

Developing a Connected Model of Integrated Science Material to Improve Students' Science Process Skill

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Abstract—The research and development was proposed to produce a connected model integrated science teaching material with proven effectiveness. The teaching material was packaged in the printed form and based on student characteristics. The teaching material was developed to improve science process skills of junior high school students. The researchers developed the teaching material using a model of research and development by Borg and Gall (2003). The stages consisted of six steps, namely: 1) preliminary study; 2) planning; 3) development; 4) validation; 5) trial; 6) the final product. The validation results of the teaching material and the development of materials experts showed that the teaching material was valid and the responses of two science teachers indicated that the teaching material was generally good and appropriate for use in learning. The results of the analysis of legibility and attractiveness of the teaching material by 6 students of class IX showed that the teaching material was very easy to read and very interesting for students. The results of science process skills after treatment showed significant difference between the two classes. The science process skills in the experimental class were better than the science process skills in the control class. Based on these data, the connected model integrated science material was appropriate for use because it has been categorized as very valid, effective in improving student learning science process skills, and practical in the process of learning science in junior high school in Malang city.

Keywords—*Developing Material, Integrated Science (IPA), Connected Model, Science Process Skill*

I. INTRODUCTION

Integrated Natural Science consists of several fields of scientific study, including Astronomy, Biology, Chemistry, Geology, Physics, and Zoology. Therefore, it requires an integrated approach to avoid overlapping concepts in several fields of scientific study [1]. The scopes of natural science in SMP/MTs are the energy and its conversion (Physics), earth space (IPBA), living organisms and life processes (Biology), and the materials and its characteristics (Chemistry) [2]. According to the Regulation of Indonesian National Education Ministry (*Permendiknas*) No. 22 in 2006, the scopes of the science are taught in one course. Therefore, there is a science learning approach which connects or unites various fields of scientific studies into one discussion. Learning science integrally improves the achievements, science process skills, and attitudes toward science [3].

The outcome of education in Indonesia, especially in the field of natural science is still low based on the data of PISA (Program for International Assessment of Student) in 2009, namely; Reading (57), Mathematics (61) and Science (60) [4]. Based on the data, the science literacy in Indonesia is still low. The students' science ability in Indonesia can also be seen by the results of the TIMSS research in 1999, 2003, 2007, and 2011, which were consecutively 435, 420, 427 and 406. Indonesian students' science achievement scores only reach low international benchmark with the average score of 500. With these achievements, on average, the Indonesian students are only able to recognize some basic facts. They have not been able to communicate and associate the various topics of science as well as apply critical and abstract concepts [5].

Another finding observed in November through direct interviews and questionnaires to 15 science teachers and 100 students of junior high school in Malang shows that most of the teaching materials are derived from MGMP forum or from the publisher or bookstore. It is only a fraction made by the junior high science teacher. The field of physics, biology, and chemistry are described separately which are not in accordance with the cover title of integrated natural science. This is due to the teachers' diploma or disciplines. It is not science but physics, chemistry, and biology. The reason of the teachers who do not use the 2013 curriculum-based teaching materials is because the teachers' skills in preparing the material are still low. According to the science teachers, the materials are too dense. Moreover, there are too many exercises with a little example, too small writing, and unappealing image display.

Based on the results of questionnaires for some students in Malang, 85 students reveal that they love science because of their interest in nature. Instead, 15 students dislike science because they find it difficult to understand the materials and too many demands to memorize. In general, the students learn science by memorizing them, not understanding them. This problem is often experienced by students especially when they do practical and memorize the Latin names and the formulas. According to the students, natural science learning will be more interesting if the theory presented by the teacher is accompanied by the practice.

Interviewed teachers reveal that the text books used are good enough because the materials presented are complete, compact, and profound. Therefore, it can be said that the perception of the teachers about good textbooks is still not

right. Good textbook is not only complete and dense in terms of contents or materials but also accurate, relevant, communicative, complete and systematic, student oriented, nation and state ideology oriented, has appropriate language rules, and has high legibility [6].

After conducting an analysis of the teaching materials entitled Belajar IPA Membuka Cakrawala Alam Sekitar (BSE) and Alam Sekitar IPA TERPADU to support the learning process in the classroom, the results show that both are less appropriate for the learning process standards of the 2013 curriculum. The science materials such as physics, chemistry, and biology in those two books are still presented separately. The student competencies and the benefit for the students of learning the material are not listed. Although the language used in the books is quite communicative, the dense material presented and the difficult words make the students less interested in reading the books.

The alternative or possible solutions to deal with the aforementioned condition is to develop an integrated natural science teaching material which can help students to learn science as stated in the 2013 Curriculum by using a scientific approach inquiry. Beside the teaching materials for students, this study also developed the teaching materials for teachers to help them guide their students in integrated natural science learning.

Teaching material produced of this research was a connected model of integrated natural science teaching materials for students and science teachers of SMP/MTs to implement the integrated learning as the demand of the 2013 curriculum. The teaching material presents the interrelation of natural science by combining several basic competences at once. This is based on the main base of integrated learning which tries to combine several subjects, integrate and unify a number of basic competences which are seen to have similarities or associations in a theme. Integrating some basic competences in one theme can make the students acquire the knowledge of science completely and thoroughly so the integrated learning will be more easily achieved [2].

In general, this research and development aimed to find the solutions to problems faced in the education system. The research and development of integrated natural science teaching material has been done using the different product development models. Some research developments that have been produced are: the development of integrated natural science teaching material based on ideational learning to improve the junior high school students' creativity [7], the development of integrated natural science teaching material to improve junior high school students' higher thinking skills [8], the response of Khodijah Surabaya junior high school students to the test of integrated natural science teaching materials [9], and the development of integrated natural science teaching material using connected model in English with a contextual base focused on material about energy, nutrient, and molecule for junior high school students VIII [10]. Based on the former research, it can be concluded that the development of teaching materials can be used to improve science process skills and students' achievement in accordance with the objectives of this research.

II. METHOD

This research was conducted by using research and development. The development model chosen was a modified model of Borg and Gall's Research and Development by Cunningham. The modification was a simplification from 10 stages to 6 stages. It needed to be modified due to the inability of researchers in conducting large scale field testing and dissemination. The stages of research and development are: 1) research and data collection, 2) planning, 3) development of the preliminary form of the product, 4) preliminary field testing, 5) main product revision, 6) main field testing, 7) operational product revision, 8) operational field testing, 9) final product revision, and 10) dissemination and distribution. Then, the stages modified were: 1) preliminary study; 2) planning; 3) product development; 4) product validation; 5) product trial; and 6) the final product.

Product validation of teaching material development was conducted by two expert lecturers in content/materials natural science and two teachers of natural science as practitioners. The product trial was divided into two. They were a small group trial which was used to determine the level of legibility as well as attractiveness and a limited class trial which was used to determine the effectiveness and practicality of teaching materials. The small group trial was carried out on a group of six students in the ninth grade of SMPN 1 Malang while the limited class trial was carried out at class VIII C (experimental group) and VIII D (control group) at 2013/2014 academic year.

The data in this research were quantitative and qualitative data. The data obtained during the process of the research were analyzed using descriptive statistical analysis.

III. RESULT

A. Validation Result by Experts and Practitioners

The data of teaching material validation were obtained from assessment by two expert lecturers and two science teachers as practitioners. The validation results showed the validity of the teaching material in the aspect of contents or materials. The validation results are presented in Table 1.

TABLE I. VALIDATION RESULTS BY MATERIAL EXPERTS AND PRACTITIONERS

No	Material Experts	Material Practitioners
1	79.12%	81.50%
Average	80.31%	

The data in Table 1 show the percentage of validation for each aspect. They were 79.12% for the experts of teaching materials and 81.50% for the practitioners of teaching materials. The average was 80.31%. After the average score was included in the conversion table, the integrated natural science teaching material using connected model was categorized quite valid.

B. Legibility Results of the Teaching Material

The data of legibility level of the teaching material were obtained by testing the material to a small group. The researchers provided valid teaching material based on the results of expert validation to six ninth-grade students of SMPN 1 Malang. The ninth graders were chosen since the legibility test had to be done by the subjects who had received the materials from the teaching materials before it tested on limited trial subjects. The recapitulation of the legibility results is presented in Table 2.

TABLE II. RECAPITULATION OF LEGIBILITY RESULTS

No	Score
1	52
2	55
3	47
4	49
5	51
6	47
Average	50.2
Percentage	89.6%

Based on Table 2, the percentage of the legibility of the material was 89.6%. The score was then converted in a table of legibility criteria for teaching material. The legibility was categorized as excellent. Thus, the teaching material can be used by the eighth graders of SMPN 1 Malang.

C. Effectiveness Results of the Teaching Material

1. Mann-Whitney Test (Science Process Skills)

In this study, the Mann-Whitney test was used to see whether there was difference in science process skills between the experimental class and control class after the treatment. The Mann-Whitney test result can be seen in Table 3.

TABLE III. THE RESULTS OF MANN-WHITNEY TEST ON STUDENTS' SCIENCE PROCESS SKILLS

	TABLE IV. SIG (2-TAILED) ON MANN-WHITNEY TEST
Students' Science Process Skills	0.030

The result of the Mann-Whitney test for students' science process skills scale was 0.030. This value is smaller than 0.05, so H_0 was rejected, which means that there was significant difference in process skills between the experimental class and control class. Thus, it can be said that integrated science teaching material using connected model effectively improve students' science process skills.

2. Practicality of the Teaching Material

The practicality of the teaching material was examined through the response of users (teachers and students) after the implementation of learning by using connected model of

integrated natural science teaching material. The percentage of score given by the students and the teachers is presented in Table 4.

TABEL IV. PERCENTAGE OF TEACHING MATERIAL PRACTICALITY

No	Students	Teachers
1	88.12%	93.63%

On Table 4, it is known that the percentage of students' responses was 88.12% and the teachers' responses was 93.63%. When matched with practicality criteria table, both students' and teachers' responses were very practical. Thus, the integrated natural science teaching material using connected model is practical to use in learning activities in the eighth grade of SMPN 1 Malang.

IV. DISCUSSION

The teaching materials developed in this research were packaged in the form of Integrated Natural Science book using connected model. Based on the analysis of basic competences, this research and development used a connected model [11]. This model has advantages such as a problem is not only seen from one field but also from the other field and the learning implemented follows the basic competences. Unfortunately, this model has a weakness. The area of the field is already visible, but it is still dominated by a specific field [2]. The teaching materials developed used *Transportation Systems in Living Things* theme and was compiled with the connected model.

The book had undergone three revisions. Revision I was obtained from the validation of materials and development experts. The parts needed to be revised were the home page (cover), the indicators of learning, and the materials. The materials in it were considered less integrated. Therefore, all the materials in the sub units should be related with the flow of blood pressure in Pascal principle, so the integration of the materials was more visible. Additionally, the researchers provided an experimental activity in each learning activity and assessment of performances on certain materials. The validation results were used to make some revisions before the preliminary test [12].

Revision II was done after the trial to a small group involving two junior high school science teachers and six students of the ninth grade. Based on the evaluation from junior high school science teachers, there were some of the contents to be revised. They were the clarification of indicators, the integration of natural science, and the accuracy of the answer key. Furthermore, the results of the data analysis from the questionnaire distribution for six ninth graders showed that the materials should be clearer, the more materials should be added, and the cover should be made attractively. All the data that had been obtained from the small group trial were used to consider in Revision III.

Integrated natural science teaching materials using connected model consisted of a student's handbook and a teacher's handbook. The technology used to compose the book was Adobe Photoshop CS4 for its front page and the

contents. The parts of the book consisted of front page, opening paragraph, preface, table of contents, the instructions for use, the learning materials, the concept maps, the summaries, the glossaries, the test capability, the references, and a biography of the author. In general, the color chosen used consistently to make it easier for the reader to understand the contents of the teaching materials. For example, the information of science was written consistently in an orange box with a picture and black writing and placed at the end of a learning material, *ayo kunjungi* (containing a website) was written consistently in a purple box with black writing. Other findings on the product which had been revised were the front page, the student experimental activities, and the materials. The front page of the book experienced three changes. The changes were on the color, picture, and text. The front page color was dominant in blue. The front page after being revised can be seen in Figure 1.

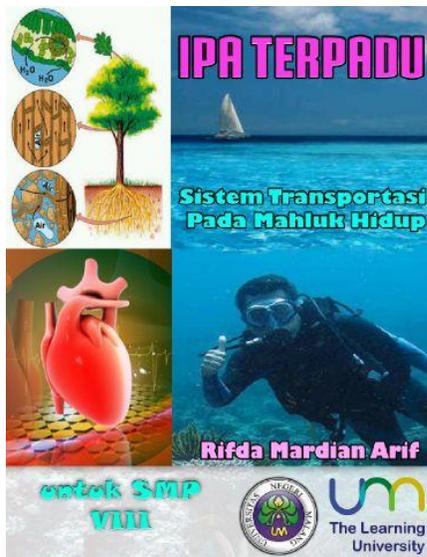


Fig. 1. The front page of the book

The students' experimental activities were only found in certain meetings. After the revision, the experimental activities for students were given in each meeting to increase the students' science process skills before learning the materials in each learning activity. In addition, teaching materials were presented integrally by directing all the sub units on the chosen theme.

The examples of syllabus and lesson plans were only found on the teacher's handbook. They could be used by the teacher originally or they could be customized to the needs of the learning process in the class. The method used in those examples was a scientific approach.

The revised integrated natural science teaching material was used in the learning process. The learning process involved two classes, VIII D as the control class and VIII C as the experimental class. The control class used BSE teaching materials by Saeful Karim, et al and the experimental class used the integrated natural science teaching material using connected model with the theme "*The Transportation Systems*

in Living Things". The effectiveness of the teaching material was done using post test only control group design. Before the treatment, the researcher gave a pre-test to choose two classes that would be studied. Then, the researcher found two classes. They were VIII C and VIII D. The selection was based on the normality and homogeneity test. The effectiveness test of teaching materials and students' science process skills were conducted in the two classes and done in three meetings using guided inquiry learning model. During the treatment, the two classes were observed in the ability of science process skills between the experimental and control classes. The science process skills were measured using observation sheet. Based on the results of the Mann-Whitney test for students' science process skills scale, the difference of the process skills was significant between the control group and the experimental group.

The effectiveness results reinforce the findings of the previous studies. Learning the natural science integrally can improve the learning achievement, the science process skills, and the students' attitudes toward science [3]. Developing teaching materials can increase high-level thinking skills of junior high school students [9].

V CONCLUSIONS AND SUGGESTIONS

In the explanation of the observation results, the data analysis, and the studies, it can be concluded that the connected model of integrated natural science teaching material is valid from the aspect of the contents or materials. It effectively improves the learning achievement and science process skills of the students in SMPN 1 Malang Academic Year 2013/2014. Moreover, it is practical to use by both the students and the teachers.

Integrated natural science teaching materials which have been revised can be used in the classroom but it need to pay attention to a few things. To optimize the utilization of integrated natural science teaching materials connected models, the researchers suggests the following points. Before using the teaching materials, the teacher should understand the teacher's teaching materials handbook first so the teaching and learning process in the classroom is more purposeful. These teaching materials are based on the characteristics of the students of SMPN 1 Malang. If it will be used for the other schools, it should be adapted to the characteristics of students of the school. At the end of the teacher's teaching materials handbook, it is presented an example of syllabus and lesson plans but the teachers can also create a syllabus and lesson plans which fits their individual needs. Before inviting the students to undertake the activities, the teachers should do first outside of the lesson hours in order to make the learning process more effective. It is done because the students' activities are given every meeting. The teachers should guide their students to do the activities seriously and pay attention to the time allocation which has been planned.

In order to make the usefulness of these materials be felt on a broader scale, the products of this teaching material should be tested further in a field test on a large scale. After

that, the product can be published and disseminated. The suggestions given to develop the product are as follows.

- a. The development of the teaching materials in this study is to enhance the science process skills and the students' achievement. To develop the product in the future, the teaching materials developed can also be used to increase the activities and to improve critical and creative thinking of the students.
- b. The learning model used in the testing of teaching materials effectiveness is guided inquiry learning. To develop the product in the future, at this effectiveness testing stage, it can use the other learning model alternative of Problem Based Learning and Project Based Learning. Yet, there are some methods which cannot be implemented such as direct learning and jigsaw method for these materials involve the students in groups and the same activities performed by all groups.

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