Feasibility of physics teaching materials oriented on cognitive ability and argumentation skill of student

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Abstract. This study aims to determine quality and understanding textbooks of physics-based multimodal representation oriented on the provision of student’s cognitive abilities and argumentation skills. The research method is used research and developments design. Instrument that are used test of quality and understanding test of textbooks. Data analysis technique for textbook quality instrument through a questionnaire consisting of several aspects and the instrument of textbook understanding using the main idea test and supporting the main idea test that consist of 38 paragraphs. The results of data analysis for the quality textbook test obtained through the scores of questionnaires scores from three expert lecturer and 10 teacher in comprehension of physics studies are converted in the form of a percentage of textbook quality obtained in the developed 87.4% that is in the category very well. The results of data analysis for understanding test of students obtained by 88% that is in the category of independence (high understanding). The average of quality test and understanding test is 87%. Thus, the feasibility of textbooks based on multimodal representation oriented on the provision of cognitive abilities and argumentation skills in the feasible category.

1. Introduction

The development of the 21st century marked by the development of technology that growing rapidly. Along with that needed resources capable to answer all challenges and problems that exist. This 21st century challenge puts the school at the forefront of creating human resources. Aspects of 21st century skills that must be possessed by students is that students are able to solve problems by submitting their arguments verbally or in writing. The important aspects of the learning process include formulating questions, describing mechanisms and constructing arguments. In the case of building his argument, a statement must be accompanied by reason and accompanied by supporting evidence to justify the statement [1]. The process of arguing students learn about various scientific concepts and have the opportunity to train scientific argumentation which argues that argument plays an important role in developing critical thinking patterns and adds a deep understanding of ideas and ideas [2]. Roza.et al (2017) apply argument driven inquiry (ADI) models to supported by argument maps (AM) on identify the student argumentation levels and The results that there was different of student’s argumentation levels in two classes. But, the student’s argumentation levels in the experiment’s class using argument maps was better than in experiment’s class without using argument maps. Thus, ADI supported by argument maps was an effective method for improving and identifying the argumentation levels [3]. The
other research to improve the argumentation skill using the study which state that conceptual change text that can improving science teaching and learning [4] and conceptual change text enhanced student’s understanding [5].

From several previous studies, there are still few research reports that improve students' argumentation skills by developing teaching materials. Thus, the researcher is interested to do research by developing the argumentation-based teaching materials which aim to be able to pass argumentation to the students, the need for good and qualified teaching materials can also encourage the student in his argument.

The use of teaching materials has a direct effect on learning compared to the influence of teaching methods used by teachers and the behaviour’s teacher in selecting all the more important teaching materials [6]. A student needs to learn about multiple representation traits in scientific inquiries, the goal of making different representations of concepts in the context of science, which are part of the general development of students [7]. According to Ainsworth it is necessary to combine two or more multiple representations known as multi-mode representation by integrating verbal representation modes with one or more visual representation modes, resulting in a cohesive and comprehensive written outline describing a concept or phenomenon [8].

Previous research that has developed textbooks using multimodal representation. Zakiyah conducted a textbook study using multimodal representation to increase student science literacy. Textbooks used significantly improve the literacy skills of students' science compared to textbooks typically used in schools [9]. Sinaga conducted research on trans-mode representation on teacher preparation test using question instrument with multi representation approach. The ability of translation between representations modal is strongly influenced by the level of students’ understanding of the concept of physics using in verbal representation [10]. Nussifera conducted research and development of textbooks using multimodal reordering in physics-oriented learning on the provision of cognitive abilities and students' creative thinking skills. The result is a physics teaching book that involves multimodal representations more effectively in improving the cognitive abilities and creative thinking skills of students than the usual textbooks used in school [11]. Simbolon conducted research and development of physics teaching books using multimodal representation to improve students problem solving abilities. The result shows that the N-Gain significance value is smaller than α (0.000 <0.05) so that H₀ (hypothesis) received can conclude that the use of physics teaching materials using multimodal representation can significantly improve students' problem solving abilities [12]. Thus the problem in this research are: 1) How is the quality of textbook developed using multimodal representation for physics learning which is oriented on the provision of cognitive ability and argumentation skills? 2) How students' understanding of textbooks developed using multimodal representation for physics learning is oriented on the provision of cognitive abilities and argumentation skills?; 3) How is the feasibility of teaching materials developed using multimodal representation for physics learning oriented to the provision of cognitive ability and argumentation skills?

In general, the research was aimed to design physics teaching material which specifically promoted students to provision of cognitive abilities and argumentation skills in high school. The contribution researcher to development of science was through developing the modelling process of making physics materials for students in high school using multimodal representation.

2. Method
The research method used in developing the teaching material was Research and Development by Borg and Gall [13]. An arranging the sub chapters of the teaching material, the next stage was to design the teaching material. The development of the teaching material was adopting the Design Representational Approach Learning to write technique proposed [14]. Instrument that are used of the test are quality and understanding textbooks.

The developed teaching material had been quality test instruments by experts and some related stake holders, they are three physics lecturers and ten physics teachers for textbook quality instrument through a questionnaire consisting of several aspects. Additionally, the quality of teaching material instrument was used to see the quality of physics teaching materials using multimodal representation. The instrument used in the process of quality test in the form of questionnaire rating scale with interval 1-4.
It was classified as very appropriate, appropriate, not quite appropriate, and inappropriate. There were 30 questions and a suggestion column to fill in so the writer could improve the developing teaching material. In this case three physics lecturers and ten physics teachers are given physics textbooks based on multimodal representation which is oriented to the provision of cognitive ability and scientific argumentation skill of students. After that lecturers and teachers are asked to fill in the questionnaire in accordance with the statement contained in the questionnaire to see the level of quality textbooks that have been developed by researchers.

While to see the test of textbook understanding will be tested to check the understanding’s students. The teaching material was also tried out by some of students of SMA Manbaul Huda Bandung Indonesia. The instrument of textbook understanding using the test idea of the main idea and supporting the main idea of paragraph. The instrument used to measure each passage in every sub topics of developed teaching materials. Students are divided into 8 groups, each group determines the test of the main idea and supporting the test of the main idea of each discourse consisting of 38 discourses or paragraph.

The feasibility of physics-based textbooks on multimodal representation to improve cognitive abilities and scientific argumentation skills in measuring using textbook quality tests and textbook comprehension tests. The average result of textbook quality and students' understanding is the level of feasibility of textbooks.

3. Result and discussion

3.1. Quality instrument
The instrument for assessing the quality of textbooks is adapted from Sinaga.et al (2014), which has a textbook quality criteria covering several aspects: (1) component of presentation, (2) component of graft, (3) component of updating, (4) conformity core’s competencies and basic’s competencies, (5) clarity and correctness of concepts or laws, (6) problem-solving steps undertaken, (7) mode of representation used, (8) breadth and depth of subject matter, (9) conceptual hierarchy and organizing writing, (10) main ideas or main ideas of writing, (11) rules of writing and the use of punctuation, (12) the influence of textbooks. The first draft of tool optic’s teaching materials had been quality test by three expert lecturers and ten physics teachers in senior high school. The aim was to grade the quality of the materials and to develop the second draft of the teaching materials [14].

Table 1. Textbook’s quality test by three expert lectures.

| Lectures | Result (%) |
|----------|------------|
| 1        | 79.2       |
| 2        | 90.8       |
| 3        | 81.7       |

Table 1 showed the results of textbook quality test to three expert lecturers. From the analysis, the average quality test given to the three lecturers is 83.9%. Not only the questionnaire is given, the expert lecturers are also asked to provide some suggestions or inputs so that the developed textbook can be improved and minimize the existing shortcomings.

Table 2. Textbook’s quality test by ten physics teachers in senior high school.

| Teacher | Result (%) |
|---------|------------|
| 1       | 83.3       |
| 2       | 86.7       |
| 3       | 89.2       |
| 4       | 90         |
| 5       | 90         |
| 6       | 90.8       |
| 7       | 94.2       |
| 8       | 94.2       |
| 9       | 95.8       |
| 10      | 95.8       |
Table 2 shows the results of physics teaching textbook quality tests by ten teachers. From the analysis result, the average of the quality test that was given was 91%. Ten teachers are given suggestion columns in order to provide input whose purpose is to make the textbook better.

The criteria for percentage of textbook quality is adapted from Arikunto. From the results of quality analysis of textbooks that have been developed, there are some criteria such as categories very bad, bad, enough, good, and very good [15]. Average data analysis technique for textbook quality instrument through a questionnaires score was conducted in 30 descriptions which measured the teaching materials using likert scale consisting of several aspects from three expert lecturers and ten teachers in the field of physics studies are converted in the form of a percentage of textbook quality obtained in the developed 87.4%. Thus, the result is textbooks of physics-based multimodal representation oriented on the provision of student’s cognitive abilities and argumentation skills in the category very good.

3.2. Understanding instrument
The textbook’s understanding instrument using the test consists of the test of the main idea and the supporting test of the main idea of each paragraph. It consists of 38 paragraphs or discourses. Students divided into 8 groups, each group worked on 38 discourses to determine the main idea and support the main idea. The results of the main idea test and the main idea support test in a sense to measure the level of students' understanding of textbooks that have been developed. The percentage of the textbook understanding test result is interpreted by classification by category according to Rankin and Culhane. Criteria of such understanding include low (difficult category), medium (Instructional category) and high (independent category).

Table 3. Textbook’s understanding instrument by students.

| Group | Main Idea (%) | Supporting Main Idea (%) |
|-------|---------------|--------------------------|
| 1     | 92,7          | 93,4                     |
| 2     | 78,2          | 82,8                     |
| 3     | 85,5          | 84,8                     |
| 4     | 89,4          | 94,7                     |
| 5     | 88,7          | 93,4                     |
| 6     | 87,8          | 87,8                     |
| 7     | 87,1          | 88,9                     |
| 8     | 88,6          | 88                       |

Table 3 shows the results of data analysis for main idea test can be concluded that the materials had 87%, for supporting the main idea of paragraph test amount 89%. The average of main idea and supporting the main idea of students obtained by 88% that is in the category of independence (high understanding). Sinaga claimed that On the other words, the developed teaching material could be categorized as very good if the instructional material that is written should meet the requirements of good teaching material; the provided concepts must be described well and in understandable manner; the description must be in order, whether it is inductively or deductively; the content must be suitable for the students; the verbal and visual representation are integrated in the content; the order of the multimodal representation is appropriated and is used to make the concept clearer; the materials can motivate the readers to read more about the given information; and the punctuation and the grammar are well-organized [14].

3.3. Feasible teaching material
After the quality test and understanding test, the average of both results is interpreted in the textbook feasibility category that is very feasible, feasible, quite decent, and not worth it. This range was adapted from the scoring rubric of Book Analysis of Guide Ministry of Education Indonesia [16]. Thus, the feasibility of textbooks based on multimodal representation on the provision of cognitive abilities and argumentation skills in 87%. Thus, the feasibility of teaching material based on multimodal representation on the provision of cognitive abilities and argumentation skills in the feasible category.
From the tests of quality and understanding test, it can be restated that the developed learning material had feasible of teaching material. Moreover, it allowed students to learn autonomously.

4. Conclusion
The physics teaching material that had been developed using the multimodal representation was feasible is used for student to learn autonomously. It is recommended for the physics teachers, especially in senior high school level, to write their own learning material involving the multimodal representation. Finally, the further study needs to explore the influence of the domains in developing teaching material in promoting students’ cognitive ability and argumentation science skill.

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