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# Developing Learning Instruments using Tracker in Measuring Students' Science Process Skills

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# Developing Learning Instruments using Tracker in Measuring Students' Science Process Skills

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**Abstract.** This study aims to determine the characteristics and effectiveness of the use of learning instruments using Student Worksheets (LKS) to measure science process skills of class X high school students by tracker application using guided inquiry learning models. The development procedure using the 4-D model proposed by Thiagarajan, namely define, design, develop and disseminate. The results of the study show that (1) the characteristics of the instrument have a difficulty level in the range of 0.09 to 0.54 with reliability at 0.74; (2) the instrument is said to be feasible in terms of content validity, empirical, and reliability; (3) the results of the measurement of science process skills of students of SMAN 1 Seyegan are in a good category with a percentage of 78.11%, and can be effective instruments to measure the science process skills of students.

**Keywords:** Learning instruments; Tracker; Science process skills

## 1. Introduction

Physics is one of the subjects that has an important role in designing the implementation of education it can focused on mastering the concepts support daily life [1]. The aim of science education is to help students understand scientific knowledge and improve students' ability to investigate through scientific approaches [2]. Students are expected to be more active, therefore the steps and the learning process must be truly cared for and student-centered [3]. The teacher has a very important role in teaching students' science process skills and planning and compiling learning activities in the classroom and teaching students how to achieve scientific information [4]. One of the main goals of science education is to teach students to be involved in the process of inquiry. In other words, students must improve scientific skills, knowledge and attitudes in order to develop understanding of scientific concepts. So the teacher must focus on teaching students' science process skills with facts and concepts and theories to encourage students to conduct scientific investigations [5].

The process skills in learning are known as student science process skills. Students' ability to apply scientific methods in understanding, developing and discovering science is an understanding of science process skills [6]. Development of science process skills is still difficult due to lack of time and tools for practice is one reason that is often met [7]. Science process skills are a very important tool in learning and understanding science, and are very important goals in science education. Not only scientists, but also every individual must have scientific process skills in order to solve problems in everyday life [8]. Science process skills can hone scientific inquiry such as the ability to compile and describe objects and natural events [9].

Low student science process skills are caused by several factors including: low science background, lack of laboratory infrastructure [10], the only book in learning [11], the school administration has not initiated contextual learning [12], only emphasizes mastery of concepts, as well as learning activities that have not explored students' scientific process skills [13]. Science process skills need to be developed through direct experience involving the use of various materials and physical actions [14]. The development of science process skills is used to help students gain understanding of material that is more long term memory so that it is expected to be able to solve all forms of everyday life problems, especially in the face of global competition [15]. Added that the development of intellectual attitudes and skills needed to improve concept understanding can be done by developing scientific process skills as a basis for inquiry activities. In a revealed that the development of students' science process skills is indispensable, especially in aspects hypothesize, control variables and plan experiments. Observations show that there are still several types of science process skills that are still lacking and not done by students. Lack of teacher guidance and lack of columns of science process skills in worksheets is a factor that causes the students' lack of scientific process skills. According to the results of research with the research title How pre-service teachers understand and perform science process skills show that there are still many pre-service teachers who do not have complete conceptual understanding for science process skills [16].

Inquiry learning model is one type of learning model that emphasizes activities, skills, and knowledge through active search based on curiosity [17]. The inquiry learning stage consists of orientation, formulating problems, submitting hypotheses, collecting data, testing hypotheses and formulating conclusions [18]. The learning phase of the inquiry learning model is identical to aspects of science process skills including observation, classification, asking, hypothesizing, planning experiments, using material tools, applying concepts, communicating, and conducting experiments [4]. Therefore, they can be used to improve process skills of science [19] through the application of each learning step. Inquiry learning models include asking, looking for explanations, testing explanations and generating knowledge. In other words, students use science process skills when using inquiry learning models [20].

Based on the results of a study in [21] that the use of guided inquiry learning models in improving process skills student science and achievement. Based on the results of the research in [22] show that the achievement of students' science process skills enters into good category with a percentage of 74.52%. The learning model is guided inquiry applied so that students are free to develop the concepts they learn and they are given the opportunity to solve problems they face in groups, interact socially with their peers to exchange information between groups [22]. The student must be able to do something using the processes and scientific principles that have been understood [23]. Inquiry has high effectiveness as a learning model that helps students find concepts and use science process skills [24]. So that learning objectives can be achieved well, process skills need to be developed through direct experiences as a learning experience. Through direct experience one can more appreciate the process or activity being carried out [25].

Thus, the purpose of this study was to determine the characteristics, feasibility, and effectiveness of the use of learning instruments using the tracker application to measure students' science process skills.

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

The type of data used is quantitative with descriptive methods. Collecting data from the research subjects was done through the questions in the student worksheets with a total of 4 questions about the description and through direct observation when the students conducted an experiment using tracker twice as much experiment. Aspects of process skills measured in this study include asking questions, observing, hypothesizing, planning experiments, interpreting, and communicating. The tracker product based application learning instrument developed was validated by 2 material experts and 2 media experts and 1 physics subject teacher as the implementer of learning. The results of validation analysis by expert lecturers and teachers indicate that the instrument developed is valid or in other words the learning instrument developed is suitable to be used for physics learning on work and energy materials.

The model used in this study is research and development. The development model used is a model adapted from the 4-D (four-D model) developed by Thiagarajan [26]. This research starts from the preparation of instruments developed to the dissemination of development products. The small and wide scale trial phase was conducted in May 2018 at SMAN 1 Seyegan. Research subjects for small-scale trials were 5 students of class X Science and for large-scale trials as many as 33 students of class X Science. Development procedures used in this study consists of four stages: Define (definition), Design (design), Develop (development) and Disseminate (deployment). The phase define consists of initial analysis, analysis of students, concept analysis, and formulation of learning objectives. The stage design consists of the preparation of instruments, selection of media and teaching materials and initial designs (draft 1). The phase develop consists of validation by expert lecturers and physics teachers and then in development testing. Furthermore, the stage is disseminate only limited to physics teachers in SMA 1 Seyegan and 5 students in class X IPA.

### *2.1. Overview of Science Process Skills Research*

Based on the study results by Koksal & Beberoglu [22] that indicated the positive effect of guided-inquiry approach on the Turkish students' cognitive as well as affective characteristics. The guided inquiry enhanced the experimental group students' understandings of the science concepts as well as the inquiry skills more than the control group students. Based on the results of the research by Lati [23] with the research show that the achievement of students' science process skills enters into good category with a percentage of 74.52%. The learning model is *guided inquiry* applied so that students are free to develop the concepts they learn and they are given the opportunity to solve problems they face in groups, interact socially with their peers to exchange information between groups. Ambarsari, *et al.* in [24] revealed that students must be able to do something using the processes and scientific principles that have been understood. Inquiry has high effectiveness as a learning model that helps students find concepts and use science process skills [13]. So that learning objectives can be achieved well, process skills need to be developed through direct experiences as a learning experience. Through direct experience one can more appreciate the process or activity being carried by Yager & Ekcay in [25].

### *2.2. Equations and Mathematical Expressions*

Test of item validity and item reliability using SPSS 17 with *Corrected Item-Total Correlation* to determine item validity and *Cronbach's Alpha if Item Deleted* to determine item reliability values. The values above (item validity and item reliability) are valid and reliable by comparing $r_{count}$ with $r_{table}$ at df = n-2 and a probability of 0.05. The basis for decision making in the validity test is as follows:

a. If the value of $r_{counts} > r_{table}$, then the item question or statement in the questionnaire has a significant correlation to the total score (meaning the questionnaire item is declared valid).
b. If the value of $r_{counts} < r_{table}$, then the item question or statement in the questionnaire does not correlate significantly to the total score (meaning the questionnaire item is declared invalid).

A measuring instrument is said to have high reliability if the tool is able to provide stable results. Instrument reliability can be determined by determining *Alpha*. Instrument reliability calculation is done with the help of SPSS 17 (see Table 1).

**Table 1.** Criteria for Reliability

| Reliability Value | Criteria |
|---|---|
| $0.00 \leq r < 0.50$ | Bad |
| $0.50 \leq r < 0.60$ | Ugly |
| $0.60 \leq r < 0.70$ | Enough |
| $0.70 \leq r < 0.80$ | Good |
| $0,80 \leq r < 1,00$ | Very Good |

The question is good if the problem is not too difficult and not too easy. The degree of difficulty of the problem is analyzed by the following formula:

$$P = \frac{\bar{S}}{Smaks}$$

where:
P = difficulty index
$\bar{S}$ = average of item question
S_max = maximum score of item question
Difficulty level category according to Daryanto in [27] is described in Table 2.

**Table 2.** Difficulty Level Category

| P Value | Category |
|---|---|
| 0.00 – 0.30 | Difficult |
| 0.30 – 0.70 | Medium |
| 0.70 – 1.00 | Easy |

The formula to categorize the ability of each aspect of student is used described in Table 3 as follows:

**Table 3.** Student Science Process Skills Categories

| Value (%) | Category |
|---|---|
| 0 – 25 | Very Low |
| 26 – 50 | Low |
| 51 – 75 | Moderate |
| 76 - 100 | High |

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

### *3.1. The Empirical Validity*
The results of assisted analysis of SPSS 17. Program for 7 questions developed are 4 questions that are declared valid, namely questions 4, 5, 6, 7 and 3 invalid questions, namely questions number 1, 2, 3

because they do not meet the validity criteria of 0.3440 (according to $r_{table}$). The $r_{count}$ for item 1 is -0.192, item 2 is 0.055, item 3 is 0.128, item 4 is 0.910 item 5 is 0.265, item 6 is 0.455 and item 7 is 0.725.

### *3.2. The Instrument Reliability*

The results of the reliability analysis with the help of the SPSS 17 program show that the value *Alpha Cronbach* for work and energy material is 0.740 value *Cronbach's Alpha* is in good criteria. This is because the value *Alpha Cronbach* is 0.740> 0.6 so that reliability is in good criteria.

### *3.3. The Difficulty*

Level of items about work and energy material in the range of 0.09 to 0.54. The standard deviation value is 0.3. If the standard deviation value is combined with the average value can be identified into 2 groups of questions, namely easy questions and difficult problems. The questions are relatively easy, namely items 1, 2, 5, 6 and 7. As for the relatively difficult questions, numbers 3 and 4. After the tracker application based learning instrument product is tested on a small scale and revised, then the assessment product is tested try on a broad scale to see the effectiveness of using instrument products to measure student science process skills. In a large-scale trial involving 33 students as a sample in 1 class at SMAN 1 Seyegan. The Composition Instrument for Assessment of Learning Process Skills (Table 4).

**Table 4.** Final Product Composition Instrument for Assessment of Learning Process Skills

| **Type of Assessment** | **Category Composition** | | **Indicator** |
|---|---|---|---|
| Science Process Skills | LKS Experiment Table | a. Asking Question | 1 |
| | | b. Hypothesis | 1 |
| | | c. Planning | 1 |
| | | d. Observing | 1 |
| | | e. Interpretation | 1 |
| | | f. Communicating | 1 |

The percentage of SPS scale trial (Table 5).

**Table 5.** Mastery of Science Process Skills Broad Scale Trial

| **Aspects of SPSS** | **Average** | **%** | **Category** |
|---|---|---|---|
| Asking Question | 3.40 | 75% | Good |
| Hypothesis | 3.25 | 83% | Good |
| Planning | 3.12 | 69.4% | Good |
| Experiment | 4 | 88.8% | Very Good |
| Observing | 3.40 | 75% | Good |
| Interpretation | 3.50 | 77% | Good |
| Communicating | | | |
| **Average** | **3.44** | **78.11%** | **Good** |

Based on Table 5, the first aspect is asking questions obtained by the average value of Science Process Skills (SPS) of students at 3.40 so that the percentage is 75% or categorized aspects of good student skills. The second aspect is hypothesizing, the average value of SPS of students is 3.25 so that a percentage of 83% is obtained or categorized as aspects of good student skills. The third aspect is planning the experiment, the average value of SPS students is 3.12 so that a percentage of 69.4% can be obtained or categorized as aspects of good student skills. The fourth aspect is observing, obtained by the average value of SPS of students by 4, so that a percentage of 88.8% is obtained or categorized as very good aspects of student skills. The fifth aspect of interpreting, the average value of the SPS of students was 3.40 so that a percentage of 75% was obtained or categorized as aspects of good student skills. The sixth aspect of communicating is obtained by the average value of SPS of students by 3.5 so that a percentage of 77% is obtained or categorized as aspects of good student skills.

The following will explain the research data on each aspect of SPS:

a) *Aspects of Asking Question*

Asking questions is a fundamental skill that students must possess before students before learning a further problem. Science process skills in this aspect of asking questions use the following indicators:

- Asking to ask for an explanation
- Asking about an experiment conducted

In this aspect has a high enough percentage value. This is because asking questions is an easy thing for students to do. Seen when presenting the problem to the worksheet and students are asked to provide an explanation, many students answered quite well. In addition, it was seen during the trial that many students asked how to use tracker software. Based on the data above, the average data obtained from this aspect in groups of one to eight groups is 3.40 with a percentage of 75% categorized as good.

b) *Hypothesis*

The ability to hypothesize is one of the very basic skills in scientific work. The hypothesis is a reasonable estimate to explain a particular event or observation. Based on the average assessment data on the aspects of groups one to eight by 3.25 with a percentage of 83% and can be categorized as good. This is because not all students have hypotheses on sloping field experiments on mechanical energy material.

c) *Planning an Experiment*

Before students conduct an experiment, through a demonstration by the teacher and students record the results of the teacher's demonstration into the students' worksheet or LKS. The average score of groups of one to eight was 3.12 with a percentage of 69.4% in the good category.

d) *Observation*

Observing is one of the fundamental scientific skills. Observing is not the same as seeing. In observing (students) students must be able to use all their senses including seeing, hearing, feeling, tasting and kissing. Science process skills in observing aspects use the following indicators:

- Using as many senses as possible
- Collecting / using relevant facts

This aspect is the highest aspect. This was seen during the experiment; students were very enthusiastic in making observations. Based on the results of the observation sheet, this aspect obtained an average of 4 with a percentage of 88.8% with a very good category. This is because students make observations according to work steps.

e) *Interpreting*

Like other aspects, the interpreting aspect also has several indicators, namely:

- Linking observations
- Find patterns in an observation

- Summarizing

Based on the average assessment data on this aspect in groups of one to eight by 3.40 with a percentage of 75% in good category. This is because students can write conclusions from observations and relate to the concept of matter.

f) *Communicating*

Communicating can be done through writing, drawing, reading and speaking (discussion and presentation). The skills of communicating to this aspect include describing empirical data from experimental results or experiences with graphs or tables or diagrams discussing the results of the experiment and comparing it with other groups and compiling and submitting systematic reports. Based on the results of the observation sheet, the average value was 3.5 with a percentage of 77% and included in the good category. This is because students are free to convey their ideas according to the experiments that have been conducted.

Large scale trials take advantage of 2 hours of subjects for work and energy materials. The trial results are then used to see the results of the measurement of students' science process skills in physics learning on work and energy material. The science process skills that are measured consist of asking questions, hypothesizing, planning experiments, observing, interpreting and communicating. Based on the results of a large-scale trial, an analysis of the mastery of students' science process skills by looking for an average percentage value on each indicator of science process skills. The level of mastery of science process skills of students with observing indicators is the highest indicator.

### *3.4. The Product Revision*

Tracker-based learning instrument product developed was validated by 2 material experts and 2 media experts and 1 physics subject teacher as the implementer of learning. The results of validation analysis by expert lecturers and teachers indicate that the instrument developed is valid or in other words the learning instrument developed is suitable to be used for physics learning in work and energy materials. Small-scale trials aim to see the validity of items, instrument reliability and level of difficulty of the problem. Test the validity of the items obtained 4 invalid items and 3 valid items. Instrument reliability developed when viewed from the *Alpha Cronbach's* value included in the good category. Furthermore, the analysis of the level of literary problems shows that the distribution of questions with the level of difficulty of the lace and height. The difficulty level category of questions is grouped into 2, namely, easy and difficult questions.

### *3.5. The Final Product Study*

Product tracker based application learning instrument developed was validated by 2 material experts and 2 media experts and 1 physics subject teacher as the implementer of learning. The results of validation analysis by expert lecturers and teachers indicate that the instrument developed is valid or in other words the learning instrument developed is suitable to be used for physics learning in work and energy materials.

Small-scale trials aim to see the validity of items, instrument reliability and level of difficulty of the problem. Test the validity of the items obtained by 3 invalid items and 4 valid items. Instrument reliability developed when viewed from the price is *Alpha Cronbach* included in the good category. Furthermore, the analysis of the level of literary problems shows that the distribution of questions with the level of difficulty of the lace and height. The difficulty level category of questions is grouped into 2, namely, easy and difficult questions.

Based on the results of the validation of expert lecturers and teachers, then the validity test was conducted empirically at SMAN 1 Seyegan which in learning familiarized students to train students' science process skills. The instrument tested includes a brief description and is equipped with a table of experimental results to measure students' science process skills. From the results of the empirical validity test, obtained 4 work questions and valid energy. The value *Cronbach Alpha* shows that the instrument is in good reliability. Final product study through the validation of expert lecturers and teachers, and empirical validation shows that the instrument developed has been valid in theory and empirical.

## 4. Conclusion

Based on the formulation of the problem, the purpose of the study, as well as the discussion of the results of the study it can be concluded that the tracker application-based learning instrument developed has a level of difficulty from easy to difficult with a range of 0.09 to 0.54 for work and energy materials. Learning instruments that are developed are feasible to measure student science process skills based on the results of validation by material and media expert lecturers and physics teacher assessment. Reliability for the instrument developed was categorized as good with the value *Cronbach Alpha* of 0.740. The results of the measurement of science process skills in class X IPA 3 of SMAN 1 Seyegan are included in the good category. This can be proven by the average value of SPS of 3.44 with a percentage of 78.11%. The aspect of observation / observation is the highest aspect in the aspect of the observed SPS. This is because students are very enthusiastic in observing experiments on inclined fields carried out by researchers. The guided inquiry model is very suitable to be used in physics learning using software tracker. Because the learning syntax in the inquiry model can influence students' interest in experimenting using the tracker.

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