The Development of Guided Inquiry Based Science Basic Concept Teaching Materials

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Abstract Natural Science is mostly delivered using the lecture method and providing exercises or written assignments as well as laboratory activities which are limited to carrying out the activity steps according to the worksheets used. In this case, the educators do not provide opportunities for students to conduct experiment according to their ideas and knowledge. As a result, the process of learning becomes less interesting and meaningful. The purpose of this study was to determine the development of guided inquiry based science basic concepts teaching materials. The method used in this study was a research and development. This study was conducted in several stages, they are define, design, develop, and disseminate. This study was conducted at STKIP Muhammadiyah Blora by using the research data sources that derived from experts, professionals, educators, and students. The results of this study indicated that; (1) the define stage was carried out by using front end analysis (FEA) which consists of field studies and material analysis; (2) the planning stage (design) begins with the preparation of learning tools, preparation of questionnaire guidelines, observation, interviews, preparation of guided inquiry based teaching materials, and restrictions on the scope of the research; (3) the development stage (develop) was conducted through two steps, namely; 1) expert judgment followed by revision; 2) limited scale trial and error. The results of the validation of the feasibility of teaching materials for the guided inquiry based science basic concepts obtained an average percentage of 83\% with feasible criteria; and (4) the product dissemination stage in the form of guided inquiry based science basic concepts teaching materials conducted on lecturers and students. The conclusion of this study is that guided inquiry based teaching materials are suitable to be used for teaching. The implication of this study is that the development of guided inquiry based science basic concepts teaching materials can increase the activity of students in the learning process.

1. Introduction

The quality of learning must also be improved along with the improvement of the quality of education, one of which is by providing quality teaching materials, especially for the basic science concept courses for students. Science learning is a knowledge that is acquired and developed based on experiment (inductive) and based on theory (deductive). There are two things that are inseparable from IPA or science, namely IPA as a product and IPA as a process. Science as a product is in the form of factual, conceptual, procedural, and metacognitive knowledge, while Science as a process is a scientific work. Science education is directed to inquiry and act so that science education can help students to gain a deeper understanding of the natural surroundings.

The current problem, students perceive science as difficult learning, resulting in a lack of understanding of their concepts \cite{1}. In the science learning, lecturers give more lectures and provide
Inquiry-based science describes a variety of philosophical, curricular and pedagogical approaches to teaching. The requirement is that the learning must be based on questions relating to the existing material. Pedagogy and curriculum require learners to work independently to solve problems rather than receive direct instruction on what to do from the teacher. Lecturers or teachers are seen as facilitators of learning and not containers of knowledge. Therefore, the role of the lecturer or teacher in the inquiry learning environment is not to provide knowledge, but to help learners along the process of finding their own knowledge [3].

The learning model of guided inquiry is a learning model that fulfill many curriculum requirements through engagement, motivation, and learning challenging in line with the purpose for the 21st century for educational institutions to guide students to think and learn through inquiry [4, 5, 6].

Guided inquiry is characterized by identifying problems and some questions by educators as a research procedure and the learners are given clear and concise performance goal for investigation activities [7, 8]. Application of guided inquiry learning does not only improve the ability of students to understand the material but can also enhance science process skills and scientific work [9, 10].

Inquiry-based learning reflects modern practice in pedagogical science. Constructivist learning theory is embedded in the idea of inquiry-based learning. These theories are learning ideas based on investigation and based on the way scientists work and scientists themselves work in a constructivist way. This theory is strategic while connecting science, science education, and the results of constructivism in a teaching method that combines the strengths of each discipline [11].
Guided inquiry learning model consists of six stages (phases): (a) planning, (b) information, (c) processing information, (d) making information, (e) communicating information, and (f) evaluating [12]. Guided inquiry learning allows learners to build knowledge independently and helps them to develop understanding of the concept of representative and exercises their scientific literacy [13, 14, 15, 16, 17, 18].

The success of using guided inquiry which showed that the increase of students obtained through the guided inquiry occurs since the students have better opportunity to provide more explanations and reasons [19]. When teaching using the guided inquiry, teachers use more appropriate questioning strategies to support students' accommodation of newly learned conceptions into their conceptual framework.

The science learning strategy is similar with the inquiry strategy, the implementation of inquiry strategy provides students with an opportunity to investigate science-based issues that they are interested in [20]. This learning strategy is in accordance with the constructivist principles, which is to provide students with opportunities to construct new understandings based on their experiences by exploring various phenomena in their environment [21].

Several research results show that the implementation of inquiry strategy has a significant effect on the improvement of students' understanding of science concept. The students who implement inquiry strategy has better science concept understanding than those who implement traditional strategy. The implementation of the inquiry strategy also has an effect on the increase of students’ motivation and science learning results [22].

There are four levels of inquiry, namely demonstrated, structured, guided, and open inquiry [23]. The four levels of inquiry are distinguished by the amount of teachers’ involvement in learning. Teachers’ involvement decreases with the increasing inquiry level. The biggest teachers’ involvement is in the demonstrated inquiry, and then it becomes less and less in structured, guided, and open inquiry.

The material contained in guided inquiry-based teaching materials is size and measurement, force and motion, material and its changes, energy and work, light, electricity, and magnetism. Activities carried out emphasize direct experience which aims to develop the competence through the process of finding out and taking action. Learning that fits this activity is inquiry learning since inquiry learning is designed to invite learners to participate directly in the scientific process. Based on the background described, the researcher formulated the following statement of the problem: “How is the development process of the guided inquiry science basic concepts teaching materials for the students of the elementary school teacher education?”

This study has purpose to; (1) find out the procedure for developing the teaching materials and (2) determine the feasibility of the teaching materials for the Science Basic Concepts subject for the students of the elementary school teacher education through guided inquiry-based learning.

2. Research Method
This study refers to the 4-D development model. This model was suggested by Thiagarajan, Semmel, and Semmel. This model consists of four stages of development, namely define, design, develop, and disseminate. The subjects of this study were students of the second semester of the elementary school teacher education program at STKIP Muhammadiyah Blora. The target of this study was the development of teaching materials for science basic concepts which will then be distributed.

The data collection instruments used in this study were questionnaire sheets, interviews, and observations. The questionnaire sheet was used to determine the validity of the essence of the teaching materials developed and the responses from students. The interview sheet was intended for students to find out their response and satisfaction regarding the teaching materials developed. The observation sheet was used to determine the activity of students when using guided inquiry-based teaching materials.

The results of this study were presented in the form of qualitative and quantitative analysis. The teaching materials compiled were validated by experts in order to obtain suggestions to obtain
appropriate teaching materials. After being validated by the expert, the teaching materials were then tried out limited to 15 students of the elementary school teacher education program to find out their activeness in using guided inquiry-based teaching materials. Furthermore, after the results were determined, the teaching materials were distributed to university lecturers and students.

3. Results And Discussion

At the define stage, which is in the form of front end analysis, it consists of field studies and material analysis. The observation stage was conducted using the National Education Standards (SNP) which consists of 8 standards. The results of the observation showed that there was a difference/GAP found in the standards 1, 2, 3, 4, and 8. The difference between the maximum score and the score obtained was mostly found in the standard no. 4, which was at 3.91%, then the standard no. 3 and standard no. 5, which was at 3.34%, standard no. 8 with a difference of 2.65, and on the standard no. 1 with a difference of 2.32%. From the SNP results, the highest GAP value was found in the standard no. 4, the standard of educators and educational staff. The next highest GAP value was in the standard no. 3, the competency standard of graduates and the standard no. 5, the standard of facilities and infrastructure.

After conducting a field study, an analysis was carried out on the results obtained by students to determine the material with a low level of activity. The low level of student activity was seen when they obtained material related to observation and experiments. Based on the results of the analysis, the teaching materials developed were the basic concepts of science.

Information gathering was followed by a needs analysis carried out by interviewing students. Based on the results of the interview, it was concluded that students would find it easier to understand the material if the lecturer explained it clearly and then had a discussion. Books and teaching materials used are books available in the market. According to students, a good teaching material is one that is easy to understand, colorful, the material is complete and always up to date, and uses a grammar that is not confusing. The internet is used when needed to find material.

The planning stage (design) begins with the preparation of learning tools, preparation of questionnaire guidelines, observation, interviews, preparation of guided inquiry-based teaching materials, and restrictions on the scope of the research.

The develop stage was carried out in two steps, namely: 1) expert judgment followed by revision; 2) limited scale and wide scale trial. The purpose of these two stages was to produce the final form of teaching materials after going through revisions based on input from experts and practitioners as well as limited-scale and wide-scale trial data.

At this stage of development, it produces teaching materials for the science basic concepts that have been reviewed from the material experts and linguists, validation, and trials on students. Based on the suggestions and reviewers and validators and the activeness of teaching materials, the results of the readability questionnaire and student responses after using the guided inquiry-based science teaching materials were obtained decent results. The following will provide a more detailed discussion of the feasibility of teaching materials for the guided inquiry based science basic concepts.

A guided inquiry-based science teaching material study (draft 1) was conducted by material experts and linguists. Input from experts as well as the revision of the guided inquiry based science basic concepts teaching materials resulted in draft 2. This teaching material (draft 2) was then be tested limited to 15 students. Based on the results of the analysis of experts, it was found that the teaching materials developed were in accordance with the needs of students based on material criteria, language criteria, and design criteria. Furthermore, consultations were conducted with experts regarding the results of the limited-scale trial then revised draft 3, then carried out wide trials with 30 students.

3.1. Results of validation

Validation was carried out by science lecturers using validation sheets. The validation results were then analyzed descriptively and quantitatively as presented in the following figure.
The feasibility of teaching materials which consists of material criteria, language, and design that get a percentage of ≥61%, it is declared feasible [24]. Based on Figure 1, it can be seen that the material eligibility criteria is 82%, it can be happened since the material presented in the teaching materials is easy to understand and in accordance with the content. The language eligibility criteria obtained a percentage of 84%, it can be happened since the language used in the teaching materials is easy to understand and does not cause multiple meanings. The eligibility criteria for the teaching material component with a percentage of 83%, it can be happened since the presentation in the teaching materials in the form of materials, pictures, and tables is clear and does not cause misconceptions. Then, on the average, the percentage of eligibility of teaching materials is 83% with a proper criteria.

3.2. Result of Trial

The trial was carried out on a limited scale and a wide scale. From these trials, research was carried out on student activity and student responses. The following Table 1 presents the percentage of the activeness of students in using guided inquiry-based science basic concept teaching materials.

3.2.1. The Activeness of Students

Table 1. The Activeness of Students in Using Guided Inquiry Science Basic Concept Teaching Materials Based

| No | Aspects of Activeness                        | Limited Scale Trial | Wide Scale Trial |
|----|---------------------------------------------|---------------------|------------------|
|    | Percentage | Criteria | Percentage | Criteria |
| 1  | Asking to friends or lecturer              | 79% | Good | 80% | Good |
| 2  | Answering the questions of lecturer or friends | 80% | Good | 81% | Good |
| 3  | Active in formulating problems in the learning | 79% | Good | 78% | Good |
| 4  | Searching for information and references   | 88% | Very Good | 87% | Very Good |
| 5  | Discussing                                | 89% | Very Good | 89% | Very Good |
| 6  | Conducting task individual or in groups    | 87% | Very Good | 88% | Very Good |
| 7  | Giving perspectives or ideas               | 80% | Good | 79% | Good |

Based on Table 1, from 7 aspects, satisfactory results were obtained with good and very good criteria, therefore the average obtained was in good criteria. In the aspect of asking friends or lecturers, good criteria were obtained since most students dared to ask questions when they experienced difficulties in understanding the material or in conducting the material investigations. The aspect of
answering questions from lecturers or friends obtained good criteria since when lecturers give questions related to the material or the investigations being carried out, they were able to answer correctly. In addition, when other friends asked questions, most students showed openness by answering questions from their friends. The active aspect of formulating problems in the learning obtained good criteria since students were able to provide questions on what events they want to investigate. The aspect of looking for information or references obtained very good criteria since students appear to be active in looking for references to support their understanding of the material and their investigations. The discussion aspect obtained very good criteria since students seemed to have serious discussions, were able to work with teams, and were able to collaborate well. The aspects of conducting individual and group assignments obtained very good criteria since students seem enthusiastic and do not complain in doing assignments, they enjoy to do assignments. The aspect of giving perspectives or ideas obtained good criteria since not all students were able to provide perspectives and ideas.

The results of this study prove that guided inquiry is able to stimulate the activeness of students, inquiry-based learning has been shown to stimulate student activity, assist students in constructing meaning and obtaining scientific knowledge [25].

3.2.2. Responses of Students

Student responses were obtained from the results of limited trials used to describe the responses of students on the teaching materials that had been developed and in terms of readability and use of the teaching materials, then the results of these responses were analyzed descriptively and quantitatively to determine the interest of students in the developed teaching materials by considering the percentage of students who answered "yes" in every aspect.

| No | Aspects                              | Limited Scale | Wide Scale |
|----|--------------------------------------|---------------|------------|
|    |                                      | Percentage of “Yes” | Percentage of “No” | Percentage of “Yes” | Percentage of “No” |
| 1  | Completeness of the material         | 73%           | 27%        | 75%           | 25%          |
| 2  | Clarity of the language used         | 95%           | 5%         | 98%           | 2%           |
| 3  | Clarity of the material              | 90%           | 10%        | 90%           | 10%          |
| 4  | Ease of understanding command        | 85%           | 15%        | 86%           | 14%          |
| 5  | Interest in the display of teaching material | 80%           | 20%        | 85%           | 15%          |
| 6  | Pleasure in using teaching material  | 79%           | 21%        | 80%           | 20%          |
| 7  | Motivating the learning              | 78%           | 22%        | 80%           | 20%          |
| 8  | Increasing activeness of students    | 85%           | 15%        | 87%           | 13%          |
| 9  | Adding the understanding of students on the material | 80%           | 20%        | 86%           | 14%          |

Based on the results of the student response questionnaire to the guided inquiry based science basic concepts teaching materials, the aspect of completeness of the material obtained "yes" by 73% in limited scale and 75% in wide scale while the rest answered "no". According to the statements of students who answered "yes", the material presented in the teaching materials was complete in accordance with the course achievements to be achieved, while the statements of students who answered "no" said that the material was more complete if it was added with lots of pictures. The aspect of clarity of the language used obtained a percentage of 95% for "yes" answers in limited scale and 98% in wide scale and obtained a percentage of 5% for "no" answers in limited scale and 2% in wide scale. According to the statements of students who answered "yes" that the language used was clear and easy to understand, while according to students who answered "no" it was stated that they
found language that they did not understand in the teaching materials being developed. The clarity aspect obtained a percentage of 90% for “yes” answers in limited scale and wide scale and 10% for “no” answers. This can be happened since students stated that the material contained in the teaching materials is clear and easy to understand, while for students who answer no stated that there are several words whose meaning is unknown. The aspect of ease of understanding the command obtained a percentage of 85% for "yes" answers in limited scale and 86% in wide scale and 15% for "no" answers in limited scale and 14% in wide scale. This results is in accordance to the statements of students who answered "yes" that the instructions given in the student worksheets were easy to understand and straightforward.

The aspect of interest in the display of teaching materials obtained a percentage of 80% for "yes" answers in limited scale and 85% in wide scale and 20% for "no" answers in limited scale and 15% in wide scale. According to the students who answered "yes", stated that the pictures presented were clear and did not cause misconceptions, while according to the students who answered "no", it was stated that the pictures were better in color. The aspect of pleasure in using the teaching materials obtained a percentage of 79% for “yes” answers in limited scale and 80% in wide scale and 21% for “no” answers in limited scale and 20% in wide scale, this can be happened since those who answered “yes” felt that the activities contained in the teaching materials made them do something so that it was not only refer to the textbooks only. The motivating aspect of learning obtained a percentage of 78% for "yes" answers in limited scale and 80% in wide scale and 22% for "no" answers in limited scale and 20% in wide scale, this can be happened since through guided inquiry-based teaching materials makes students feel challenged in carrying out the lecture activities. The aspect of increasing student activeness obtained a percentage of 85% for "yes" answers in limited scale and 87% in wide scale and 15% for "no" answers in limited scale and 13% in wide scale, this can be happened since through investigations they are required to be active in carrying out learning. The aspect of increasing student understanding related to the material obtained a percentage of 80% for "yes" answers in limited scale and 86% in wide scale and 20% for "no" answers in limited scale and 14% in wide scale, this can be happened since they feel that they understand the material better since through investigation, it is not only memorizing according to the teaching material.

Based on the data obtained in the analysis, it can be concluded that the students have given positive response on the guided inquiry based teaching material. In relation to the results of this study, the application of guided inquiry learning has a significant effect on the scientific behavior and attitudes shown by grade 7 students towards learning science and technology in Turkey [26]. The guided inquiry model has an impact on increasing the understanding of concepts and developing the creative thinking skills of students. The application of inquiry-based learning can increase motivation and interest in learning science [27]. The study stated that different environments greatly influenced the effects of inquiry-based teaching in each school. Inquiry-based learning can improve the scientific process skills of students [28].

Guided inquiry has also shown its efficacy in a developing country, Thailand. The effect of guided inquiry on 239 students, the measures are knowledge, activeness, science process skills, scientific attitudes, and student stress [29]. The results showed that there was a greater increase in the learning using guided inquiry. The process of developing practical guidance Physiology which is oriented towards guided inquiry through the stages of identification and problem analysis (preliminary research), the development and prototyping stage (the development or prototyping stage), and the assessment stage (the assessment phase) obtained significant results.

An analysis of student results from the Organization for Economic Cooperation and Development (OECD) in many countries shows that students who have experience in guided inquiry learning show higher scientific literacy than open-ended. The development of guided inquiry-based teaching materials on the chemical bonding material for SMA/ MA high school/ MA students has a very high prevalence, high practicality and is effectively used in the learning process [30].
A guided inquiry-based basic physics module that has been done a lot to facilitate students in the training process skills and support students to find their own knowledge including the laws of physics and physics concepts. Each section of the module is associated with the guided inquiry syntax [31].

The last stage of this study was the dissemination of the product in the form of guided inquiry-based science teaching materials. Product distribution was carried out to lecturers and students.

4. Conclusion
1. The define stage is carried out by using front end analysis consisting of field studies and material analysis.
2. The planning stage (design) begins with the preparation of questionnaire guidelines, observation, interviews, preparation of guided inquiry-based teaching materials, and restrictions on the scope of the research.
3. The development stage (develop) was conducted through two steps, namely: 1) expert judgment followed by revision; 2) limited scale trial and error. The results of the validation of the feasibility of teaching materials for the guided inquiry based science basic concepts obtained an average percentage of 83% with feasible criteria. The results of the guided inquiry-based science teaching material trial for 15 students and 30 students obtained an average of 83% student activity with good criteria. The results of student responses to teaching materials on the limited scale test obtained a percentage of 83% while on the wide scale test obtained a percentage of 85% with very strong criteria.
4. The product dissemination stage was in the form of guided inquiry-based science basic concept teaching materials. Product distribution was carried out to lecturers and students.

Acknowledgments
The author would like to thank the parties who have helped the completion of this article, namely the lecturers and students of STKIP Muhammadiyah Blora and those whom the author cannot mention one by one.

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