Development of mathematical learning module based on findings about measurement in class IV basic school Jakarta, Indonesia

ABSTRACT

This study aims to develop a discovery-based module on "Measurement" of Mathematics subjects. This study was conducted on the fourth graders of 120 students. This research uses research and development (R and D). The test results state that the module is feasible to apply. To see the effectiveness of product it was followed by field test group with 120 students. The results of the Independent Samples Test analysis show that there is a significant difference between the control and experimental class, while the t-test shows differences in learning outcomes between pre-test and post-test. Judging from the average rating, it indicates that the effective module is used to improve the learning outcomes of measurement materials.

Key words: Research and development, module, guided discovery, elementary school.

INTRODUCTION

National Education Unit Act No. (2003: 1), explains that education is a conscious and planned effort to create a learning process and a conducive learning environment so that learners actively develop their own potential and have spiritual strength, self-control, personality, intelligence and noble character, as well as, the skills needed for him / herself to be beneficial to the society, nation and state.

Mathematics learning is one of the subjects that play an active role in improving student’s competence. Suntawijaya (2007: 1), suggests that mathematics examines abstract objects arranged in an axiomatic system using symbols or numbers.

Herry and Revelation (2014: 802) mentions that the Teaching and Learning Process (PBM) is often confronted with abstract materials and beyond the experience of everyday students, mathematics becomes difficult to teach teachers and difficult to understand by students. Komariah (2007) explains that the difficulties of elementary students in general in learning mathematics is in understanding the problem of measurement, fractional problems, geometry problems and solve the story. Based on observations in one school located in East Jakarta it shows a similar problem that students find it difficult to understand the concepts that have an impact on the low mathematics learning outcomes of students.

The use of minimal teaching materials and inappropriate learning strategies is one of the factors that makes the learning process of mathematics difficult. It needs the use of teaching materials that can be integrated with learning strategies that improve thinking ability and understanding of student concepts.

Research conducted by Alelaimat and Ahowala (2017: 40) shows that learning by using modern media such as modules is superior. Similarly, Hotman (2014: 14) in his study showed that the application of approach in the learning process will have a positive effect on student learning outcomes with the help of teaching modules, while in the scope of elementary school Nilasari et al. (2016: 1403) concluded that the use of contextual learning module shows differences in student learning outcomes. The
average learning outcomes showed that student learning outcomes were higher in the group using the module as teaching material. Modules are teaching materials that can effectively be integrated with learning strategies with a variety of approaches.

The statements of these experts are in accordance with the statement of James (1974: 3) which states that, a module is an instructional package dealing with a single conceptual unit of subject matter. The student can take it to the library, to a study carrel or to his home. The length of a module may vary from a few minutes of student time to several hours. The modules can be used individually or combined in a variety of different sequences.

One of the learning approaches that can be used is guided discovery learning model. This model was first introduced by Plato in his dialogue between Socrates and a child. Therefore, this model is often called the Socratic Method (Coohey, 1975: 138). Kuhlthau and Todd (2007: 1-2) refers to this model as a means for educators to guide learners in building a deep knowledge and understanding of the subject matter through carefully planned and carefully supervised, but gradual, carefully planned inquiry and directing learners to free learning.

A guided discovery learning or inquiry model is a series of learning processes that emphasize critical and analytical thinking activities to seek and / or independently find answers to a questionable problem with the guidance of an educator (National Research Council, 2000: 29).

Guided discovery based learning materials developed is a module of mathematics learning. A module developed in general can answer or solve problems or difficulty in learning (Mone, 2008). Menururt (2009) stated that there are several advantages gained if in the learning process module teaching materials are used, namely: 1) Able to improve the motivation of learners, because the tasks are arranged with stages from simple to complex and clearly limited in accordance with the ability of learners; 2) In the activities of evaluation, where educators and learners will know exactly which part of the material that has not been mastered by students or who have mastered the material; 3) Learners can achieve learning outcomes in accordance with the ability they have; 4) Teaching materials are divided evenly in one semester; and 5) education is more efficient because the lesson materials are organized according to the level of education.

MATERIALS AND METHODS

The purpose of this study is to produce learning modules with guided discovery method on the subject of measurement for fourth grade students of SD and produce modules that fit the curriculum. Research and development activities was conducted from February to August, 2017. This research was conducted in class IV SDN Rawamangun 12 PagiPulogadung East Jakarta. The target of the study is the fourth grade of elementary school students who follow the mathematics of measurement. This study was developed as a basic learning media on knowledge and understanding of measurement materials. Through this module of learning mathematics students are expected to understand the basic concept of measurement consisting of five measurement form that is length, area, weight, angle and time.

This research uses research and development method (Research and Development). According to Borg and Gall (2007: 783), the method of research and development is "process used to develop and validate educational products". Gay (2009: 469) says that Mixed methods research is fully functional. Research and development methods are a process for developing and validating research products. Sugiyono (2007: 407) states that, research and development methods are methods used to produce a particular product and test the effectiveness of the product.

The research method that will be used in the development of this product will use the model proposed by Dick et al. (2015) in combination with the models put forward by Borg and Gall (2007). This is done because that to be developed in this research is an educational product that is integrated in learning in school. Dick et al. (2015: 6-7) models to be undertaken only at the stage of: 1) identifying the learning objectives (Identify instructional goals); 2) conducting a learning analysis (Conduct instructional analysis); 3) analyzing learners and the environment (Analyze learners and contexts); and 4) formulate performance goals (Write performance objectives); 5) for the next step the researcher uses the steps in the development of a model with the Borg & Gall (2007) approach that begins at the initial model stage until a revised operational product is ready for trial.

Validation is done by an expert Judgment or seeking opinions from experts. The goal is to determine the feasibility of models theoretically and empirically in order to be tested further on the larger respondents. Experts involved are material experts to validate developed learning materials and media experts to validate the media’s developed look.

The next stage is formative evaluation. According to Dick in Briggs (1997: 311), the purpose of formative evaluation is "to correct the mistakes which have been made prior to the step in the instructional design process". Formative evaluation is done in three stages, namely:

- One-to-one evaluation: The evaluation process is done by selecting 1 to 3 students from the population. If using one student, the selected ones are students who have below average skills. If two or three more students can be identified, then choose students with average and above average skills.
- Small group evaluation: The evaluation process is done by selecting 8 to 12 students who describe the population. These students do not need to meet in one place at the same time.

- Field evaluation (Field Trial Evaluation): At this stage, the mathematics learning module is tested with a total of about 30 students. Summative evaluation is done when the mathematics learning module has been fully completed and used. The purpose of summative evaluation is to know the educational impact of the module on student learning outcomes. The instruments to be used in this evaluation are two-folds: 1) compare control classes and experimental classes, and 2) compare Pre-test and Post-test. While revision or module improvement will be done before the implementation in accordance with the input obtained from trials that have been previously done.

Results stages of research and development of guided discovery based mathematics module is divided into two parts. The first is the development stage consisting of pre-production and production. The second is the research phase consisting of the feasibility test stage and the effectiveness test. At the pre-production stage, the developer conducts a preliminary study with literature analysis and field observation. The results of the preliminary study suggest that modules are well suited to be combined in guided discovery strategies that can improve students’ understanding of the measurement material. At this stage, the process is also carried out: 1) Identification needs analysis; 2) Instructional analysis and initial characteristics of students; 3) Write specific instructional objectives; 4) Develop assessment tools; 5) Develop learning strategies.

At the production stage, the developer selects instructional materials and begins to create guided discovery-based modules. Overall, the compilation and selection of learning materials departs from the development of step 1 to step 6 in the development of instructional design (Walter et al., 2015). Developing measurement learning materials on mathematics is based on learning content that has been outlined from general and specific goals in the steps. For the development of research modules using Microsoft Power Point programming to compose text, images, and backgrounds, Adobe Photoshop to create or edit images / characters, and Google Image Internet to take pictures for both material and characters is necessary. Fonts used are Comic Sans MS, and Arial size 12 to 15. The paper used is A5 to A4 size. The modules are designed according to the planned instructional design.

At the stage of evaluations, the initial step after the finished product is made is to perform the feasibility test with the steps: 1) expert judgment; 2) one to one; 3) small group. The first step of an expert judgment is done by a professorship and doctorate personnel who is proficient in media, materials and language. Expert judgment results show that two media experts gave a value of 3.73 and 3.64 which stated that the module viewed from the media aspect is very feasible. The material expert gives a value of 3.60 which states that the module viewed from the aspect of the media is very feasible, and in terms of language considered feasible with a score of 3.20. In general, experts provide constructive input and suggestions and state that the module is eligible for further tests after revision.

In the second stage the individual test shows the result that the module is feasible to use with some revisions. Improving the use of sentences and clarifying job instructions is the result obtained in the assessment of individual product trials. The next step is to conduct a small group trial after the revision is done. The results of small group evaluation indicate that the indicator for the material evaluation aspect of the problem and the sample question is declared good or feasible with a value of 3.50, while the aspects of appearance, planting characters, images, and background is well categorized with a value of 3.60.

There are three types of field trials, namely: a) conformity test such as small group, and b) experimental test and c) pre-test and post-test test. Large group trials are the final stages of formative evaluation. The purpose of large group trial is to test the effectiveness and see weaknesses of guided discovery-based module products on mathematics subjects of measurement materials.

Product effectiveness test was done by experiment, using two classes, namely IVA and IVD classes at SDN Rawamangun 12 District Pulogadung East Jakarta with 30 heterogeneous respondents respectively. After the data is obtained, the next step is to test the normality, and the homogeneity of the data prior to the T-test. The result of homogeneity test shows that p-value is bigger from α that is p = 0.165 > α = 0.05 indicating the test decision taken is H₀ accepted. It can be concluded that the class data control and experimental classes are drawn from a homogeneous sample (Table 1).

Table 1: Test of homogeneity of variances.

<table>
<thead>
<tr>
<th>Levene statistic</th>
<th>df1</th>
<th>df2</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.979</td>
<td>1</td>
<td>59</td>
<td>0.165</td>
</tr>
</tbody>
</table>

Table 2 shows that in the results obtained for the experimental class the value of significance p = 0.200 is greater than α = 0.05, hence, p> α and for the control class the significance value p = 0.200 is greater than α = 0.05, so p> α. Thus, the test decision taken is H₀ accepted. It can be
Table 2: Test of normality.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Kolmogrov-Smirnov&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Shapiro-Wilk</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>KELAS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Statistic</td>
<td>df</td>
</tr>
<tr>
<td>Modul</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experiment</td>
<td>0.094</td>
<td>30</td>
</tr>
<tr>
<td>Control</td>
<td>0.122</td>
<td>31</td>
</tr>
</tbody>
</table>

<sup>a</sup> Lilliefors significance correction; *: This is a lower bound of the true significance.

Figure 1: Test results for pre-test and post-test based on the data analysis above seen the acquisition of tcount = -4.583 <ttabel = - 1.660, at significance level α = 0.05 / 95% confidence.

concluded that the sample came from a normally distributed population. Based on the test of two-way significance it shows the value of 0.013. If seen from the level of significance it shows that sig = 0.013 and α = 0.05; then, sig = 0.013 <α = 0.05 so that the test decision taken is H<sub>0</sub> = Rejected. It can be concluded that there is a significant difference between the control class and the experimental class on the mathematics learning of measurement materials using guided discovery-based modules. To see whether there is an improvement in the learning outcomes of measurement materials using guided discovery-based modules pre-test and post-test results data was conducted on 93 grade IV students. Figure 1 shows results of the data analysis.

Figure 1 shows test results for pre-test and post-test based on the data analysis seen in the acquisition of tcount = -4.583 <ttabel = - 1.660, at significance level α = 0.05 / 95% confidence. It can be concluded that there are differences in student learning outcomes between pre-test and post-test, thus, the use of guided discovery-based modules is effectively applied to the material of grade IV mathematics measurements, since there is an increase in learning outcomes seen from the average student scores of 58, 38 to 65.91 with a difference of 7.53. For the student's response about the module that has been developed, the researcher divides the questionnaire to 32 grade 4 students. The response indicators to be obtained include: 1) Demonstrate the usefulness of guided discovery-based modules; 2) Demonstrate interest in guided discovery-based modules; 3) Demonstrate the usefulness of studying measurement; 4) show interest in learning mathematics. Rating scale made with 20% (Very weak); 40% (Weak); 60% (Enough); 80% (Strong); 100% (Very strong). The results of the questionnaire show the value given by respondents as a whole in percentage are: 1) Uses of module = 82%; 2) Interest to module = 80%; 3) Usability measurement = 84%; 4) Interest in mathematics = 75%. Overall, it can be concluded that the student's response likes guided discovery-based modules for measurement materials. It is seen in percentages that most lead to strong categories.

RESULTS AND DISCUSSION

One of the important things that requires attention in educational activities in school is how to make students learn well and have fun. Students need to have the ability to learn and how to learn. According to Roncevic (2009: 237) in general, schools teach, test and mark logical mental tasks. Logic, sequence, calculation, categorization and verbal skills at school are highly appreciated abilities. Intuition, feelings, sight, humor, rhythmic movements, imagination and other gestalt brain abilities in schools are not practiced, tested or specifically assessed. Only in the real world, beyond the classroom, where success depends on entrepreneurship, imagination and insights that value the importance of the gestalt brain.

The results of this study have resulted in learning modules based on the discovery of guided measurement materials on mathematics subjects for grade 4 students of Primary School. Based on t-test with experimental data and pretest post-test data there are differences in student learning outcomes. Judging from the average control class
learning outcome (67) was lower than the experimental class (75) and the mean pretest score (58) was lower than the post-test value (66) indicating the average learning outcome after using the higher module than before or not using the guided discovery-based module. Student responses to modules are also well categorized with a percentage of 80.125% and the child likes to study mathematics measurement materials with guided discovery and modules and strategies. In general, it can be concluded that the discovery-based learning module is effectively guided as compared to other modules on learning mathematics measurement material in the fourth grade of elementary school.

From experimental test results comparing the advantages of guided discovery-based modules with ordinary learning package module can be seen. The development of inventory-based modules guided by measurement material in addition to having advantages also has drawbacks. However, these shortcomings have been made in accordance with inputs and opinions of experts and observations. Given these improvements one can minimize the drawbacks of this guided discovery-based module. The following are some of the shortcomings identified during the study:

1) There are some images and characters in the module book that are not exact, but have been revised so that they become relevant to the material;
2) There are some wrong texts in typing, but has been corrected in accordance with the use of standard words;
3) This module requires other media to maximize the process of learning activities such as rulers, bows, scales, compasses, ropes and other tools in measurement materials.

**Conclusions**

The result of research and development of guided discovery based module of class IV measurement material can be summarized as follows: First, the discovery-based module is more effectively guided than the ordinary modules on Mathematics subject measurements in Grade IV Primary School. Secondly, research and development based on the Dick and Carrey instructional designs yield instructional products of measurement materials and guided discovery-based modules. The steps include: 1) Preliminary study with literature analysis and observation; 2) Create a media development plan with Dick and Carrey’s instructional design stages; 3) Testing and evaluating the product with stages: 1) expert judgment, 2) one to one evaluation, 3) small group, and 4) field test.

**REFERENCES**


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