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Developing of Learning Instruments based on Software Tracker in Measuring Cognitive Learning Outcomes

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Abstract This paper aims to: (1) determine the characteristics, flexibility and effectiveness of tracker software-based learning instruments, and (2) measure the cognitive outcomes of products in the form of cognitive process dimensions with the C2-C5 category of Bloom Taxonomy on learning instruments integrated Tracker software. This study uses the 4D research method. The results showed that the learning instruments developed were suitable for use in terms of media, material and users based on the results of the validation of media experts with very good criteria, material experts with excellent criteria and expert users with good criteria. Then the level of difficulty of the item has 5 easy questions and 2 difficulty questions. The results of cognitive assessment conducted on eight groups, there are five groups that achieve minimum completeness criteria, and three groups do not achieve the minimum completeness criteria. measurement of learning outcomes through the instrument is said to be good. Tracker software is a good learning media in practicum activities that can be done outside the Laboratory. The use of worksheet and learning videos can clarify the material and use of tracker software.

Keywords: Learning instruments; Software tracker; Guided inquiry; Bloom taxonomy; Cognitive learning results.

1. Introduction

The teaching and learning process is the most important activity of all school teaching activities. In accordance with the reference for the preparation of syllabus contained in process standards, the material used in learning must contain relevant facts, concepts and procedures in accordance with the indicators and competencies to be achieved [1]. Learning physics in scientist research class is one of activities in accordance with real-world situations [2]. It states that in general learning activities must be limited by memorizing scientific facts, because students should be able to explore deeper conceptual understanding through the modeling and modeling skills of students from environmental exploration [3].

Based on observations that have been made, the learning process carried out in the grade is almost completely done by the lecture method without conducting an investigation. Learning activities are limited in terms of conceptualizing and doing practice, questions, without investigation, process to find a concept. Learning activities are carried out rarely use the laboratory space. Based on the results of interviews, there are several reasons why the laboratory space is rarely used, which is not conducive and the limited learning time cannot cover all aspects of the material contained in the teaching and learning plan (RPP).

Regarding the Graduates Competency Standards, to improve the efficiency and effectiveness of the achievement of graduates' competencies, they can utilize learning technology [2]. The technology that is often used often utilizes computer media. Innovative learning strategies using video clips in subjects of material elasticity and strength increase student satisfaction in learning and student



learning outcomes. The use of video can replace face-to-face learning that is usually done at the Laboratory [4].

Besides that, the video usage can specify instructions for each session. The use of simulations on computers can improve learning outcomes in science learning. Besides that the use of simulation can replace traditional instruction activities in the Laboratory. Simulation is a tool that can be used to gain knowledge with aspects that cannot be measured directly [5]. To get accurate and reliable results, the simulation must represent the actual system [6].

One of the uses of video-based simulation is software tracker [7]. Software tracker can make physics learning software is relevant to real life [2]. Besides that, software tracker is a free video analysis and modeling tool. Software tracker is part of data analysis techniques using video [2,4]. Tracker is an analytical technology and modeling tool built by Java-based Open Source Physics [8]. Some advantages of software Tracker have the ability to do tracking (tracking). Then can analyze diffraction patterns and interference through pixels in the image. It shows that software Tracker has several advantages over the APAS software and logger software, which has good quality in measuring position, angle, speed vertically or horizontally [8]. Software Kinovea excellence with software Tracker. The results of tracking are done for both of them are not much different. But to measure the position vertically, horizontally and avoid noise (video noise) software Tracker is superior [9].

One of the learning revised 2017 suggested in the 2013 curriculum for use is inquiry learning. To strengthen an integrated scientific and thematic approach, it is necessary to take attitude-based learning or research, namely discovery learning or inquiry learning models [9]. Web-based inquiry learning is used in science classes must use theory, technology in the form of a set of laptops, and scripts to optimize learning and learning outcomes. Online learning and inquiry mixed from a learning environment with various sources can improve cognitive understanding and learning outcomes [10]. Guided inquiry-based laboratory instructions have advantages in various knowledge and long-term memories of students [9]. Learning by guided inquiry increases curiosity, producing high-level critical thinking skills, authentic learning, and learning experiences that can be applied in the real world. In addition, the guided inquiry model includes cognitive, metacognitive, affective, personal and community aspects with different results per individual [9].

Concerning the National Education System has adopted taxonomy in the form of attitudes, knowledge, and skills. The learning process is fully directed towards the development of these three domains in a holistic manner. Gradations of attitude aspects are accepting, running, appreciating, living, and practicing. Then the gradation of knowledge remembers, understands, implements, races, evaluates. The skill aspect includes observing, asking, trying, reasoning, presenting, creating [9]. revision of the structure of the cognitive domain, namely remember, understand, apply, analyze, evaluate, create [11].

Based on the results of these observations and interviews, the learning tool is needed to make students able to learn actively and efficiently in terms of time and cost. The learning device can represent practicum activities and measure students' cognitive learning outcomes. This paper aims to determine the characteristics, feasibility, and effectiveness of tracker software-based learning instruments, and to measure the cognitive outcomes of products in the form of cognitive processes dimensions with the C2-C5 category of Bloom Taxonomy on learning instruments integrated software Tracker

This paper focuses on the assessment instrument of learning tools in the form of RPP and work sheet based tracker software. Learning activities are only done when the teacher has finished discussing business and energy materials. Researchers do not examine the problems of gender, IQ, social and economic background of students. Learning activities do not compare between the initial and final cognitive abilities of students, so learning outcomes. Preliminary observations made are only available in schools, as well as teaching and learning activities conducted by the teacher in the classroom. Practical activities based on Bloom's Taxonomy, with categories C2-C5 that are understand, apply, analyze, evaluate, and learning completeness is fulfilled if the minimum completeness criteria (KKM) is 75.

The rest of this paper is organized as follow: Section 2 describes the related works. Section 3 presents the proposed research method. Section 4 presents the obtained results and following by discussion. Finally Section 5 concludes this work.

2. Related Works

Research conducted by Mediartika has several differences with the paper to be studied, the learning material presented in the paper includes acid-base material, while the material is in this paper is energy conservation material [12]. The aspect of measured in the paper is to measure critical thinking and scientific attitudes while this paper measures cognitive learning outcomes. Data analysis using Reliability technique, validity and level of difficulty of the problem were analyzed using RASCH Model application with Alpha Cronbach technique. Meanwhile, SPSS used this paper with Alpha Cornbach technique, Correlated item total correlation and the level of problem [13,14,15].

Products that are expanded in papers are work sheets, practicum reports and formative tests, while in this paper produce products in the form of RPP, work sheets, inclined fields, and observation sheets [14]. The learning model in this paper is guided inquiry, while the paper is assignment. Equality of paper with this paper aims to determine the characteristics, flexibility and effectiveness of instrument use. Development procedure using 4D proposed by Thiagarajan [16]. Test the validity of the instrument using expert judgment. The research was only conducted in one class, without pre-test post-test, and without experimental-class control class.

Research conducted by Iswatun has several differences with the paper to be studied, namely the subjects presented in the paper are science with light reflection material, while this paper is physics with business and material energy [17]. While this study measures cognitive learning outcomes, the correlation between cognitive learning outcomes and their correlations [17]. Analysis of paper data uses homogeneity test, normality test, independent samples t-test, N Gain test, Pearson correlation test and determination coefficient, while this paper uses SPSS with Alpha Cornbach technique, Corelated item total correlation and level of problem from adopten theory by Daryanto [15].

Product developed paper includes experimental observation sheet and description test, while in this paper RPP, work sheet, inclined field video, and initial observation sheet [17]. Research was carried out in two classes (control and experiment), with pre-test post-test, while this paper did not do this. The similarity of the paper with this paper is the use of guided inquiry, learning activities through experiments, cognitive student learning outcomes, the value of the school is met.

3. Research Method

This research is a research and development R & D with the aim to produce and test the effectiveness of the product. This study uses a 4-D (four-D model) development model developed by Thiagarajan [16]. This research was conducted at SMAN 1 Sayegan, Tegal Gentan, Margoagung, Sayegan, Sleman, Yogyakarta in May 2018.

There are four stages in the 4D models define, design, develop, and disseminate. The first stage is conducted by the researcher is defining. At this stage the researchers carried out an initial diagnostic of the curriculum used, analysis of students including individual motivation and academics, and the condition of the school environment. Then do material analysis that is adjusted to the learning tools that will be developed. In addition, researchers formulate goals before developing learning tools. This approach to limit and focus on research on student learning needs of devices that will be developed. All of these activities are carried out through interviews and direct observation.

In the design stage, the things that are done are compiling criteria tests, choosing learning media that are appropriate to the characteristics of students, the form of media presentation, and simulating learning materials with the media that will be used. Test criteria used are the basic competencies and developing evaluation items. Evaluation items use a Likert scale with a scale of 1-4. The scale has Very Good (SB), Good (B), Less (K), and Very Less (SK) categories.

The form of presentation media in the form of experimental worksheets in the form of handouts and videos on CD. The material used is business material and energy in the inclined plane with the mass independent of the beam and the dependent variable is the slope of the track. The inclined plane trajectory is recorded in the video form so that it can analyze the speed and acceleration of objects using the tracker software version 4.72. Before installing the software tracker, it is certain that the computer is installed with a Java application. Furthermore, the making of worksheets is intended as a trial guide. In addition, the worksheets containing practice questions used to measure students' cognitive outcome abilities.

Then the develop stage, at this stage product validation, product revision, limited trial, product revision based on the results of the trial. Validated instruments in the form of assessment instruments for products that have been developed. Validation was carried out by material experts and media experts, namely two physics education lecturers and physics subject teachers. The results of the validation that have been assessed by material experts and media experts are then made improvements. Then a limited product trial was conducted on 5 students. Furthermore, the product was revised based on the results of limited trials before being widely tested. The final stage is disseminated where at this stage the wider trial is carried out on students in SMA 1 Sayegan with in total involving 34 students. The results of the wide scale trial were used to determine the reliability of the tracker software based work sheet learning assessment instrument. The type of data in quantitative and qualitative descriptive [3].

Quantitative data are the results of item validity, item reliability and difficulty levels of essay questions, and the feasibility test of learning instruments. Validity is the degree of accuracy of a test, so it can be known to actually measure what is being measured [18]. Validity is done by correlated items to total correlation using SPSS. Correlated-item Total Correlation techniques use a correlation formula for spurious overlap effects. The validation requirement is 1) if the value of $r_{count} > r_{table}$, then the item is valid, 2) if the value of $r_{count} < r_{table}$ then the item is invalid [13].

Valid items are valid then the reliability is calculated using SPSS. Reliability is a series of measurements that have consistency if the measurement is repeated with the measuring instrument repeatedly. The resulting score is consistent and relatively unchanged even though it is done in different situations. Reliability is using alpha Cronbarch [14]. The following alpha Cronbarch criteria according to [19] are shown in Table 1.

Table 1. Reliability Criteria

No	Reliability Value	Criteria
1.	0.0-0.20	Bad
2.	> 0.20-0.40	Poor
3.	> 0.40-0.60	Enough
4.	> 0.60-0.80	Good
5.	> 0.80-1.00	Very good

Next the problem that has been reliably tested is the level of difficulty of the problem. The question is good if the problem is not too difficult and not too easy. The level of difficulty can be classified as follows [15]:

$$\text{Level of difficulty} = \frac{\text{average value}}{\text{maximum score applied}} \quad (1)$$

with the criteria shown in Table 2.

Table 2. Criteria for Levels

No	P Value	Criteria
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1.	0.00 – 0.30	Difficulty Questions
2.	0.31 - 0.70	Moderate Questions
3.	0.71 - 1:00	Easy Questions

The feasibility test can be done by analyzing the percentage tabulated feasibility (data Recapitulation), as follows:

$$s = n \times L \quad (2)$$

Then the number of observed scores from the assessment indicator:

$$N = M \times n \quad (3)$$

Then the collected the data is processed by adding up, Compared to the expected number by percentage [3].

$$P(s)(\%) = \frac{s}{N} \times 100\% \quad (4)$$

Description:

$P(s)$ = Presentation of feasibility (%)

s = score observed

N = Total score criterion

L = response score

m = score highest

Following the interval validation criteria used are shown in Table 3.

Table 3. Validation interval criteria

No	Interval	Qualitative criteria
1.	0%-25%	Not good
2.	26%-50%	Poorly
3.	51% - 75%	Good
4.	76% - 100	Very Good

Then the quantitative data has been changed to qualitative data that is descriptive.

3. Results and Discussion

3.1 Evaluation of Expert

Learning Tools that have been printed, then validated by three material experts and three media experts. Then when using instructional media, students are given the opportunity to assess learning media as an expert user. The Table 4 is the results of the media test, material, and expert users:

Table 4. Expert judgment

No	Validator	Value	Category
1	Media Expert	77.2%	Very Good (SB)
2.	Material Expert	87.5%	Very Good (SB)
3.	experts Users	72%	Good (B)

Media expert respondent two lecturers and one physical education teacher of physics. Based on the results of the analysis, the media developed by researchers can be used as a percentage of 77.2% so that it can be said if the media in the form of sloping videos, RPP, and work sheet are said to be suitable for learning in the classroom. Respondents of material experts were two physics education lecturers and one physics teacher. Based on the results of the analysis, the material used by researchers can be used in accordance with the Syllabus and RPP with a percentage of 87.5% "Very Good" so that it can be said if the material is in the form of sloping video, RPP, and work sheets are said to be suitable for classroom learning.

The expert user respondents are 32 students of Senior High School in three grade science. Based on the results of the analysis, the learning tools developed by researchers can help students in understanding the learning material with a percentage of 72%. Based on these results, the learning device can be said to be "good" from the user aspect.

3.2 Validity, Reliability and Level of Difficulty of Questions

Work sheet that have been given to students are tested for validity. The r table value is 0.3440 and compared to the r count of the SPSS calculation. The following validity of test results are shown in Table 5.

Table 5 Value validity

Item	Validity Value	Criteria
1	-0192	Invalid
2	0055	Invalid
3	0128	Invalid
4	0910	Valid
5	0.3	Invalid
6	0.455	Valid
7	0.725	Invalid

Based on Table 5, items are valid with the numbers 4, 5, 6 and 7. The validity number is tested for reliability using Alpha Cronbach. The reliability value obtained is 0.740. The reliability value is Good (B). There are seven essays practice questions with three of them being an analysis of the experiment. The following data on the level of difficulty of the questions are presented in Table 6

Table 6. Level of Difficulty

Item	Level of difficulty	Criteria
1	0,96969697	Easy
2	0,898989899	Easy
3	0,090909091	Difficulty
4	0,545454545	Dissiculty
5	0,954545455	Easy
6	0,870707	Easy
7	0,818182	Easy

Problem number 1 is the matter with easy categories, into the C2 group Bloom's taxonomy is characterized. The problem number 1 is an invalid question because many students can answer the question easily. Question number 2 is an easy category problem, which is included in the C4 group of Bloom's taxonomy which is analyzing. The problem number 2 is an invalid question because many students can answer the question easily.

Question number 3 is a problem with a difficult category, included in the C4 group of Bloom's taxonomy which is analyzing. The question number 3 is an invalid question because there are many

students who can answer the question easily. Problem number 4 is a problem with a difficult category, included in the C4 group of Bloom's taxonomy, which is analyzing. The results of the question number 4 are valid questions because some students could answer questions and some were not questions Number 5, 6, 7 were analytical questions from practicum activities. Questions number 5 and 6 enter into group C5 Bloom's taxonomy is measuring. Then for question number 7, it is included in the group C5 Bloom Taxonomy is concluded. The three questions are said to be valid in the easy category.

Minimum passing score in Sayegan High School is 75, so students are expected to exceed that score. The following cognitive values obtained by students divided into eight groups are presented in Table 7.

Table 7. KKM Category

Group Group	Value	Category
Group 1	82.50	Completed
Group 2	77.50	Completed
Group 3	47.50	Completed
Group 4	50.00	Not Completed
Group 5	80.00	Completed
Group 6	64.00	Not Completed
Group 7	85.00	Completed
Group 8	82.50	Completed

Based on the Table 7, there are 5 groups that have values above the KKM, and 3 groups that are below the KKM score or not complete.

3.3 Experiment activity

Figure 1 depicts initial display of tracker software.

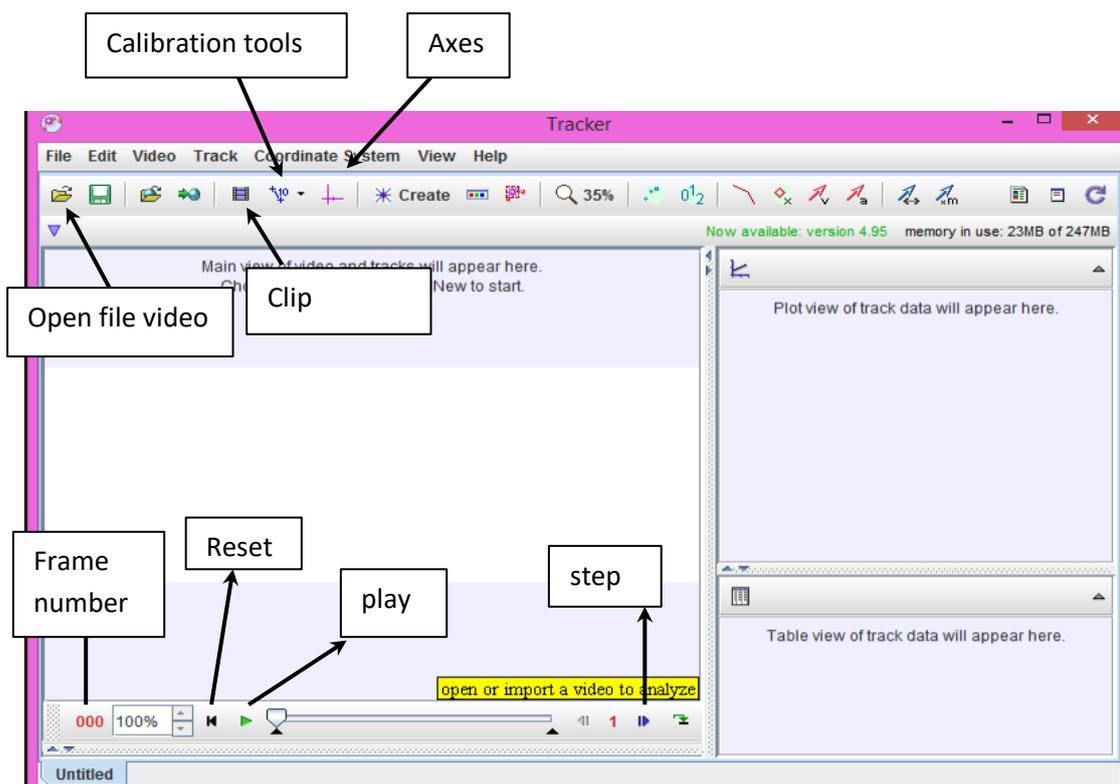


Figure 1. Initial display of Tracker software

From Figure 1, the initial activity of the practicum is the introduction of the tracker software to students and their use. Next, work on the questions contained in the Student Worksheet to find out students' knowledge about business and material energy. Then shows two inclined plane videos with different beam masses. The first experiment, students in groups is conducted a joint experiment with the teacher. For the experiment both students did it in groups without direction from the teacher (see Figures 2 and 3).



Figure 2. First experimental in tracker software



Figure 3. Second experimental in software tracker

From Figure 2 and 3, the inclined plane experiment is done twice with the variable being changed, namely the beam mass. In the first experiment the mass of the beam was 20 grams, while in the second experiment the mass of the beam was 40 grams. Analysis of speed, acceleration, direction of force, slope angle of the board using tracker software. Before analyzing, students were asked to determine the benchmark in the form of track length, track height, mass of the beam and fill in the tracker software column. then students analyze potential energy, kinetic energy, and mechanical energy from the results of the experiment using a spread sheet. The results of this research are: This is evidenced by comparing the speed of two beams. The beam speed in the

second experiment is worth more than the first experiment (see Figure 4). This is in accordance with the theory.

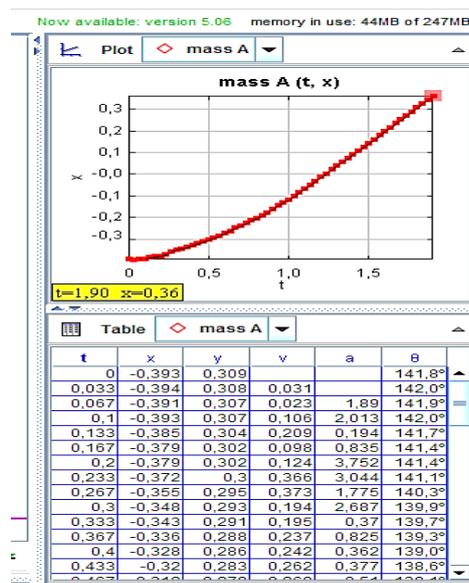


Figure 4. Results of the first experiment using tracker software

In addition to assessing the cognitive aspects, attitude and assessment skills was also conducted. Assessment of attitudes and skills is assessed based on teacher observations on learning activities and practical activities. The following assessment of attitudes and skills can be seen in Table 8. Table 8 presents the assessment of scientific attitudes and skills in wide-scale trials.

Table 8. Indicators of scientific attitudes and skills

No.	Type of Evidence	Scientific attitude indicators	Mastery (%)	Remarks
1.	Observations	Responsive and Collaborative	71.5%	Good
2.	Observations on practicum activities	Presentation systematics and Responding to questions	84%	Very Good

4. Conclusion

This paper has focused on the assessment instrument of learning tools in the form of RPP and work sheet based tracker software. Based on the assessment of material experts, media experts and user experts, it can be concluded that the development of learning instruments in the form of lesson plans, work sheet and video analysis based on tracker software with the guide inquiry model approach is said to be appropriate, in accordance with the results of media, material and user tests. The items that have been developed, there are four valid questions from the seven questions developed. Measurement of learning outcomes through the instrument is said to be good. In addition to cognitive assessment, there are assessments of aspects of attitudes and psychomotor aspects. The attitude aspect assessed is responsiveness and cooperation, while the psychomotor aspects are assessed based on systematic presentation and responding to questions. Based on observations, the average value of aspects of student attitudes is said to be good (B). Then for the average value of psychomotor aspects students can be said to be very good (SB). Thus it can be concluded that the learning that has been done using tracker software and developed learning instruments makes most students active.

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