell phones are using transmitting and reflecting techniques ...... (4) through ...... (5) Cell phones were first discovered by ... (6) an employee of the Motorola on April 3, 1973 with a model first is .... (7) Beginning with the emergence of mobile phone networks throughout the world using spectrum ..... (8) for the process of sending and receiving data. The two main mobile communication technologies currently are ... (9) and ..... (10)

Figure 3. Example of cloze procedure
2.2. Data analysis
After getting data from scientific literacy test and teaching materials readability test, researcher use some method to analyse the result.

2.2.1. Data analysis of student’s scientific literacy. Data that collected from scientific literacy instrument test is in form of interval 1-100. The score calculated by formula bellow:

\[
\text{Score} = \left( \frac{\text{Right answer}}{\text{total problem}} \right) \times 100
\]

(1)

Score from each student collected, then calculate the average of score to determine students scientific literacy skill.

2.2.2. Data analysis of teaching material (cloze procedure). Cloze procedure technique was introduced by Wilson Taylor [5] named cloze procedure, is a research technique to assess understanding through incomplete interview to reader so they can fill it with perfect understanding. Steps of (cloze procedure) are explained bellow:
1. Check students answer
2. Score of cloze procedure calculated based on formula bellow

\[
\text{Score} = \left( \frac{\text{right answer}}{\text{total of lost words}} \right) \times 100
\]

(2)
3. Categorize the result
Rankin and Culhane [7] state that cloze procedure result can be categorize as bellow

| Score | Readability Category |
|-------|----------------------|
| > 60% | High                 |
| 40% < Score < 60% | Medium              |
| < 40% | Low                  |

Table 2. Teaching materials score criteria

3. Result and discussion
The average score of scientific literacy test is 56,2. From the score it can be determined that student’s scientific literacy skill is in medium category.

3.1. Narrow test of teaching material
Narrow test have been done by 22 students of eight grade student, researcher give teaching material toward students to read in several time, then students asked to fill cloze procedure test. The result of cloze procedure teaching material from narrow test shows in the table 3 bellow

| Chapter | Readability (%) |
|---------|-----------------|
| 1       | 84              |
| 2       | 70              |
| 3       | 56              |
| 4       | 60              |
| Average | 67,5            |

Table 3. Readability score test result

Through cloze procedure test 10 problem of simple machine subject was given toward student and the result shows 84% readability level, technology communication subject got 70% readability level,
eco friendly technology got 56%, while magnetism application subject got 60%. The average of score calculated from those score that we got above which the result 67,5% which can be categorize into high readability level.

3.2. Extensive test of teaching material

Based on narrow test result some of revision done toward teaching material. In extensive test the same teaching material still used, with amount of sample 107 from three cluster school. The percentage of readability shows in the table 4 bellow.

| Chapter | Readability (%) |
|---------|-----------------|
| 1       | 86,67           |
| 2       | 72,22           |
| 3       | 62,90           |
| 4       | 65,71           |
| Average | 71,87           |

Table 4. Readability teaching material result

Through cloze procedure test 10 problem of simple machine subject was given toward student and the result shows 56,67% readability level, technology communication subject got 72,22% readability level, eco-friendly technology got 62,69%, while magnetism application subject got 65,71%. The average of score calculated from those score that we got above which the result 71,87% which can be categorize into high readability level. If its compared to narrow test result, the average of percentage readability from extensive is increase.

4. Conclusion

Teaching material readability designed base on scientific literacy got score 71,87% which categorized into high. This teaching material can be used in science leaning in school based on scientific literacy. For further research it needs to spread teaching material and effective test by implementing the teaching material in learning process in school. Then, scientific literacy test conduct to determine scientific literacy skills improvement.

5. References

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