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Development of Experiment Performance Assessment Instruments using Guided Inquiry Learning Models to Assess Science Process Skills

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Abstract. This study aims to produce an experimental performance assessment instrument with guided inquiry learning model, prove the validity and estimate the reliability of instrument products, and determine the effectiveness of instruments to improve process performance. The method used is R & D (Research and Development) adopted from Dick et al which is divided into preliminary stage, planning stage, development stage, limited trial stage and extensive trial stage. Based on the results of the trial, the reliability of the rating results of the assessment instrument of science process skills were 0.707–0.989. The t-test results show that there is an improvement of science process skills. The results of this study are: (1) an experiment performance assessment product for science lesson of junior high school material of light properties, shadow formation, and working principle of optical instrument; (2) the experiment performance assessment instrument product has valid and reliable categories for assessing science process skills; (3) an effective experiment performance assessment instrument to improve science process skills.

Keywords: Development; Experiment performance; Guided inquiry learning models; Assess science process skills.

1. Introduction
Science develops from the interpretation of data collected through observation, experimentation and investigation, so that science has scientific product dimensions, scientific processes, scientific attitudes, and applications in everyday life [1], [2]. Therefore, science learning should use a scientific approach and research-based / discovery / inquiry learning [3].

The inquiry refers to the activities of students developing knowledge and understanding of scientific ideas, as well as understanding how scientists study the universe, teaching students to find and use various sources of information and ideas to improve understanding of problems, topics, or issues [4], [2]. Guided inquiry is used when problems and procedures for solving problems are provided by the teacher [5], [6]. The guided inquiry cycle in the experimental activities, starting from: (1) determining the problem; (2) compiling a hypothesis; (3) planning and conducting experimental activities, making careful observations, and collecting data; (4) analyzing and interpreting data; (5) drawing conclusions; (6) testing, applying, and revising conclusions [7], [8], [9].

The process, progress, and improvement of student learning outcomes must be monitored by educators on an ongoing basis through evaluating learning outcomes. Performance assessment is one form of authentic assessment that is very suitable to be applied in the assessment process of science learning. Performance assessment is an assessment of students' ability to carry out tasks in a real life context, not just to show knowledge. Testing involves demonstration and application of actual
knowledge or skills in real life [10], requires students to make products or demonstrate a process, or both, and uses clearly defined criteria to evaluate the quality of student work [10].

In this study, performance appraisal focused on the performance of students when conducting experiments, so it was called the experiment performance assessment, and was used to assess science process skills. This performance assessment is included in the performance appraisal in the form of direct investigative activities [11] and consists of an assessment of several related experiments so that they are included in the long-term project group [10]. The learning process with the guided inquiry model which is assessed by the performance assessment experiment is expected to improve the science process skills of students.

The rest of this paper is organized as follow: Section 2 describes the proposed research method. Section 3 presents the obtained results and following by discussion. Finally Section 4 concludes this work.

2. Research Method
This research is a research on the development of an experimental performance assessment instrument to assess science process skills in science learning in junior high school with guided inquiry learning model. The instruments developed include syllabus, learning implementation plan, handouts, student worksheets, and science process skills assessment instruments.

The development research model refers to the model proposed by Dick et al., [13]. In this study the ten development stages are grouped, adopted into five stages, namely: stage (1) identify instructional goals, (2) conduct instructional analysis, (3) analyze learners and contexts are grouped into Preliminary Stage; stage (4) write performance objectives are Planning Stage; stage (5) develop assessment instruments and (6) revise instruction are grouped into Development Stage; and stage (7) develop instructional strategy, (8) develop and select instructional materials, (9) design and conduct formative evaluation of instruction and (10) design and conduct summative evaluation carried out at the Limited Trial Stage and Extensive Trial Stage.

In the preliminary stage, identification of development objectives, literature review and field study was carried out. At the planning stage, the assessment criteria and product design are determined. In the development stage, drafting of instrument product experimental performance assessment draft was carried out which was then validated by expert judgment by ten validators consisting of three peers, two lecturers and 5 junior high school science teachers. The draft of instrument product was also empirically validated for students to determine the level of product readability. The implementation of the guided inquiry model learning process was observed by teachers and observers of students who had been trained. Input from validators, observers, and students is used as a revision of the instrument product draft.

Limited trial stage activities were conducted at SMP 2 Playen. Extensive trial stage activities were carried out in SMP 2 Karangmojo, SMP 1 Playen, SMP 1 Ponjong and SMP 1 Semanu. Limited trial subjects involved 32 students, while for extensive trials involving 124 students. Data collection technique uses a test and non-test techniques. The test technique is carried out to assess the empirical validity of the experimental performance assessment of instrument product to assess science process skills. Non-test data collection techniques are used to assess the construct validity of instrument products.

The instrument used to collect research data consists of:

a) Product Validation Sheet of Instrument Experiment Performance Assessment, to obtain quantitative data in the form of product feasibility scores and qualitative data in the form of suggestions from the validator.

b) Questionnaire for Student Response, to find out the students' assessment of the Student Handout and Worksheet, as well as the response to the learning process.

c) Learning Process Implementation Observation Instrument, to determine the syntax of the guided inquiry learning model.

d) Questions about science process skills designed in the form of Student Worksheets as a guide to performing performance.

e) Observation sheets and scoring rubrics for science process skills.
Data Analysis Techniques includes:

a) Product Feasibility Analysis
   Evaluation of syllabus products, Learning Implementation Plans, handouts, Student Worksheets is carried out by validators and assessment of handout products and LKPD based on questionnaire responses of students analyzed descriptively using a four-scale standard scale index [14].

b) Analysis of Science Process Skills Assessment Instruments
   Quantitative data in the form of scores of validator assessments of products in the form of Science Process Skills Assessment Instruments were analyzed using Aiken validity index [15], [16].

c) Score analysis of observations of science process skills
   To determine the reliability of science process skills assessment instruments, the total score of the three observers' assessment was analyzed by rating method [16]. To determine the effectiveness of the experimental performance assessment instrument in improving science process skills, a t-test analysis was carried out between the first experiment and the fifth (last) experiment.

d) Analysis of the learning process
   Quantitative data on the students' response to the learning process and the observation scores of the implementation of the learning process were analyzed descriptively using a four-scale standard scale index [14].

3. Result and Discussion
   This section presents the obtained results and following by discussion

3.1. Initial Product Development Results
   The initial product instrument experiment performance assessment is a product that has passed several stages of development.

3.1.1. Preliminary Stage Results
   The results of the preliminary stage were the formulation of the research objectives, namely to produce instrument experimental performance assessment products with guided inquiry learning model for junior high school students in science subjects on the properties of light, shadow formation, and the working principle of optical devices. Field surveys have been conducted in 16 junior high schools in Yogyakarta City, Bantul Regency, Gunungkidul Regency and Kulonprogo Regency, and involved 67 science teachers as respondents, and concluded that the teacher had difficulty conducting experiment performance assessment.

3.1.2. Planning Stage Results
   The results at the planning stage are the formulation of the criteria for performance assessment to be an indicator of the assessment of science process skills. Science process skills that are assessed consist of skills: hypothesizing, observing, conducting experiments, classification, measurement, communication, and inference [17].

3.1.3. Development Stage Results

3.1.3.1. Expert Validation Results
   The results of the development stage in the form of a draft experimental performance assessment instrument consists of: (1) syllabus; (2) Learning Implementation Plans; (3) handouts; (4) Student Worksheets; (5) instruments for assessing science process skills; The results of product validation by ten validators have been analyzed descriptively qualitative.

3.1.3.1.1. Syllabus Product Validation Results, Learning Implementation Plans, Handouts, and Student Worksheets
   Based on the results of descriptive analysis using a scale 4 index, the overall aspects and indicators of product assessment syllabus, Learning Implementation Plans, Handouts, and Student Worksheets are
very well assessed. The mean score of the syllabus aspect of the content eligibility: 3.95, linguistic aspects: 3.98 and presentation aspects 4.00. The average score of the Learning Implementation Plan aspects of content eligibility: 3.97, linguistic aspects: 3.96, presentation aspects 3.94 and graphic aspects 3.93. The validator provides input so that the handout is given an example of the problem and typing the equation using the equation. The Student Worksheet product received an average score on content eligibility: 3.94, linguistic aspects: 3.94, presentation aspects 3.98 and graphic aspects 3.97. The rainbow image is revised into a mirror image, and typing the equation using the equation.

3.1.3.1.2. Validation Results of Science Process Skills Assessment Instrument
Science process skills assessment instrument are Student Worksheet as a guide in carrying out performance, observation sheets and scoring guidelines to assess the performance of students. Student Worksheets are designed with the guided inquiry learning model. Assessment instruments are prepared in the form of Student Worksheets and are not displayed in the form of questions so that learning settings are natural and students can maximize their performance [18]. Based on the results of the Aiken validity index analysis, the whole instrument of scientific process skills assessment was considered very useful.

3.1.3.2. Empirical Validation Results
Products that have been validated by experts are then used in one class at SMP 1 Playen. Empirical Validation Results for Student Handouts and Worksheets were analyzed descriptively using a standard scale index, and as a result the overall aspects of the product handout and Worksheet of Learners were responded very well by students. Students respond that learning using guided inquiry models is interesting, encourages active, motivates, supports increased faith, develops scientific attitudes, improves science process skills, teaches cooperation, and is fun. Empirical Validation Results Science Process Skills Assessment Instrument is known that all indicators of assessment of science process skills can be observed clearly. Based on the results of standard scale index analysis, it can be seen that the implementation of the learning process is very good. This means that the learning process is in accordance with Learning Implementation Plans and according to the guided inquiry syntax.

3.2. Product Trial Results
The initial product instrument experiment performance assessment is a product that has passed several stages of development.

3.2.1. Limited Trial Stage Results
Limited trials were conducted at SMP 2 Playen.

3.2.1.1. Results of Handout and Student Worksheet Limited Product Testing
Based on the results of the analysis using a standard scale index, the overall aspects of the handout product were responded very well by limited trial subjects. The mean score of the aspect of feasibility of the content: 3.75, linguistic aspects: 3.82 and presentation aspects 3.80. The Student Worksheet product also responded very well. The mean score of aspects of feasibility content: 3.78, linguistic aspects and graphic: 3.83 and presentation aspects 3.81. Observer provides input so that a complete set of equipment for each object is placed in the experiment of shaping the mirror on a concave mirror and convex lens making it easier to carry out the experiment.

3.2.1.2. Student Response to Learning
The response of students to learning is very good. Based on observations during learning with the guided inquiry model, students must be guided by the teacher in conducting experiments, and guided to find and conclude concepts based on the results of the experiment.
### 3.2.1.3. Results of Science Process Skills Assessment

The results of the assessment of science process skills in the Limited Trial (Table 1 and Figure 1) show that in general the science process skills of students increased (9%). The results of the t-test showed the results of $t$ count $= 8.423$ greater than $t$ table $= 1.696$. This means that the use of instrument experimental performance assessment can improve students’ science process skills.

#### Table 1. Results of Science Process Skills Assessment in Limited Trial Stage

<table>
<thead>
<tr>
<th>Aspects of Science Process Skills</th>
<th>Experiment Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Develop hypotheses</td>
<td>3.03  3.28  3.38  3.50  3.53</td>
</tr>
<tr>
<td>Do experiments</td>
<td>3.71  3.77  3.79  3.88  3.88</td>
</tr>
<tr>
<td>Observe</td>
<td>3.61  3.63  3.63  3.81  3.84</td>
</tr>
<tr>
<td>Measurement</td>
<td>3.47  3.47  3.47  3.53  3.69</td>
</tr>
<tr>
<td>Classification</td>
<td>3.06  3.06  3.06  3.06  3.06</td>
</tr>
<tr>
<td>Communication</td>
<td>3.27  3.27  3.37  3.56  3.64</td>
</tr>
<tr>
<td>Inference</td>
<td>3.44  3.56  3.58  3.64  3.72</td>
</tr>
<tr>
<td>Average</td>
<td>3.42  3.50  3.47  3.65  3.74</td>
</tr>
</tbody>
</table>

#### Figure 1. Results of Science Process Skills Assessment in Limited Trial

The results of the calculation of reliability assessment of science process skills is described in Table 2. It shows that the reliability coefficient of assessment of science process skills is high and very high, meaning that the assessment instrument of science process skills can be used well in SMP Negeri 2 Playen in limited trials [19].
3.2.2. Extensive Trial Stage Results
Extensive trials were carried out at SMP Negeri 2 Karangmojo, SMP Negeri 1 Playen, SMP Negeri 1 Ponjong and SMP Negeri 1 Semanu. Experiments were carried out as many as 5 experiments, namely: reflection of light, formation of shadows on a flat mirror, formation of shadows on concave mirrors, refraction of light and formation of shadows on convex lenses. During the experiment activities were carried out an assessment of science process skills.

3.2.2.1. Extensive Trial Stage Result of Handout Product and Student Worksheet Product
Based on the results of the standard scale index analysis, the overall aspects of the handout product were responded very well by the subject of extensive trials. The mean score of the feasibility aspect contents: 3.53, 3.43, 3.38, and 3.34. Average linguistic aspects: 3.56, 3.67, 3.41, and 3.33. Average presentation aspect scores: 3.69, 3.66, 3.44, and 3.37. The Student Worksheet product was also responded very well by students. The mean score of the feasibility aspect contents: 3.47, 3.50, 3.45, and 3.31. Mean score of linguistic and graphic aspects: 3.56, 3.62, 3.48, and 3.29. The average score of presentation aspects of the Student Worksheet Products: 3.66, 3.53, 3.49, and 3.32. Students can use the Handout and Products of the Student Worksheet well and feel helped.

3.2.2.2. Student Response to Learning in Extensive Trial Stage
Based on the calculation of the standard scale index, it is known that the response of students to learning is very good. Students respond that learning stimulates curiosity, attracts, actively encourages, motivates, supports increased faith, develops scientific attitudes, improves science process skills, teaches cooperation, and is fun. Based on observations during the learning implementation with the guided inquiry model, students were enthusiastic and actively participated in conducting experiments. But during learning, students must be guided so that learning outcomes are in line with expectations.

3.2.2.3. Science Process Skills Assessment
Science process skills assessment of students at SMP Negeri 2 Karangmojo, SMP Negeri 1 Playen, SMP Negeri 1 Ponjong and SMP Negeri 1 Semanu in an extensive trial stage showed an increase (see Table 3 and Figure 2).

Table 3. Results of Process Skills Assessment in Extensive Trial Stage

<table>
<thead>
<tr>
<th>SMP</th>
<th>Science Process Skills Score of experiment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>SMP N 2 Karangmojo</td>
<td>3.20</td>
</tr>
<tr>
<td>SMP N 1 Playen</td>
<td>3.14</td>
</tr>
</tbody>
</table>
The results of the t-test on the science process skills of students in SMP Negeri 2 Karangmojo obtained the results of t count = 15.668, in SMP Negeri 1 Ponjong obtained the results of t count = 6.052, and in SMP Negeri 1 Semanu the results of t count = 12.276. The overall results of t count are greater than t table = 1.696. Likewise, the results of the t-test on science process skills of students in SMP Negeri 1 Playen obtained the results of t count = 8.193 greater than t table = 1.701. This means that the use of experiment performance assessment instruments can improve science process skills in broad test students. Science process skills of SMP 2 Karangmojo, SMP 1 Playen, SMP 1 Ponjong and SMP 1 Semanu, respectively increased by 14%, 16%, 13%, and 15%. The results of Suryandari's research [20] stated that students felt assessed by a rubric whose assessment criteria were clear and detailed, so that students were more earnest in conducting experiments, and showed their best performance. Raj & Devi [21] suggested science teachers narrow the gap between science and its application in everyday life through experimental activities, because experiments were able to develop the abilities of students and procedural skills used in their careers later. Science process skills are crucial for meaningful learning because learning takes place throughout human life, and every human being needs to find, interpret and evaluate evidence based on different circumstances [22]. The rating reliability instrument calculation result of science process skills assessment are 0.707-0.980 with high and very high categories [19]. It means that the instrument can be used properly in SMP Negeri 2 Karangmojo, SMP Negeri 1 Playen, SMP Negeri 1 Ponjong and SMP Negeri 1 Semanu.

3.2.2.4. Implementation of the Learning Process using the Guided Inquiry Model

The results of observing the implementation of the learning process in extensive trial stage are very good. The learning process with guided inquiry is in line with the NSTA recommendation [13] which views inquiry as a "basic" for science education, emphasizing that teachers focus on conducting inquiry and developing understanding. The results of Ergül et al. [23] shows that the application of inquiry learning significantly improves the science process skills and attitudes of students. Guided inquiry learning involves students directly in finding and finding themselves, practicing solving problems, and also developing cooperation, tolerance, thoroughness, confidence and responsibility for their findings.
4. Conclusion
This research has presented development of experiment performance assessment instruments using guided inquiry learning models to assess science process skills. The results of this research are: (1) an experiment performance assessment product for science lesson of junior high school material of light properties, shadow formation, and working principle of optical instrument; (2) the experiment performance assessment instrument product has valid and reliable categories for assessing science process skills; (3) an effective experiment performance assessment instrument to improve science process skills of learners. Students gave a happy response to the guided inquiry and experiment performance assessment based on the analysis of the questionnaire data of the respondents' responses.

References