Analysis on readability of scientific literacy enrichment book on earth science concept

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Abstract. The gap between Earth Science material on PISA and on the textbook used at school, encourages research related to the development of scientific literacy enrichment book on Earth Science concept that can support and complement the school textbook. As the learning material source that are used independently, the developed scientific literacy enrichment book is required to have good quality texts that suit to student’s reading level. The purpose of this study was to analyse the readability of science book especially scientific literacy enrichment book on earth science context that developed based on scientific literacy competence on PISA 2015. Method on this research was descriptive quantitative with determining main concept on passage as instrument to collect data and Raygor Graph to analyse book’s reading grade level. Passage on instrument were passages without graph, picture, or formula. Data collected included main concept explanation for determining passage readability percentage and difficult words for determining reading level of the passage. Participants that contribute on this research were 7th grade students at one of junior high school in Cilacap distric in Central Java, Indonesia. Data showed that readability percentage of the passage was 56% and categorized as readable. However, it also concluded that the passages were more suitable for 8th grade student’s reading level. It can still be concluded that even though some texts were more suitable for higher class, the developed book was still readable as an enrichment book.

1. Introduction
Science is a major that learned by student from elementary school until middle school or high school. As the main major on learning and teaching process, science’s main goal is not only knowing the concepts or formula. One of the teaching and learning science’s goal in school is making student to know science concepts and to know how the development of them on nature so they can be used for technology as the problem solver in real life [1]. Indonesian students’ science knowledge has been evaluated in PISA since 2006 on some scientific literacy issues. The result shows that Indonesian students’ ability are below standard of PISA [2-4]. Scientific literacy of Indonesian students’ influenced by some factors. Learning materials play a role as the factor that influence the student’s scientific literacy. Independent learning materials that available in home give positive correlation to
student’s scientific literacy, teaching and learning activity gives no significant correlation to student’s scientific literacy and in the other side student’s centre activities give negative correlation to student’s scientific literacy [5]. The level of scientific literacy of students is closely related to their science lessons applied and used textbooks [6]. The use of teaching materials is limited to textbooks and syllabus is one factor that causes low achievement of learning objectives [7].

In Indonesia, most of students depend on school’s tools and sources to learn science. Few of them have some science book as the addition source but most of them do not. They depend on science book that published by government. It naturally happens because most of science teacher depend on science textbook for teaching science [8]. In the other side, most of the science book that available on bookstore are not specifically developed for scientific literacy issue or correlate with current curriculum. So they need science book that enrich their knowledge and literacy on science and consist of materials or concepts that in line with current curriculum. According to Ministry Education Book Centre [9], an enrichment book is a book that can be used as an addition book to build student’s knowledge on certain concepts or materials. Specific criteria on the enrichment book is various grade use. An enrichment book can be used for some different grade. In order to achieve that criteria, an enrichment book must readable or fair readability text. So, the developed book need to run some test to know the readability of the text.

Readability of the text can be measured by some popular method such as Flesch-Kincaid, Gunning or Fry methods. But, readability can be expressed both as speed reading and reading comprehension level of the students with respect to the material they are reading. It’s in line with the Fry [10] that the readability of a text depends upon how easily it can be understood by the reader. According to Soyibo [11] readability level depends on the length of the sentences and the complexity of the language used in the book. It’s similar with the Fry method. The Fry method provides a graph that can be used to find out the level of reader that matches the text being tested. The graph requires data in the form of sentence length and the number of difficult words in a paragraph. Fry Graph has similarities with Raygor Graph. But in its use the Raygor Graph is easier because it has familiar axes as in the Cartesian diagram. In this study the graph used to analyse the level of reading the text in the developed book is the Raygor chart. Besides requiring information about the level of reading in accordance with the text in the book being developed, the readability of the book is also seen from the reader's understanding of the text presented in the book. To see the reader's understanding used passages of text and participants are asked to re-express the contents or concepts discussed in the passages.

As one of a series of books development research, the results of this study have an impact on the improvement and development of books so that books developed in accordance with the goals and objectives of developing books as supporting textbooks that can be used independently by students. So, the objectives of this study are measuring the reading level of the text to find out whether the text matches the reading level of the junior high school student or not and measuring the readability percentage of the text to find out whether the text can be understood or not by the students as the reader.

2. Methods

This study is descriptive quantitative that used some passages from the scientific literacy enrichment book on Earth Science concept as the instrument. The book was developed by authors. This study was conducted at one of the junior high schools in Cilacap District, Indonesia. The participants are 30 students of 7th Grade. The instrument used in this research are passages from scientific literacy enrichment book that developed. One of the passage on the instrument shown on picture 1. Participant need to determine the main concept and choose difficult words on each passage. The main concept that determined by the participants will show the readability percentage and difficult words of all the passage will show the reading level of the book. Raygor Graph used for analysing difficult words data to determine the book reading level [12].
Figure 1. One of passage on the instrument

Readability percentage determined by analysing participants’ answers and scoring them to 1 or 0 point. Participant’s answer got 1 point when it explains the main concept of the passage or one of the concept that was on the passage. Participant’s answer got 0 point when it doesn’t explain concept on the passage at all. Participant’s total scores on each passage will summarized and calculated for its average score for all of the passage. Readability percentage calculated by dividing passage’s average score with maximum score then time it with 100%. If readability percentage is 50% or under 50%, it means that the text is difficult to read but if the readability percentage over 50%, it means the text is fair or easy to read.

Reading level of the book determined using Raygor Graph analysis. Raygor Graph needs two kind of data to analysis reading level of the book. They are average number of difficult words on passage and average number of length paragraph (based on the number of sentence on passage). Criteria of the difficult words on the passage is consists of more than 6 characters or words that classified as difficult word by participants. Average number of difficult words will be x-axis and length paragraph will be the y-axis on the Raygor Graph [12].

Figure 2. Raygor Graph [12]
3. Result and Discussion

3.1. Readability Percentage

Readability percentage determined by calculating the right answers percentage on the instrument. Readability instrument consist of 15 passages from three (3) different sub-content that is 1) atmosphere, 2) hydrosphere, and 3) lithosphere. Maximum score is 15 points and minimum score is 0 point. Participants got 1 point if they can give an explanation about science concept on the passage and they got 0 point if the explanation does not consist of any science concept on the passage. The example students’ answers shown on picture 3.

![Image](a)

![Image](b)

**Figure 3.** The example of false answer (a) and right answer (b)

Students’ answer are collected and calculated. The analysis results of readability percentage on each sub-content presented in Table 1.

| Sub-Content | Percentage (%) | Criteria |
|-------------|----------------|----------|
| Atmosphere  | 62             | Fair     |
| Hydrosphere | 50             | Difficult|
| Lithosphere | 52             | Fair     |
| **AVERAGE** | **56**         | **Fair** |

Based on Table 1 it is found that sub-material Hydrosphere has difficult text to read, while Atmosphere and Lithosphere text are fair or easy to read. The other factor that can caused Hydrosphere’s low readability percentage is the concept on the passage. Participants’ might have some unfamiliar vocabularies from the passage. By determining the main concept on the passage, the complexity of the concepts on the passage might be the other factor that cause the Hydrosphere’s low readability percentage. These predictions are in line with the Zamanian and Heydari [13] statement that readability analysis can help writer to know if the readers can understand the material or not and gives some information to revise the written material with plain language but can’t know the difficulty of the concept. Another statement that in line with those predictions came from Eslami [14] that the complexity of the syntax on the text creates comprehension problems especially for mid and low proficient students. Based on the result and that statement, so the writer need to revise some complex passage or concept with plain language and simpler syntax or gives some addition explanation on complex vocabularies.

3.2. Reading Grade Level

Reading grade level determined by calculating the difficult words and sentence length. The number of difficult words and sentence length placed on the Raygor Graph to analyze the reading grade level of the text. The calculating results showed that the number of average difficult words and sentence length are showed on the Table 2.
Table 2. Number of Difficult Words and Sentence Length

| Sub-Content | No of Sample | Number of Difficult Words | Sentence Length |
|-------------|--------------|---------------------------|-----------------|
| Atmosphere  |              |                           |                 |
| 1           | 28           | 5                         |                 |
| 2           | 36           | 5                         |                 |
| 3           | 33           | 8                         |                 |
| 4           | 34           | 5                         |                 |
| 5           | 35           | 8                         |                 |
| Hydrosphere |              |                           |                 |
| 6           | 23           | 6                         |                 |
| 7           | 22           | 5                         |                 |
| 8           | 33           | 7                         |                 |
| 9           | 29           | 8                         |                 |
| Lithosphere |              |                           |                 |
| 10          | 24           | 6                         |                 |
| 11          | 19           | 5                         |                 |
| 12          | 28           | 6                         |                 |
| 13          | 29           | 7                         |                 |
| 14          | 35           | 7                         |                 |
| 15          | 27           | 4                         |                 |
| AVERAGE     | 29           | 6.133                     |                 |

Average number of difficult words placed on x axis data and average number of sentence length placed on y axis. Both of the data are rounded off and placed on the Raygor Graph like the Figure 4.

Figure 4. Raygor Graph with Data of Difficult Words and Sentence Length

Based on the Raygor Graph coordinate from difficult words and sentence length, the reading grade level over all text is 8th grade. It means that the reading grade level is higher than the grade of participants. The height of the reading grade level in line with the low of the readability percentage. According to Gyasi [15], the main factor why the book is hard to read is the incompatibility between the book reading grade level and the grade of the students. The different between book reading grade level and grade of the reader might be the problem if the book developed for specific grade, but it is not a problem if the book developed as an enrichment book. According to Ministry Education Book Centre [9], an enrichment book must be readable for various reading grade level. So, even has higher reading grade level than the grade of participants, the developed book qualifies as the enrichment book because it is readable based on the criteria of readability percentage.
The written text on science book play as one of main roles to make student (reader) get the concepts and information correctly. Not only concept or information that written as a text or passage, but a science book also has other part that contain crucial concepts and information such as graph, table, picture and illustration. They help reader to gain more understanding when reading the written concepts. So as a science book, written text is not the one and only part that deliver concepts and information to the reader. Graph, table or pictures on science book can guide reader to match the theory written with the real life condition. It relates with the main goal of learning science as stated by NRC [1]. Discussion on this topic can be developed in further research related to the validity and feasibility of the book as a whole research product.

According to Erdas Kartal [5], learning materials at home gives a positive correlation to student’s scientific literacy but student’s center activity gives negative one. As an enrichment book that can be used independently by student, the readability of the written text on the book must be good enough for the student. So the result on the readability study of the book’s text can give a guide to writer for revising the long paragraph, difficult words or another written part to be better one.

4. Conclusion
Based on the result, the average readability percentage were 56%, hence categorized as fair (easy) to read. The percentage is low but it is readable. The results of the readability percentage have served as feedbacks to the writer for revising the explanation of the complex concept to the simpler one. Raygor Graph showed that the reading grade level of the text was suitable for 8th grade students. The reading grade level was higher than the participants’ grade, this may be the culprit for the low readability percentage. However, the results suggest that the texts from the developed book were still qualified as an enrichment book.

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