The Development of Basic Natural Science Learning Materials to Improve Students’ Competence

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Abstract. This research aimed to improve students’ scientific competence through integrating the role of moslem scientists and inventors into Basic Natural Science learning materials. Through a series of activities that had been designed, a relevant and innovative Basic natural science learning material is expected to be obtained. This was intended to develop the three aspects of Students’ Competence, namely the students’ knowledge, skills, and attitudes. The research subjects were third semester students who were taking the Basic natural science course at Faculty of Teacher Training and Education, Universitas Islam Nusantara. The design research method was performed. In general, this research has been carried out in three stages, namely preparation, development, and implementation. Currently the preparation stage has been concluded. The outputs were the learning instruments, the research instruments, and the initial design of Basic Natural Science learning materials. The initial design, consist of seven learning programs: orientation, subject explaining, worksheets distribution, discussion activities, materials presentation, task reports, and reflections. Instructional materials that are designed to be discussed in the group and should be accounted for on an individual basis, can foster students’ competence. Learning atmosphere that gives comfort to the students to think and express opinions expected to develop students’ competence.

1. Introduction
University students are gradually expected to have all basic competencies a scientist must possess; especially the scientific attitudes such as honesty, creative thinking, persistence, tenacity, curiosity, open mindedness, search for truth, willingness to change opinion, respect of evidence, and ability to work in a team [1]. These various competencies can be achieved by students when they are able to appreciate the beauty of science, which encourages them to earnestly study and gain the knowledge, attitudes, and skills of a scientist. Such genuineness begins with having pleasure in learning and motivation.

Basic Natural Science (BNS) is one of subject in society life (MBB) subjects group that must be given to college students as part of core curriculum lecture was held as general subject and held on lower semester [2]. BNS became one of the required courses for all students in Indonesia, with hope that the students would be motivated to have scientific attitudes and skills, besides the knowledge that will be very useful in the life with society.

Stories about the hard work of moslem scientists and inventors (MSI) who have produced brilliant works were not much told. The successful of MSI proves how the beauty of science have motivated
and encouraged them to explore science and work endlessly. This information would certainly have a positive impact on the efforts of developing the competence of students.

Based on the above description, the researchers have added Moslem Scientists and Inventors materials on the topic of the development of science in BNS course, to improve students’ competence. By describing the process of science discovery by Moslem scientists and inventors, then imitating their steps in finding solutions to our current problems, the students’ interest and confidence are fostered in BNS course at the Faculty of Teacher Training and Education (FKIP) Universitas Islam Nusantara (Uninus). This helped achieving the objectives of the course.

However, in practice there are always students with low competence or not achieving all the expected competencies. The efforts to improve students' scientific competencies through integrating the material of the role of MSI into the topic of the development of science, had not achieved satisfactory results. The problems were “How to integrate the role of Moslem scientists and inventors in Basic Natural Science learning Materials that can improve students’ competence?”. The presented conditions encouraged researchers to develop the Basic natural science learning materials, entitled The Development of Basic Natural Science Learning Materials to Improve Students’ Competence.

2. Research Methods

2.1. Research Design
The method of educational design research by Plomp was conducted in the form of experimental learning in the classroom, intended for the development of BNS learning materials by reformulating the hypothesis of student learning process, through the integration of the role of MSI [3]. Research was planned to be carried out in three stages, namely: preparation, development, and implementation. As the initial hypothesis is the alleged design of teaching materials, which in this study referred to as Basic natural science Design. The design of this learning material becomes an instrument in the form of draft instructions to carry out each stage of the research.

The first stage, preparation phase, begins with need assessment from both sides, expectation of the students and curriculum. Curriculum review to determine the aim and competence of learning materials that will be developed, as well as identify the main material that needs to be taught. The next step is the study of literature; carried out by collecting and selecting relevant materials, putting it back together systematically, so that eventually it is acquired the design of learning instruments and research instruments.

Design and instruments are then validated, tested on a limited basis, analyzed and revised. Validation of learning materials based on expert judgment. Then this learning material becomes a reference in designing the learning materials to be used in the next phase. The preliminary design consisted of learning instruments, research instruments, and learning program.

2.2. Research Location and subjects
The research was conducted at Universitas Islam Nusantara on several study programs in FKIP. The subjects of the study were third semester students of English language education major, special education major, and open school education at the Faculty of Teacher Training and Education Universitas Islam Nusantara. The selection of subjects was based on the learning materials to be developed as well as the characteristics of the students. There were 125 students to be the subjects of research.

2.3. Data Collection and Analysis
The constant comparative method was used to collect datas [4]. Data collection techniques was using observation sheets, validation by expert sheets, and tests supported by interviews. The observation sheet was used to collect the required information by observing the research subjects. The observation sheet was complemented with recording media such as CCTV, Handycam, and digital cameras.
Through this method, a detail and accurate information was expected to be obtained. The observation sheets were analyzed to obtain a suitable design of study materials and relevant teaching profiles. In addition, the results of the observation analysis would provide information about the students’ learning attitudes.

The validation sheet was used to collect the expert recommendations in designing learning materials based on experimental results or implemented literature studies. The validation sheet became one of the references for revisions or decision-making in the design of learning materials. The test was used to collect information on students’ attitude changes and its effect on test scores.

The data are analyzed using constant comparative analysis technique. Constant Comparative Analysis is one method to analyze qualitative data. This method is described by Kolb (2012) [5]. This method provides an opportunity to perform analysis according to the observed focus repeatedly. If there is an interesting section to be analyzed, the data can be examined repeatedly. The initial stage of analysis is the set list from the temporary answer to each question based on the initial analysis and validation. The analysis is continued by consolidating the list of temporary answers and the result of observation data. The observation data are analyzed by two persons separately. The aim is to consolidate the results of the analysis. The results of the analysis are then discussed in regular meetings in the research forum. The analysis is conducted repeatedly until obtaining a sample saturation point theory.

3. Findings and Discussions

3.1. Need Assessment

“Need assessment” was conducted through classroom action research [6] in BNS course. The purpose of this study was to investigate the success of learning, with student’s graduation as indicators. The minimum graduation criteria would be achieved when 65% of students received a minimum score of 65. Of the 38 students who attended the course, there were 14 (37%) students who had not graduated, and the remaining students who have not passed after remedial were 5 people (13%). Researchers then interviewed the five students to find out the difficulties they faced in learning BNS. The five students agreed, they got into trouble because of the unavailability of special textbooks that are interesting and easy to understand, which could be used as main reference for BNS courses. This was also agreed by seven other students, who did not get a direct graduation in the Final Exam Semester (UAS). In addition, seven students who did not pass UAS also suggested the addition of inspirational material to explain all subjects in BNS course, such as the role of MSI materials on the development of Natural Science topic. They were delighted to be informed about the achievements of MSI, as little has been known. Books on the development of science usually do not tell the role of MSI [7]. As a result the students were motivated to study the subject by doing the assigned tasks, and taking the lectures seriously. It was accordance with the statement of Alahmadi et al about the effect of motivation on thinking [8];[9];[10].

The analysis of the students’ learning profile in BNS course was conducted up to three cycles. In the initial analysis, it was determined that two categories of learning could improve students’ competence. The categories were 1) learning activity provides an opportunity for class discussion, and 2) learning activity provides the opportunity for students to make presentation in front of class.

Both categories were then consolidated with the observed field data. The observed field data were analyzed by two analyzers separately. The result was discussed in the research team regular meetings. The data analysis results were consolidated repeatedly to set out the sample theory as follows: "A learning atmosphere that gives comfort for students to think and express opinions".

Students who dare to express their ideas have better competencies. Although there was possibly a mistake in the idea concept, but it could be determined directly, and the lecturer could provide assistance to overcome the students’ weaknesses in understanding the BNS concept. In contrary, the weaknesses of students who did not dare to express their ideas could not be directly detected, therefore creating difficulty in achieving students’ competencies.
The development of scientific attitude is one among the most important outcomes of science education [11]; [12]. Scientific attitude is very important in science learning, because it could encourage questioning mind and a spirit of enquiry [13];[14]. Therefore MSI material needs to be integrated on science learning. Firstly, could generate a sense of fun and get involved in science development. Secondly, the application of the scientific attitude of the MSI will be a real example for the students.

3.2. Preliminary Design
Based on the study of curriculum, it was found that the role of MSI material can be integrated into all subjects in BNS course. But in this study, it will be addressed in three subjects, namely: the Development of Science, the Role of Humans on Natural Environment, and the Impact of Technology on Human Life. Meanwhile the characteristics of the role of MSI materials are: 1) content of the MSI learning materials are in accordance with BNS subject; 2) content of the MSI learning materials are containing indicators to be observed; and 3) the MSI learning materials can answer the established problem.

Table 1. Learning Instruments and Research Instruments.

| A. Learning Instruments | Descriptions |
|-------------------------|--------------|
| 1 Semester Learning Plan | Revising the current learning plan to make it in accordance with the objectives of the research. |
| 2 Highlights of learning topics | Arranging the questions based on the skills tested. |
| 3 Developing lesson plan | Identifying topics that are in accordance with the learning model, formulizing objectives, developing learning procedures, and identifying strategy of learning and evaluation. |
| 4 MSI materials | Developing MSI material as an inserted material. |

| B. Research Instruments | Descriptions |
|-------------------------|--------------|
| 1 Test | There were two tests: pretest and posttest. A multiple-choice test designed to identify students’ understanding of learning indicator. |
| 2 Students’ worksheet | The worksheets were used as tools for measuring students’ scientific work based on the principles of inquiry learning. |
| 3 Scientific attitude observation sheets | The worksheets were graded based on the rubrics with certain criterions. Intended to record students’ attitude towards the learning process which integrated with MSI material. |
| 4 Observation Sheets and Guideline | Consists of guideline and observation sheets which Intended to records students and lecturer activities. |
| 5 Questionnaires | To measure students’ responses |
| 6 Evaluation Rubrics | |
7 Field Notes

Guidelines for evaluating students’ scientific work, and cognition ability during the learning process.
Research notes by the researcher and observer during the research process.

Students’ competencies that become the benchmarks of successful development of learning materials of BNS were: cognition ability, scientific work, and scientific attitude. The indicators of cognitive ability and scientific work used in this study were: (1) utilizing data, (2) formulating problems, (3) formulating hypotheses, (4) identifying variables, (5) calculations, (6) creating tables/graphs, (7) predicting, (8) making conclusions, and (9) communicating [15].

There were nine indicators of scientific attitude i.e.: (1) curiosity, (2) expressed opinion, (3) cooperation, (4) diligent, (5) honest, (6) responsibility, (7) creativity, (8) open and (9) care about the environment [20]. But in this study, it will be addressed in seven indicators, namely: (1) curiosity, (2) expressed opinion, (3) cooperation, (4) diligent, (5) honest, (6) responsibility, and (7) creativity.

Various research instruments are needed to measure students’ competence, as shown in table 1 above [16]; [17]; [18]; [19];[20].

Design of learning program to integrate MSI learning materials on BNS course is shown in table 2.

Table 2. Learning Program of Integrated MSI Learning Materials

| Stage      | Activities                                                                 |
|------------|-----------------------------------------------------------------------------|
| Orientation| a. Informing the learning model that will be used.                           |
|            | b. Explaining the main steps of learning process.                           |
|            | c. Explaining the tasks which has to do during the learning process.         |
|            | d. Forming groups and explaining briefly about the importance of developing |
|            |   scientific work and attitude.                                             |
|            | e. Motivating students and explaining the objectives of the learning topics. |
| Subjects   | a. Conveying the subject by using appropriate learning model that has been  |
|            |   integrated with MSI learning material.                                    |
|            | b. Providing students with opportunities to get the data.                   |
| Worksheets | a. Distributing the worksheets.                                             |
| Distributing | b. Providing opportunities to understand the worksheets.                    |
| Discussions| a. Encouraging students to discuss and exchange ideas.                      |
|            | b. Acting as facilitator in scientific works.                              |
|            | c. Observers observe students’ attitudes.                                   |
|            | d. Observer observe students’ and lecturer’s activities.                    |
Presentation

a. Providing opportunities for students to present their discussion results.
b. Encouraging students to present their work.
c. Acting as facilitator in scientific works.
d. Observe students’ attitude.

Worksheets Reporting

a. Collecting the worksheets.
b. Assessing the worksheets based on the rubrics.

Reflection

Reflection of learning activities

3.3. Validation of Learning Materials

Validation of learning material has been done through expert judgment. The result of validation could be seen at Table 3.

Table 3. The Results of Instruments Validation on Materials of MSI

| Type of Instruments                 | Validator I Score | Validator II Score | Average Score | %   | Result |
|------------------------------------|-------------------|--------------------|---------------|-----|--------|
| Teaching Materials (3 items)       | 3.80              | 3.90               | 3.85          | 77  | Valid  |
| Worksheets (5 items)               | 4.30              | 4.10               | 4.20          | 84  | Valid  |
| Worksheets Rubric (5 items)        | 4.4               | 4.3                | 4.35          | 87  | Valid  |
| PreTest - Post Test (5 items)      | 4.05              | 3.95               | 4.0           | 80  | Valid  |
| Scientific attitude sheets (7 items) | 4.15              | 4.00               | 4.08          | 82  | Valid  |
| Average Value                      |                   |                    |               | 82  | Valid  |

Criteria for the percentage of validity: (a) 86%-100%, very valid; (b) 70%-85%, valid; (c) 60%-69%, less valid; (d) 0%-60%, invalid [21]. Based on Table 3, the average percentage of validity of the instrument was 82%, which fell into the valid qualification. This meant that all instruments met the criteria of the validity and could be used in the study.

4. Conclusions

The integration of Moslem scientists and inventors roles on Basic Natural Science learning materials was applied through learning instruments and learning program. The research instruments included: concept mastering tests, student attitude observation sheets, research observation sheets, and questionnaires. The learning program consists of three main subjects as follows: Development of Science, the Role of Humans in Natural Environment, and the Impact of Technology in Human Life. Characteristics of the role of Moslem scientists and inventors materials included: in accordance with the learning contents and can answer the established research indicators. Students’ competence was measured based on the aspects observed during the learning, which included: scientific work, cognitive ability, and scientific attitude. Indicators of scientific work and cognitive ability included:
(1) using data, (2) solving problems, (3) formulating hypotheses, (4) determining variables, (5) counting, (6) creating tables/graphics, (7) predicting, (8) making conclusions, and (9) presenting. The indicators of scientific attitudes included (1) curiosity, (2) expressing opinions, (3) cooperation, (4) diligence, (5) honesty, (6) responsibility, and (7) creativity. The design of Basic Natural Science learning program by integrating the roles of Moslem scientists and inventors, included: Orientation, subject explaining, worksheets distribution, Discussion Activities, Materials presentation, Task Reports, and Reflections. Instructional materials that are designed to be discussed in the group and should be accounted for on an individual basis, can foster students’ competence. Learning atmosphere that gives comfort to the students to think and express opinions could develop students’ competence. Therefore the design of BNS learning materials that integrate the materials of MSI can improve students’ competence. Further research is needed on appropriate MSI materials, the teaching style of lecturers as well as the appropriate academic atmosphere that can improve the effectiveness of BNS learning materials.

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