ANALYSIS OF GUIDED INQUIRY LABORATORY LEARNING MATERIALS TO IMPROVE STUDENTS' SCIENTIFIC PROCESS SKILLS IN NEWTON'S LAW OF MOTION

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Abstract

The purpose of this study is to develop guided inquiry laboratory learning materials to improve students' scientific process skills in Newton's Law of Motion. The research used a qualitative descriptive analysis of the results of the validity of the learning materials being developing. The results showed that valid and reliable which included the validity of the syllabus, the lesson plan, the handouts, student worksheets, the cognitive learning achievement test, the learning process implementation of learning process, the observation sheet of scientific process skills on student worksheets, and the student questionnaire. So the learning materials with the guided inquiry laboratory was developed is feasible to implemented in learning for improving students' scientific process skills in Newton's Law of Motion.

Keywords: *Validity of learning materials, guided inquiry laboratory, scientific process skills*

Abstrak

Tujuan penelitian ini adalah mengembangkan perangkat pembelajaran *guided inquiry laboratory* untuk meningkatkan keterampilan proses sains peserta didik pada materi Hukum Newton tentang gerak. Penelitian menggunakan analisis deskriptif kualitatif terhadap hasil validitas perangkat yang dikembangkan. Hasil penelitian menunjukkan bahwa perangkat pembelajaran berkriteria sangat valid serta memiliki reliabilitas sangat baik yang meliputi silabus, Rencana Pelaksanaan Pembelajaran (RPP), *handout*, Lembar Kerja Peserta Didik (LKPD), tes hasil belajar kognitif, lembar keterlaksanaan proses pembelajaran, lembar pengamatan keterampilan proses sains terhadap Lembar Kerja Peserta Didik, dan angket peserta didik. Sehingga perangkat pembelajaran yang dikembangkan dengan model *guided inquiry laboratory* dapat diimplementasikan dalam meningkatkan keterampilan proses sains peserta didik pada materi Hukum Newton tentang gerak.

Kata Kunci: *Kevalidan perangkat pembelajaran, guided inquiry laboratory, keterampilan proses sains*

INTRODUCTION

The involvement of students in the learning process will have a positive impact on the achievement of understanding the students' concepts themselves. The learning process can be forming if the teacher is not only sufficient to explain to students but the need for proofing of concept by involving students in a learning activity such as practicum or discussion (Muijs et al. 2008). In the 2013 curriculum learning process using a scientific approach which is understanding, asking, trying, reasoning and concluding (Kurniawan et al. 2016). That is in line with the demands of the 21st century, where students are required to have an expertise in learning, discovering, applying and developing facts about science (Pradipta & Kustijono, 2017).

Physics is a science that studies the symptoms of natural phenomena through scientific process based on experimental observations and quantitative measurements (Serway & Jawett, 2014). The nature of physics, which is part of the science that is in line with the 2013 curriculum, has three essential aspects, namely knowledge (cognitive), attitude (affective), and process (psychomotor) aspects. Thus physics as a body of experience, a way of investigating, and a way of thinking. A body of knowledge contains facts, concepts, principles, laws, and theories, a way of investigating contains scientific process skills, and a way of thinking hold a flow of scientific thought in the process of finding and earning an experimental product (Sari & Supriyono, 2016). Thus learning physics is the process of creating opportunities and conditions in the formation of

knowledge, scientific process skills, and scientific attitudes of students (Putri, 2019).

The scientific process skills used in discovering concepts, principles, laws, or theories in developing or refuting previous discoveries are also called scientific process skills (Toharudin & Hendrawati, 2011). Scientific process skills are dividing into two types, namely necessary skills and integrated skills. Basic of scientific process skills include observing, classifying, communicating, predicting, inferring, and measuring. Integrated of scientific process skills include formulating hypotheses, identifying and defining variables operationally, trying / experimenting, interpreting data, presenting data in graphs and tables, formulating models, and making conclusions (Ongowo & Indoshi, 2013).

According to Novitasari (2017), the problem in the current learning process is the centralization of learning to teachers while students only become objects of knowledge recipients. Lack of activities that involve students in the learning process will result in students' scientific process skills being less than optimal. Scientific process skills can be fascilated with one of the learning models, the inquiry learning model (Dahar, 2011).

Inquiry learning is a process that involves the maximum ability of students to search for and investigate something systematically, analytically, critically, and logically, which aims to make students able to formulate discoveries independently with their confidence (Nurdin & Adriantoni, 2016). One example of inquiry learning that is very compatible with the indicators contained in the scientific process skills itself as guided inquiry laboratory (A. Farid. 2018).

According to Fendy (2016), laboratory activities have a positive effect on students' learning outcomes, especially science learning. Improved learning outcomes are shown from students' activeness in the process of finding knowledge, skills gained from learning experiences, gaining meaningful experience from the learning process, and teaching students in the process of solving specific problems daily.

Newton's laws of motion are physical materials that are very close to related to everyday life. The suitability of the content with the scientific process skills can be seen from the 2013 primary competence curriculum by Permendikbud number 69 of 2013 on the aspect of skills where students are asks to conduct experiments and present the results of operations based on scientific methods. Some research results mention the concept mastery of students is still low (Nuriyah et al. 2017).

On October 17, 2019, a pre-research conducted by distributing questionnaires and examinations at SMA Negeri 8 Surabaya to 72 students of class XI Science. Based on the survey on the question points about the learning process carried out, as many as 54% of students stated the learning process carried out by the teacher was lecturing, 36,0% reported the assignment. And as many as 10,0% reported the discussion. These results state the involvement of students in learning is less than the maximum. As many as 69,4% of students consider that physics lessons tend to be difficult and tedious because teachers tend to provide mathematical material and formulas. Scientific process skill points of 58,3% of students lack mastery of several indicators of scientific process skills, for example regarding indicators formulating hypotheses, determining experimental variables, and analyzing data. These results are reinforced from work on the exam questions given. 68,05% of students can only write equation formulas and there are still many mistakes in providing examples of the application of each Newton's Law.

Based on the background outlined above, the development of learning materials requires innovation to maximize the ability of students' scientific process skills. So this research uses validity assessments to develop guided inquiry laboratory learning materials that aim to improve students' scientific process skills in Newton's Law of motion.

METHOD

This type of research is descriptive qualitative, which aims to describe the feasibility of guided inquiry laboratory learning materials in improving scientific process skills in Newton's Law of Motion material. The data collection method uses a learning materials validity sheet. The learning materials that will be validated include syllabus, lesson plan, handouts, student worksheets, students' cognitive learning outcomes test, implementation sheet of guided inquiry laboratory process, students' scientific process skills observation sheets against student worksheets, and student questionnaire responses.

The technique of analyzing the validity sheet of the learning materials uses theoretical analysis to get criticism and suggestions that will be used in revising the learning materials. The learning materials was reviewed by 2 validators, namely physics lecturers. As for the names of validators in Table 1.

Table 1. Names of Validator

No.	Name	Position
1.	Z. A. Imam Supardi	Lecture in physics, State of Surabaya University
2.	Mita Anggaryani	Lecture in physics, State of Surabaya University

The assessment category uses a Likert scale on each aspect of the learning materials developed as follows:

Table 2. Likert Scale Rating Category

Rating Category	Information
1	Poor
2	Acceptable
3	Good
4	Very Good

The mean score of the assessment results adjusted to the learning materials validation criteria, which can see in Table 3.

Table 3. Criteria for learning materials validation

Score	Information
0,00 – 1,00	Low
1,01 – 2,00	Quite Valid
2,01 – 3,00	Valid
3,01 – 4,00	Very Valid

(Sugiyono, 2015)

Calculation of the reliability of learning materials with the percentage of agreements as follows:

$$Percentage\ of\ Agreement = \left(1 - \frac{A - B}{A + B}\right) x\ 100\%$$

Information:
A: Highest rated frequency
B: Lowest rated frequency

Table 4. Interpretation of Reliability Percentage

Reliability Percentage (%)	Criteria
< 20	Very Low
21 - 40	Low
41 - 60	Middle
61 – 80	Hight
81 - 100	Very Hight

(Sugiyono, 2015)

RESULTS AND DISCUSSION

Learning materials developed include syllabus, lesson plan, handouts, student worksheets, cognitive learning outcomes tests, sheets of implementation of guided inquiry laboratory, observation sheet of students' scientific process skills on student worksheets, and student questionnaire responses. The following is an explanation of the results of the development of learning materials:

1. Syllabus

The syllabus developed refers to the analysis of student characteristics, curriculum 2013, and basic competency combined with indicators of scientific process skills so that there are eight indicators of scientific process skill being taught, namely: observing, formulating problems, formulating hypotheses, determining variables, conducting experiments, analyzing, concluding communicating. Table 5 presents the results of the syllabus validation that has been reviewed by the validator.

Table 5. Validity of Syllabus

No.	Aspects	Score's Validator	
		1	2
1.	The suitability of the physics syllabus format with the revised 2013 Curriculum	4	4
2.	Appropriate use of language with EYD	4	4
3.	Appropriate sub-topic selection with Basic Competence	4	4
4.	Conformity of indicators with basic competence	3	4
5.	The suitability of the field of study with the indicators achieved	3	4
6.	Compatibility of learning activities with indicators	3	4
7.	Conformity of the assessment with the Indicator	3	4
8.	The suitability of determining the time allocation with the Indicators achieved	4	4
9.	The suitability of learning resources with indicators	4	4
Validity		3,8	
Reliability		93,7 %	
Criteria: the syllabus is feasible to use by making slight improvements and further refinements.			

Based on Table 5 it can be seen that the average value of the syllabus validity of 3,8 thus the syllabus developed has very valid criteria because in the range of values 3,01-4,00 and the reliability value of 93,7% which has very high criteria because of the range a percentage value of 81%-100% by the criteria proposed by Sugiyono (2015). The results of the validity and reliability assessment showed that the syllabus developed was feasibly used as a reference for the preparation of learning. And they were supported by the suitability of the syllabus developed by Permendikbud number 22 of 2016, namely by including the identity of subjects, school identity, core competencies, basic competencies, subject matter by indicators of competency achievement, learning activities by adjusting indicators of scientific process skills, assessment, time allocation, and learning resources.

2. Lesson Plan

The lesson plan that is developing pays attention to the freedom of the material to be delivered and the allocation of time by referring to the syllabus and the learning model used. The lesson plan is made in 3 meetings with an assignment of 2 x 45 minutes each time. Table 6 presents the results of the lesson plan validation that have been reviewed by the validator.

Table 6. The Validity of Lesson Plan

No.	Aspect	Score's Validator	
		1	**2**
1.	Learning objectives	3,2	4
2.	Learning Activities	4	4
3.	Timing	4	4
4.	Learning Materials	3	4
5.	Serving Method	3	4
6.	Language	4	4
Validity		3,76	
Reliability		93,4%	
Criteria: the lesson plan deserves to use by making a few improvements and further improvements.			

Based on Table 6, it can see that the average value of RPP validity is 3,76. Thus the criteria are very valid because in the range of values 3,01 – 4,00 and the reliability value of 93,4%, the criteria are very high because in the percentage range 81- 100 following the criteria proposed by Sugiyono (2015). The results of the validity and reliability assessment indicate that the lesson plans that are developing are proper/well to use as guidelines in learning activities. The suitability of the lesson plan developed with Permendikbud number 22 of 2016 also became a standard guideline for the feasibility of the lesson plan be developed. Suitability is found in school identity, subject identity, class and semester, subject matter, time allocation, learning objectives based on basic competencies, basic competency indicators and competency achievement indicators, teaching materials, teaching methods namely guided inquiry laboratory by adjusting indicators of scientific process skills, syntax learning methods, learning resources, assessment of learning outcomes, but improvements are needed regarding the translation of the relationship of concepts or material that has been learned with the material to be taught.

3. Handout

The handout that was developed is base on the characteristics of the students which aims to find out the level of fundamental knowledge of students, the characteristics of the task that aims to find out the material to be taught, and analysis of learning objectives that determine the issues that need to be raised in the development of devices in accordance with the 2013 curriculum. Table 7 presented the results of validation which have been grouped into three aspects of assessment and have been reviewed by the validator.

Table 7. The Validity of Handout

No.	Aspect	Score's Validator	
		1	**2**
1.	Construction Feasibility	3,3	3
2.	Presentation Feasibility	3,2	3
3.	Language Feasibility	4	3
Validity		3,25	
Reliability		92,6 %	
Criteria: handouts deserve to be used as a guide book for students and teachers in the learning process, but by doing a little improvement and further refinement.			

From Table 7 it can be seen that the average value of the validity of the handout is 3,25, so the handout developed has very valid criteria and reliability value of 92,6% which has very high criteria in accordance with the criteria stated by Sugiyono (2015). The results of the validity and reliability assessment indicate that the handout developed is proper/well used. The feasibility of the handout that was developed was also seen from the conformity with Permendibud number 8 of 2016 where the material to be taught was in accordance with the basic competencies requested by the 2013 curriculum, illustrations were in accordance with the material taught, systematic writing and mathematical equations that were consistent and in accordance with theory, and the use of language that is easily understood by students so that it can facilitate the understanding of students in the learning process. The repairs and improvements that need to be done are the lack of connection between the concept of the material to be composed of the material that has been taught.

4. Student Worksheets

The learning tool developed by the next researcher is the student worksheets developing student worksheets based on the learning model that is guided inquiry laboratory adjusted to the indicators of scientific process skills. Table 8 presents the results of the validation of the Student worksheets that have been reviewed by the validator.

Tabel 8. The Validity of Student Worksheets

No.	Aspect	Score's Validator	
		1	2
1.	Material Concept	3,3	4
2.	Construction	3,7	3,7
3.	Purpose	4	4
4.	Deign	4	3
Validity		3,71	
Reliability		94,0 %	
Criteria: student worksheets are feasible to use by making a few improvements and further refinements.			

Based on Table 8 it can be seen that the average value of the validity of student worksheets by 3,71 states very valid and the reliability value of 94,0% which is very high criteria following the criteria stated by Sugiyono (2015). The results of the validity and reliability assessment showed that the student worksheets that were developed were proper/well used as guidelines for practicum activities. The width of students worksheets that was developed was guided by Permendikti number 8 of 2016, which contained titles, references, achievement competencies, supporting information, assignments and work steps, assessment. The preparation of student worksheets also adapts to the guided inquiry laboratory method and indicators of scientific process skills

In accordance with Nelson (2012) states the writing of student worksheets in inquiry learning is not presented in detail so that in student worksheets developed by students are able to design and formulate research independently. That is relevant to Nurdin & Adriantoni (2016) saying that laboratory investigations involve students fully in the learning process in finding and investigating something systematically, analytically, critically, and logically through experiments. The experiments used were by indicators of scientific process skills, where experiments conducted in Newton's first law, Newton's second law, and Newton's third law contained analytical data (experimental results) which required students to make tables and graphs. On student worksheets that are developed by students are also taught to analyze by linking the material that has been taught before with the material being studied, for example in lesson plan I about Newton's first law where the material is associated with business material.

5. Students' Cognitive Learning Outcomes Test

The learning device developed by the next researcher is a cognitive learning outcomes test. Cognitive learning outcomes test is an evaluation tool in the form of questions that aim to measure the increase in students' knowledge before and after the learning process. The development of these test questions is based on basic competencies regarding the material to be taught by adjusting the bloom level of the cognitive domain with basic competencies and indicators of scientific process skills. The test questions developed were then validated by two validators. The results of the validation of students' cognitive learning outcomes test can see in Table 9.

Table 9. The Validity of Students' Cognitive Learning Outcomes Test

No.	Aspect	Score's Validator	
		1	2
1.	Learning objectives	3,25	3
2.	Construction	3,5	3
3.	Language	4	3
Validity		3,29	
Reliability		91,3 %	
Criteria: test questions are feasible to use by making a few further improvements.			

Based on Table 9 it can be seen that the average value of the validity of the test questions is 3,29 with very valid criteria and reliability value of 91,3% with very high criteria by the criteria stated by Sugiyono (2015). The results of the validation and reliability carried out indicate that the test questions are feasible to be used as an evaluation tool to measure students' knowledge. The level of test questions developed is following the Revised Bloom Taxonomy guidelines (Anderson & Krathwohl, 2001) which adjusts to the basic competency requested so that the level of test questions starts from the C4 level (analyze) to C6 (create). Test questions as also guided by the guidelines of the Ministry of Health's Dikti questions (2010) where writing test questions are by indicators of competency achievement, according to the construction of question writing, according to the language used under Enhanced Spelling System (ESS). But there is an improvement by adding references from the questions used.

6. Implementation Sheet of Guided Inquiry Laboratory Process

The learning materials developed by the next researcher is an instrument of the implementation of the learning process with a guided inquiry laboratory model with a scientific process skill. This assessment aims to determine the suitability of the activities of teachers and

students in the learning process with the design of the implementation of learning that has been made. It also assesses the mastery of teachers in conditioning students. The learning achievement sheet that has been developed is then validated by two validators. Table 10 presents the results of the validation of the learning outcomes sheet with the guided inquiry laboratory model.

Table 10. The Validity of Implementation Sheet of Guided Inquiry Laboratory Process

No.	Aspect	Score's Validator	
		1	2
1.	There are instructions for charging or using the instrument	4	4
2.	The contents of the instrument in accordance with the objectives of the study	4	4
3.	The format of writing instruments is practical and easy to understand	4	4
4.	The use of sentences in instruments is communicative	4	4
Validity		4	
Reliability		100%	
Criteria: the guided inquiry laboratory learning implementation sheet is appropriate to be used as an instrument for observation.			

From Table 10 it can be seen that the average value of the validity of the guided inquiry laboratory learning sheet is 4,00 with very valid criteria and reliability value of 100% has very good criteria according to the criteria stated by Sugiyono (2015). The validation and reliability assessment states that it is feasible/well to use as an assessment of the implementation of the learning process. On the guided inquiry laboratory learning implementation sheet developed there is a match between the contents of the observation instrument with the research objectives, usage instructions, writing format and the language used which is easy to understand. The guided inquiry laboratory learning implementation sheet was adopted from the research of Novitasari et al. (2017).

7. Scientific Process Skill Observation Sheet Against Student Worksheets

The next learning materials that have developed as an instrument for observing scientific process skills on students' worksheets. This observation instrument aims to determine the achievement of the ability of scientific process skills that have trained students. Two validators then validate the learning materials that have developed. In Table 11 is the result of the validation of the observation sheet of scientific process skills on the students' worksheets.

Table 11. The validity of Science Process Skill Observation Sheet Against Student Worksheets

No.	Aspect	Score's Validator	
		1	2
1.	There are instructions for charging or using the instrument	4	4
2.	The contents of the instrument by the objectives of the study	4	4
3.	The format of writing instruments is practical and easy to understand	4	4
4.	The use of sentences in instruments is communicative	4	4
Validity		4	
Reliability		100%	
Criteria: observation sheets on science process skills on students worksheets are appropriate to be used as instruments to make observations.			

From Table 11 it can be seen that the average value of the validity of the scientific process skills observation sheet to the student worksheets of 4,00 has very valid criteria and reliability value of 100% has very good criteria according to the criteria stated by Sugiyono (2015). On the observation sheet of scientific process skills on the worksheets of learners there are instructions for use, the appropriateness of the contents of the observation instrument with the research objectives containing indicators of scientific process skills being taught, writing format and language that is easily understood, this is in accordance with Sheeba (2013) that an indicator of competence can be used as assessors of specific skills in students.

8. Students' Response Questionnaire

The learning materials developed by the next researcher is the student response questionnaire. This questionnaire aims to determine the motivation of students during the learning process using the guided inquiry laboratory model with a science process skill approach. The results of the validity of the questionnaire responses of students who have done by two validators are presented in Table 12.

Table 12. The Validity of Students' Response Questionnaire

No.	Aspect	Score's Validator	
		1	2
1.	There are instructions for charging or using the instrument	4	4
2.	The contents of the instrument in accordance with the objectives of the study	4	4
3.	The format of writing instruments is practical and easy to understand	4	4
4.	The use of sentences in instruments is communicative	4	4
Validity		4	
Reliability		100%	
Criteria: questionnaire responses of students are appropriate to be used as instruments to make observations.			

From Table 12 it can be seen that the average value of the validity of the student questionnaire responses was 4,00 and thus the criteria were very valid, and the reliability value of 100% was very good according to the criteria stated by Sugiyono (2015). In the student questionnaire responses, there are instructions for use, the suitability of the contents of the observation instrument with the purpose of the study is to find out the motivation of students during the process and after learning is done, writing format and language that is easily understood. Student response questionnaire was adopted from the research (Novitasari et al. 2017).

The results of the assessment and analysis of the learning materials that include the syllabus, lesson plan, handouts, student worksheets, students' cognitive learning outcomes test, implementation sheet of guided inquiry laboratory process, students' scientific process skills observation sheets against student worksheets, and student questionnaire responses get an assessment of validity with a range of 3,01 to 4,00 so that it is critically valid and a reliability value with a range of 81% - 100% so that it can be criticized very well. Thus the conclusion of this study is a guided inquiry laboratory learning materials to improve the scientific process skills in Newton's Law of motion otherwise feasible and well implemented as learning materials. The results of this research are supported by previous studies including research from Ayuningtyas (2015) which states that the validity of the guided inquiry model to train the scientific process skills of high school students on static fluid material is categorized as good and 93% of students have increased learning outcomes so that the learning materials is feasible, practical, and effective for learning, as well as research conducted by Mellyzar (2013) and Susanti, et al (2016) that inquiry learning influences students' scientific process skills.

CONCLUSION

Based on the results of the discussion of research data, it can be concluded that the validity of the learning materials developed is declared valid and reliable with an average validity between 3,01 – 4,00 and reliability between 81% - 100%, so that the guided inquiry laboratory learning materials to improve students scientific process skills on Newton's laws of motion is considered feasible and can be used as learning materials for conducting research.

SUGGESTION

In research on the validity of guided inquiry laboratory learning materials to improve students' scientific process skills in Newton's Law of motion, effectiveness and practical tests should also be conducted.

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