

# Development of Physical Learning Instrument by Using Newton's Laws with Inquiry Method to Complete Student's Learning Achievement in Senior High School

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DOI: 10.29322/IJSRP.9.11.2019.p9556  
<http://dx.doi.org/10.29322/IJSRP.9.11.2019.p9556>

**Abstract-** This research is a type of research development that is about developing learning instrument. Development of learning instruments including the Learning Implementation Plan, Student Activity Sheets, Student Teaching Materials, with Sheets Assessment oriented towards guided inquiry learning. The subject in this study was Newton's Law of Motion. The research was conducted at SMA Negeri 20 Surabaya, for trial I held for 12 students of class X academic year 2011-2012. While testing complete implementation for class implementation X-1 by replication I with class X-2, Replication II with class X-3 academic year 2013/2014. Learning instrument material Newton's Laws with inquiry methods which includes lesson plans, student teaching materials, worksheets, and learning achievement test is a valid instrument so it is suitable for use. The average score of validation results for the RPP obtained 3.51 with either category. The average score of validation results for Student Teaching Materials obtained 3.96 with a good category. The average score of validation results for the worksheet obtained 3.47 with a good category. While the average score of validation results for learning achievement tests obtained 3.87 in the good category. This already meets the valid criteria, that the learning instruments meets the valid criteria if it has been validated the experts get a minimum score of 2.60. Level of readability of student teaching materials developed in research this is categorized as easy, with an average percentage of the level of legibility student teaching materials by 87.16%. Students easily read material written on teaching material so that it can support the learning process. The level of difficulty of student teaching materials and worksheets developed in this study is included in the easy category, which is 19.07% for teaching material students and 17.98% for LKS. So that student teaching materials and worksheets are easy understood by students can be used to support learning. Learning instrument material Newton's Laws with inquiry methods which includes lesson plans, student teaching materials, worksheets, and learning achievement tests already meet the practical criteria, namely: the implementation of learning on each meeting can be categorized as good, student activities during the process learning is by learning that uses the method inquiry and the obstacles that occur can be overcome. Learning instrument material Newton's Laws with inquiry methods already meets the effective criteria, namely: student's responses in general expressed pleasure and interest to take part in further learning with the same method. Student learning achievement have reached KKM increase N-gain minimum 0.7 with high criteria. Research on developing of physical learning instrument by using newton's laws with inquiry method to complete student's learning achievement in senior high school that has been tested on students of class X on Newton's Laws of motion material produce instruments learning which includes RPP, LKS, student teaching materials, and THB. based on the findings of the study, it concludes that physic learning instrument Newton's Law material which developed with the inquiry method meeting valid criteria, legibility teaching material is categorized as easy, the level of difficulty of teaching material and LKS has easy category, good practicality, and good effectiveness, so it's worth using by the teacher for learning Physics.

**Index Terms-** Physical Learning Instruments, Newton's Laws, Inquiry Method, Student's Learning Achievement

## I. INTRODUCTION

Physics is an experimental science. Physicists must learn to apply the right question, design an experiment to try to answer the questions and draw the right conclusions from the results [1]. Physics is the natural phenomena that learning about science through a series of processes known as scientific process and supported with a scientific attitude and the results are tangible scientific products that can be in the form of concepts, principles, theories, and are applicable universal. The general objectives of learning physics include understanding and using scientific methods, mastering physical knowledge, using attitudes scientific, meeting personal and community needs, awareness of future careers front [2], so in physics teaching and learning students activities are conditioned in an active state by involving students directly on the process and the object being studied. With these conditions, the teaching learning process can support cognitive development as well as giving students opportunities to be creative so that they form more conceptions complete. Based on the experience of researchers

as instructors, most students responded that physics was difficult, and memorized many formulas. This means that students see physics as a product that is only memorized. This things shows that student learning experiences are not built alone, but rather limited to the facts conveyed by the teacher. "If you understand correctly the nature of Physics as a product and scientific process is certainly more should have put the experimental method in place rather than the lecture method. If indeed it is only natural that Physics is considered a difficult subject, many formulas, not contextual and seem boring" [3].

Learning should be more than just remembering. For students, to truly understand and be able to apply science, students must work hard on solving a problem at hand, find something useful for themselves which in turn can apply it in the community [4]. This means students must building knowledge in their minds. In this case, students must be active in processing information or ingredients, digesting, thinking, analyzing, and finally summarizing what he learned as a whole understanding. The teacher can help this process, by teaching ways that make information to be very meaningful and very suitable for students. In line with the statement above, in Chapter IV Article 19 Government Regulation No. 19 of 2005, it was stated that the process learning in educational units is held interactively, inspiration, fun, challenging, motivating students to participate actively, and provide sufficient space for the initiative, creativity, and then by the talents, interests and physical and psychological development of students.

Effective learning requires an understanding of how making knowledge accessible to students so they can link that knowledge with other knowledge and apply it outside the classroom. The teacher can help students learn knowledge in such a way so that making knowledge besides useful is also meaningful for them. Physics learning is carried out in scientific inquiry to foster the ability to think, work and be scientific as well communicating as one important aspect of life skills. These learning students are involved to actively think and find meaning he wants to know [5].

The inquiry can be interpreted as a process taken by humans to get information or to solve something the problem [6]. Meanwhile, the inquiry is a process took to solve problems, plan experiments, conducting experiments, collecting and analyzing data, and interesting conclusion [7]. The inquiry is a process of obtaining and obtaining information by doing observation and/or experiment to find answers or solve problems to the question or formulation of the problem by using the ability think critically and logically. Thus, in this paper what is meant by inquiry is a process is taken by humans to obtain information or to solve a problem by making observations and/or experiments using critical and logical thinking skills [8]. Learning by inquiry methods prioritizes the process of discovery to gain knowledge, the teacher must always design activities that allow students to do discovery activities in teaching subject matter taught. In inquiry learning, the teacher involves the ability of students to analyze and solve problems in a manner systematic. With inquiry, the contents and process of the investigation learned together at the same time, through a process of inquiry finally students arrive at the content of knowledge itself.

Learning with inquiry methods is based on learning theory constructivist developed by Piaget. According to Piaget, since childhood, each individual tries and can develop their knowledge through the scheme that exists in its cognitive structure. This scheme continues continuously updated through the process of assimilation and accommodation. Knowledge obtained by students in learning can be applied, both in school and outside of school. According one indication of the transfer of learning is the ability to use information and problem-solving skills [9]. Application is the ability to apply, and abstract concepts, ideas, formulas, laws in a new situation. For example, solving problems with certain formulas, apply a concept in an issue. Mastery physics concepts of students who learn through inquiry learning models better then students who learn through conventional learning models. Thing similar also stated by Censur Silalahi, that contextual learning the type of inquiry succeeds in increasing student motivation and learning achievement [10]. Meanwhile, according to Orhan Akinoglu in his research stated: "... the most objective benefits are obtained by students from the project works is their increasing interest in science and technology class. The most significant change seen by students regarding project preparation is their increasing grades in exams during and following the project works" [11]. One level of inquiry is guided inquiry, which is an inquiry with teacher involvement in the process of covering determining topics, formulating problems, tools/materials and procedures [12].

Guided inquiry is an inquiry that many teachers interfere with, through briefing through a complete procedure. The inquiry that the researcher uses is the guided inquiry method accompanied by an application (application) concept, with the following steps: formulate the problem, set a temporary answer (hypothesis), collect data, analyze data, draw conclusions, and apply the conclusion. At the stage of applying student conclusions given a contextual problem, which is accompanied by an image that is in everyday life. According to researchers, the material Newton's Laws is one material that has a high level of difficulty. Besides studying, the relationship between force and state of the object (moving or still) also associates with kinematics and vector quantities. By studying Newton's laws allows understanding of known types of motion, these laws are the basis of classical mechanics. In studying the Newton's Laws material, many students have difficulty understanding and applying it. For four the last year before the study was conducted, the average daily test scores the material is still below the minimum completeness criteria, which is 59.8.

Therefore, researchers are interested in researching learning with inquiry methods can be used to teach Newton's Laws material. With learning with inquiry methods, students besides getting knowledge in a way directly from the experiment, can also learn to apply concepts and laws to solve problems.

## II. EXPERIMENTAL METHOD

### 2.1 General Background of Research

Following the title, this research is a type of research development that is about developing learning instrument. Development of learning instruments including the Learning Implementation Plan, Student Activity Sheets, Student Teaching Materials, with Sheets Assessment oriented towards guided inquiry learning. The subject in this study was Newton's Law of Motion.

### 2.2 Sample of Research

The research was conducted at SMA Negeri 20 Surabaya, for trial I held for 12 students of class X in academic year 2011-2012. While

testing complete implementation for class implementation X-1 by replication I with class X-2, Replication II with class X-3 academic year 2013/2014.

### 2.3 Instrument and Procedures

This research was conducted in two stages, phase I was development of learning instrument. In this phase I the researcher is compiling learning instruments and validating instruments by several experts (experts at this field), followed by trial I on 12 students. At this stage intended to see the feasibility of learning instruments developed. Phase II is the implementation of learning instruments already deemed appropriate based on the results of trial I. The material used in this study is Newton's Law of motion.

The instruments referred to in this study are (1) instrument validation learning, (2) Sheet of learning instrument implementation (3) observation sheet of student activities, (4) student questionnaire sheets, (5) learning instrument test. Further explanation is as follows.

1. The learning device validation sheet includes the RPP validation sheet, validation sheet student teaching materials, validation sheet lks, and validation sheet learning instrument test.
2. Readability test sheet for students' teaching material, in the form of paragraphs 50 words were removed. This instrument was arranged based on the instrument close procedure developed by Taylor in 1953 [13].
3. The difficulty level of teaching material and worksheets, in the form of a questionnaire given to students. Students are asked to underline sentences which are not understood, then the number of sentences that are not understood are filled in a questionnaire.
4. Instruments of effectiveness in the application of learning tools which include:

- a. Learning Implementation Observation Sheet.

Observation sheet on the learning process is used to find out the suitability of the learning process with RPP. The reliability of this instrument is tested using percentage agreement.

$$\text{percentage agreement} = \left[ 1 - \frac{A - B}{A + B} \right] \times 100\%$$

Note:

A = Frequency of aspects of behavior observed by observers that provide high frequencies

B = Frequency of behavioral aspects observed by observers that provide low frequencies

- b. Observation Sheet Student Activities in KBM.

The aspects observed on this observation sheet are activities students during the learning process. The instrument reliability of observing student activities was tested by technique interobserver agreement, i.e. 2 (two) observers observe aspects the same during the learning activities take place. The formula used to calculate reliability is as follows:

$$\text{percentage agreement} = \left[ 1 - \frac{A - B}{A + B} \right] \times 100\%$$

Note:

A = Frequency of aspects of behavior observed by observers that provide high frequencies

B = Frequency of behavioral aspects observed by observers that provide low frequencies

The instrument is said to be good (reliable) if it has a reliability coefficient > 75 (75%) [14].

- c. Student response questionnaire sheet to the inquiry method

This instrument is used to describe student responses, given to be filled out by students after participating in the learning method of inquiry accompanied by the application.

- d. Learning Instrument Test.

Learning instrument test are used to measure student mastery levels with regard to material dynamics. The sensitivity of the items is calculated by statistics:

$$S = \frac{R_A - R_B}{T}$$

Information :

S = Item sensitivity

RA = Number of students who can answer correctly after ongoing learning process

RB = Number of students who can answer correctly before ongoing learning process

T = Total (number) of students

The maximum price sensitivity index of a problem is 1.00; is on the minimum index is equal to 0 (zero). This means that an item can be considered sensitive (sensitive to learning effects) if results the sensitivity calculation is positive [15]. Sensitivity about the description:

$$S = \frac{\Sigma ses - \Sigma seb}{N(\text{skor}_{maks} - \text{skor}_{min})}$$

Information:

S = sensitivity index

N = number of objects

$\Sigma ses$  = Number of subject scores after the process learning

$\Sigma seb$  = Number of subject scores before the process learning

Score<sub>max</sub> = Maximum score that can be achieved by the subject

Score<sub>min</sub> = Minimum score that can be achieved by the subject

The increase in learning achievement is calculated by the n-gain formula which is developed by Hake, namely by using the two

difference test the mean, pre-test and post-test, found differences in improvement in learning achievement before and after learning Physics with inquiry methods.

$$(g) = \frac{(S_{post}) - (S_{pre})}{100\% - (S_{pre})}$$

Information:

g (gain) = Increased learning achievement

S<sub>pre</sub> = Pre-test average (%)

S<sub>post</sub> = Average post test (%)

**Table 1.** Criteria for Gain Level

No	Range	Criteria
1	$g \geq 0,7$	High
2	$0,3 \leq g < 0,7$	Medium
3	$g < 3$	Low

e. Observation Sheet constraints

Observation sheets for these constraints are used for know the constraints or obstacles faced by the teacher, which is not in accordance with the planning in the RPP. This observation sheet filled in by observers for each meeting.

2.4 Data Analysis

Analysis of the results of the learning instrument validation and the results of the application learning instrument as follows:

a. Analysis of the learning instrument validation

Analysis validation of the learning instrument is done descriptively descriptive, which is done by means of the data score of each component averaged, then to determine eligibility, the average score is converted to sentences that are qualitative, Very Good (76% - 100%), Good (56% - 75%), Not Good (40% - 55%), Bad (less than 40%) [16]. For validation of learning tools by experts, they have a maximum score 4.00 so:

3,51-4,00 = Very Good / Very appropriate: Can be used without revisions

2.60-3.50 = Good / decent: Can be used with minor revisions

1.70-2.59 = Not good / not appropriate: Can be used with major revisions

0.00-1.69 Not good / improper: Not yet usable

b. Analysis of Readability of Student Teaching Materials

The value of the level of readability is the level of the reading level of students against teaching material developed by researchers, analyzed by percentage as the following:

$$\text{Readability} = \frac{\text{The number of keywords read}}{\text{Number of keywords left blank}} \times 100\%$$

**Table 2.** Readability Level

Percentage	Description
$p > 50\%$	Easy, the reader understands the contents of the reading
$35\% \leq p < 50\%$	Somewhat difficult, the reader needs help to understand the reading
$p < 35\%$	Very difficult, material too difficult

c. Analysis of the Difficulty Level of Teaching Material for Students and Student Worksheets

Difficulty level data were analyzed using a percentage following:

$$P = \frac{X}{X_i} \times 100\%$$

Information :

P = percentage of difficulty

X = number of sentences that cannot be understood

X<sub>i</sub> = total number of sentences

Data grading percentage percentage difficulty:

0% < P ≤ 10%: very easy

10% < P ≤ 20%: easy

20% < P ≤ 30%: easy enough

30% < P ≤ 40%: moderate

40% < P ≤ 50%: quite difficult

50% < P ≤ 70%: difficult

70% < P ≤ 100%: very difficult

d. Analysis of the Effectiveness of the Application of Learning Instruments

1) Analysis of the implementation of the learning implementation plan

To analyze the results of the assessment given by two people observers of observations of the implementation of learning use a format with a rating scale [17] as following:

1.00 - 1.99 = not good

2.00 - 2.99 = not good enough

3.00 - 3.49 = good enough

3,50-4,00 = good

2) Analysis of student activities in teaching and learning activities

To analyze the observed student activity data a technique is used percentage (%), i.e. the number of activity frequencies that appear divided overall activity multiplied by 100%.

3) Analysis of student's responses

Student responses are obtained and questionnaire with the aim that students answer honestly and correctly. The response is intended to know the opinion students towards the learning process that has been implemented, carried out descriptively qualitatively namely by testing the positive response and student negativity.

4) Analysis of learning achievement test

On the product learning outcomes, the pretest value is tested for homogeneity. Test homogeneity using Levene's test. The testing process uses the help of SPSS software. After homogeneity test, test data are results Student learning is analyzed using descriptive statistics, namely by using the level of completeness of individuals and classicals.

a) Individual completeness

Individually, a student completes if a student has a grade equal to or greater than the minimum completeness criteria (KKM) has been established. Minimum completeness criterion value (KKM) in SMA Negeri 20 for Physics is 75.

b) Learning objectives completeness

Learning objectives are said to be complete if the percentage of students is achieving learning objectives equal to or greater 70.

e. Analysis of the constraints of implementing learning

The constraints of implementing learning are analyzed descriptively by gathering, discussing and evaluating suggestions given by observers to the learning activities done.

### III. RESULT AND DISCUSSION

After conducting a complete test the following research results are obtained:

- a. Learning instrument material Newton's Laws with inquiry methods which includes lesson plans, student teaching materials, worksheets, and learning achievement test is a valid instruments so it is suitable for use. The average score of validation results for the RPP obtained 3.51 with either category. The average score of validation results for Student Teaching Materials obtained 3.96 with a good category. The average score of validation results for the worksheet obtained 3.47 with a good category. While the average score of validation results for learning achievement tests obtained 3.87 in the good category. This already meets the valid criteria, that the learning instrument meets the valid criteria if it has been validated the experts get a minimum score of 2.60.
- b. Level of readability of student teaching materials developed in research this is categorized as easy, with an average percentage of the level of legibility student teaching materials by 87.16%. Students easily read material written on teaching material so that it can support the learning process.
- c. The level of difficulty of student teaching materials and worksheets developed in this study is included in the easy category, which is 19.07% for teaching material students and 17.98% for LKS. So that student teaching materials and worksheets are easy understood by students can be used to support learning.
- d. Learning instrument material Newton's Laws with inquiry methods which includes lesson plans, student teaching materials, worksheets, and learning achievement tests already meet the practical criteria, namely: the implementation of learning on each meeting can be categorized as good, student activities during the process learning is by learning that uses the inquiry method and the obstacles that occur can be overcome.
- e. Learning instrument material Newton's Laws with inquiry methods already meets the effective criteria, namely: student's responses in general expressed pleasure and interest to take part in further learning with the same method. Student learning instruments have reached KKM increase N-gain minimum 0.7 with high criteria.

### IV. CONCLUSION

Research on developing of physical learning instrument by using newton's laws with inquiry method to complete student's learning achievement in senior high school that has been tested on students of class X on Newton's Laws of motion material produce instruments learning which includes rpp, lks, student teaching materials, and THB. based on the findings of the study, it concludes that physic learning instrument Newton's Law material which developed with the inquiry method meeting valid criteria, legibility teaching material is categorized as easy, the level of difficulty of teaching material and LKS has easy category, good practicality, and good effectiveness, so it's worth using by the teacher for learning Physics.

### ACKNOWLEDGMENT

Authors wishing to acknowledge assistance or encouragement from supervisor, colleagues and Acknowledgments section immediately following the last numbered section of the paper.

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