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Development of Problem Solving-Based Modules Assisted by Tracker Software to Improve Students' Problem-Solving Skills in High School

Santi Istiqomah[1)*] , Patricia H. M Lubis[2)] , Lefudin[3)]

[1)] Physics Education Department, University of PGRI Palembang , Jl. Lorong Gotong royong 9/10 Ulu, Palembang 30116, South Sumatra Indonesia
[2),3)] Master of Physics Education , University of PGRI Palembang , Jl. Lorong Gotong royong 9/10 Ulu, Palembang 30116, South Sumatra Indonesia

**Corresponding author: santiistiqomah7339@gmail.com*

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Abstract – *This study aims to 1) produce problem solving-based modules assisted by software tracker to improve valid problem-solving abilities; 2) produce problem solving based modules assisted by tracking software to improve practical problem solving skills; 3) find out the potential effects of problem solving-based modules assisted by tracker software to improve students' problem solving skills. This study used research and development (R&D) methods which refer to the ADDIE development procedure. includes Analysis, Design, Development, Implementation, Evaluation. One of the ADDIE's stages is modifying the development stage using Tessmer's evaluation. If it consists of self-evaluation, expert review, one to one, and small group. Data collection was carried out by observation, interviews, questionnaires/questions. The research subjects were class X IPA students at SMA Negeri 3 Sungai Lilin. Based on the analysis, the data is stated to be valid, practical and has the potential to influence students. The results obtained 1) The expert review stage showed the average value from the three experts, namely 91.11% for material aspects, 93.33% for media aspects, and 81.11% for language aspects. 2) The one-to-one stage has a percentage value of 84.44 % which is categorized as practical. 3) The small group students' response questionnaire has a score percentage of 87.778% which is categorized as practical. and 4) the field test stage shows an average value of 44 .2563 in the pretest and 83.9063 in the post-test. Therefore, it can be concluded that the problem solving-based module assisted by tracker software can be stated as valid, practical, and effective to improve students' problem-solving skills.*

Keywords: *module; problem solving skills; software tracker; research and development*

I. INTRODUCTION

Physics subjects are studied in formal education where some students think that this is just a collection of very abstract formulas (Jumardi et al., 2013). Physics is a science that studies the formation of nature which involves natural phenomena and all interactions that exist in the universe. In the process of learning physics, students are directly involved in using learning models determined by the teacher so that they can

help students understand what is meant by physics and what relationships and differences between the concepts of physics and the universe are (Triyana et al., 2018). Physics is part of science which functions in shaping the character of quality students (Agustina et al., 2020). In addition to learning about the formation of nature and natural phenomena, physics can also provide natural facts about what is on this earth, so that every thing or event that exists on this Earth can be explained or linked to physics because it can build students' ability to solve problems.

Physics subjects are expected to foster thinking skills to solve problems in everyday life so that they need to be taught optimally (Nurliawaty et al., 2017). There are plenty of teaching materials and learning resources that can be used to teach or convey material to students in order to improve students' problem-solving abilities optimally. One of the ways is to use modules. Modules are the smallest learning program units that can be studied by students individually (*self-instructional*), after students have completed the next module unit (Prastowo, 2013).

Module, is one of the teaching materials arranged coherently which contains a set of lesson plans and is designed to help students master the material. the use of the teacher module only as a facilitator (Daryanto, 2013). Modules can be developed or made in such a way with various unique and interesting variations so that they can increase students' learning interest whose concepts are very easy to understand (Daryanto, 2013). One of them is by developing *problem solving-based learning modules* assisted by tracker software to improve problem solving abilities. The problem-solving approach is expected to be very suitable for use because in this learning process students are required to have a high level of thinking in solving problems, so that the problem-solving approach in physics lessons is quite optimal when used in class. This model stimulates students to think starting from searching for data to formulating conclusions so that students can take meaning from learning activities (Shoimin, 2017).

Problem solving with the help of tracker software can be a solution to help students be more active and able to improve problem solving abilities. The problem-solving based Physics module can help students solve problems in learning (Aflaha et al., 2015). Video analysis using *tracker software* produces values that are in accordance with theory and can improve students' thinking skills (Fadholi et al., 2018). Software Tracker is software that functions to model and analyze videos based on the open source Java framework (Fitriyanto & Sucahyo, 2016). In solving problems in motion material, students can use *tracker software* to obtain systematic and specific data. Therefore, researchers developed a module based on problem solving with the help of tracker software to improve students' problem solving abilities.

There are several display menus in the tracker software application, namely object tracking with overlay position, speed acceleration, graphics, several steps of reference frames, collaboration points and line profiles. Through this tracker software application, data collection in practicum will be more systematic.

Problem solving ability is the ability to think at a higher level (Venisari et al., 2017; Bancong et al, 2021). Problems that are often experienced by students with low problem-solving skills in students are caused by a lack of understanding of the material. Problem solving skills include several important stages, including identifying problems, defining problems, determining solving strategies, solving problems, verifying solutions (Baten, 2019; Carson, 2007; Putra et al., 2020; Heller et al., 1992).

Previous research conducted by Hudha et al. (2017) revealed that the physics learning module used to improve problem solving skills has very valid criteria with appropriate criteria for its feasibility based on the experts assessment.

Similar research conducted by Aflaha et al. (2015) showed that the assessment of problem solving-based physics modules was declared feasible in the very good category and was also effective in improving students' learning outcomes. The practicum module assisted by tracker software is very suitable for use, although some attention must be addressed to several revisions from the the validators (Setyaningsih & Putra, 2021).

To find out the validity, practicality, and effectiveness of problem solving-based module development assisted by tracker software to improve students' problem solving skills. The purpose of this study was to produce module products that were valid, practical and effective to improve problem solving skills.

II. METHODS

This research is an R&D (*Research and Development*) research. The development model used in product development was the ADDIE development model which consists of five stages: (1) Analysis, (2) Design, (3) Development, (4) Implementation , and (5) Evaluation (Branch, 2009). In this study the product to be produced is a problem solving-based module assisted by tracker software on momentum material. The evaluation used is Tessmer's formative evaluation model which consists of self evaluation, expert review, one to one, small group and field tests (Tessmer & Wedman, 1995).

The data collection techniques used by researchers included 1) observations made by researchers to make complex direct observations of what happened and then analyze the results; 2) interviews to find out the initial data and information that were used as reference material for the development of problem solving-based modules assisted by tracker software; 3) questionnaire to find out

students' responses to the products being developed (Sugiyono, 2018).

Data analysis techniques used by researchers include: 1) product validity analysis (material, media, and language); 2) product practicality analysis (student response questionnaire); 3) data analysis test. To calculate the average score obtained at the expert evaluation stage, students' response questionnaires, and the average students' score during the pretest and post-test using equation 1:

$$validation\ value = \frac{total\ score\ obtained}{total\ highest\ score} \times 100\% \quad 1)$$

(Julial et al., 2014)

Table 1. Validity Criteria

Validity Value (%)	Criteria
90-100	Very valid
80-89	Valid
60-79	Fairly Valid
0-59	Invalid

To calculate the average score obtained from stage one to one, and small groups, equation 2 is used:

$$validation\ value = \frac{total\ score\ obtained}{total\ highest\ score} \times 100\% \quad 2)$$

(Julial et al., 2014)

Table 2. Practicality Criteria

Practicality Score (%)	Practicality Criteria
86-100	Very practical
76-85	Practical
60-75	Practical enough
55-59	Not practical enough
54	Not practical

At the field test stage, field trials were carried out in class X IPA using the post-test and pretest. The results of the field test trial phase are to determine the potential influence on students' problem solving abilities with equations

$$Average = \frac{number\ of\ values}{a\ lot\ of\ data} \quad 3)$$

III. RESULTS AND DISCUSSION

A. Analysis Stage (*Analysis*)

At this stage there are several analyzes carried out in the development of learning modules, namely analysis of students' characteristics, analysis of curriculum and analysis of student needs.

a. Needs analysis

This needs analysis involves material analysis, syllabus and software development in learning. In the needs analysis stage, the researcher conducted interviews with the physics teachers and then analyzed the learning objectives based on the curriculum. In determining the material the researcher obtained information from the physics subject teachers that students who had difficulties in understanding the momentum material starting from the introduction in real life, solving problems on the momentum material, and students' lack of interest in the momentum material.

b. Curriculum Analysis

The analysis is made using the 2013 curriculum. The researcher determined the core competencies, basic competencies, competency achievement indicators and learning objectives according to the material used.

c. Characteristics analysis

At this stage the researcher sought information by conducting interviews with teachers and students at SMA Negeri 3 Sungai Lilin. Based on the results of interviews conducted with the teachers, the physics learning system at SMA Negeri Sungai Lilin 3 was good, and each student also had advantages and disadvantages in the learning process. Teachers prefer a learning system as in general using makeshift media, sometimes only using textbooks provided from schools and homework assignments is an alternative so students can practice solving problems more often. Nevertheless, in the learning process, the use of Physics learning media is still lacking. As a result, the learning process is less interesting and tends to be monotonous or boring. Moreover, the teacher never tried to develop digital media as a learning medium.

Furthermore, the interview conducted with several students of class X IPA SMA Negeri 3 Sungai Lilin revealed that there were still many students who had difficulty solving problems in the physics material that had been taught. In addition, the learning looks boring and the learning media used is less attractive. This might be the cause of students' lack of understanding of the physics material presented. From this stage, the researchers can identify that students need learning media that can help them in the learning process to make it more interesting and not boring. In this development research the researcher chose to develop a module product because it can make it easier for students to learn, so this development product is useful for overcoming educator problems.

B. Stage of Planning *(Design)*

Some of the components compiled at this stage are:

a. Arranging the module components

Several components are arranged in the module: title, preface, instructions for use, basic competence, core competence, indicators, learning objectives, concept maps, materials and evaluation.

b. Compiling the Materials

In compiling the material the things that need to be done are:

1. Determining the title of the module to be developed
2. Collecting the contents of the module obtained from several sources as references such as school textbooks, the internet, journals and other sources.
3. Making a concept map that is developed, namely the momentum material and its discussion.

Then the process of preparing this product was carried out by media experts, linguists, material experts, student response questionnaires and test questions. This arrangement adjusts to the product to be developed.

C. Development Stage (*Development*)

P*roblem solving* using momentum material. This module contains instructions or steps for solving problems in momentum

material using *tracker software* that makes students interested and want to learn it. The module product design is made with an attractive appearance and the language used is very easy for students to understand. The contents of the module are in accordance with basic competence, core competence, indicators, learning objectives, syllabus based on the 2013 curriculum, materials, learning objectives, sample questions, and practice questions. Based on the results obtained from the module development, the design results can be seen in the image below:

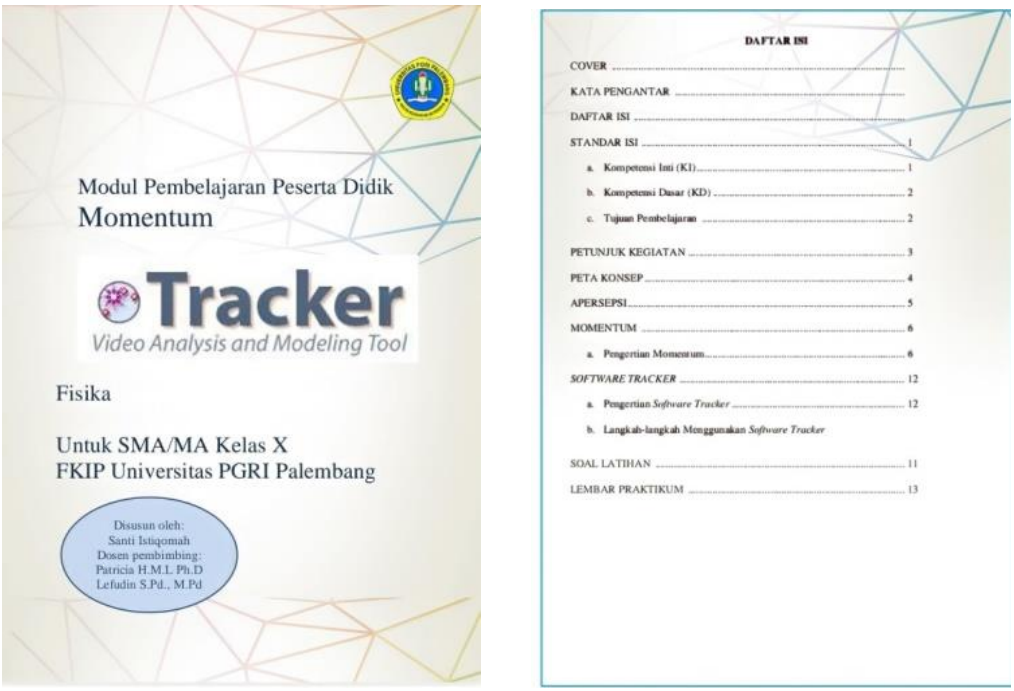

Figure 1. Display *of the Problem Solving Based Module*

a. Self Evaluation

In self-evaluation, the researchers conducted an independent assessment of the modules developed prior to expert trials. Based on the results of self-evaluation and guidance from the supervisor, the module is ready to be validated by experts.

b. Expert Validation

Through validation from experts, the validity of the module can be known based on the assessment of the validators, experts in language, media and materials. Validation results from the experts for the third aspect can be seen in table 3.

Table 3. Average Expert Validation Value

Rated aspect	Average Validator Assessment Results	Category
Theory	91.11111	Very valid
Media	93.3333	Very valid
Language	81.1111	Valid
Category	88.52	Valid

Based on table 3, it is known that the average value of the language, media and material is 88.52% or in the Valid category.

D. Implementation Stage *(Implementation)*

a. Individual test (*one-to-one*)

This individual test was given to 3 students. Researchers explained the introduction of learning media products in the form of learning modules. Students were asked to study and understood the modules provided by researchers. After the students studied and understood the module, the researcher gave a questionnaire to students to do an assessment of the product being developed or a practicality test. The following are the results of the students' response questionnaire analysis.

Table 4. One-to-One Trial Stage

Indicator	Score			Percentage	Category
	Student I	Student II	Student III		
The order of sentences must match the EYD	5	5	5	100	Very practical
Use simple and easy-to-understand sentences	5	4	4	86.66667	Very practical
The sentences used are effective	4	5	3	80	Practical
Correct use of punctuation	4	5	5	93.33333	Very practical
The definitions and examples of questions are quite clear and easy to understand	4	4	4	80	Practical
The definition and steps of the tracker software are easy to understand	3	3	5	73.33333	Practical
The condition of the pictures, colors and backgrounds are interesting	4	5	4	86.66667	Very practical
The explanation of the material is short, concise, and clear so that it is easy to understand	3	4	5	80	Practical
Can help in troubleshooting	4	4	4	80	Practical
Average				**84.44444**	**Practical**

Based on the results of the table above, it can be seen that the validity of the *module based on problem solving* assisted by *software tracker* to improve the problem solving abilities of high school students has an average value of 84.44%. This value is included in the practical category.

b. Small Group Test (*Small Group*)

In a small group trial, 10 students were randomly selected. Researchers explained the introduction of learning media products in the form of learning modules. Students were asked to study and understand the modules provided by researchers. After students studied and understood the module, the researcher gave a questionnaire to students to do an assessment of the product being developed or a practicality test. Following are the results of the questionnaire analysis of student responses to the developed module.

Table 5. Small Groups Trial Stage

Statement	Score										%	Category
	1	2	3	4	5	6	7	8	9	10		
The order of sentences must match the EYD	4	5	5	5	5	5	5	5	4	5	96	Very practical
Use simple and easy-to-understand sentences	5	4	4	4	5	5	4	4	5	4	88	Very practical
The sentences used are effective	4	5	4	4	5	5	4	5	5	5	92	Very practical
Correct use of punctuation	5	5	4	4	5	5	4	4	5	4	90	Very practical
The definitions and examples of questions are quite clear and easy to understand	4	5	3	5	4	5	4	3	5	4	84	Practical
The steps of the tracker software are easy to understand	4	3	4	3	3	5	4	5	4	4	78	Practical
The condition of the pictures, colors and backgrounds are interesting	4	4	4	4	5	4	4	4	5	5	86	Very practical
The explanation of the material is short, concise, and clear so that it is easy to understand	5	4	5	4	4	4	5	4	3	5	86	Very practical
Can help in troubleshooting	4	5	4	5	4	4	5	5	5	4	90	Very practical
Average											**87.77778**	**Practical**

Based on the results of the table data above, it can be seen that the average value obtained is 87.77778%. It means that the developed module is included in the practical category. Modules are arranged based on core competencies and basic competencies as well as problem solving abilities (Hudha et al., 2017) . It can be seen that the results of the average score indicate that students are able to understand the material well after learning using the module. This shows that the readability level of the module is very good in terms of content, language, quality of presentation and graphics (Hudha et al., 2017).

E. Evaluation Stage

At the evaluation stage, a field test was carried out to see the practicality of using the developed module. The field test phase was carried out in 1 meeting. To measure students' problem solving abilities the researcher gave practice questions to students. Researchers used the post test and pretest to fill in data on students' problem solving abilities. Following are the results of the analysis of problem-solving abilities at the field test stage.

Table 6. Results of Post-Test and Pretest Analysis

Pretest Average	Post-Test Average
50.4594	83.9063

Based on the table above, it can be seen that each student experienced an increase in learning outcomes and problem solving skills. There were several students who got the highest score. The average pretest score is 50.4594 and the average a post-test score is 83.9063.

From the results of the data obtained by the researchers, it can be seen that *the problem-solving-based learning module* assisted by *tracker software* to improve problem-solving skills in SMA that was developed is stated to be valid, practical and effective. The evaluation phase using Tessmer's formative evaluation consists of five stages, namely *self-evaluation, expert review, one-to-one,* and *small group* . After receiving advice and approval from the supervising lecturers, the researcher carried out the next stage.

After being revised according to the suggestions and input of the supervisor, the product is then validated by material, media, and language experts to determine the level of feasibility and validity of the module. The three validators provide an assessment of the product being developed. The average value obtained from the three aspects are 91.11% for material aspects, 93.3333% for media aspects, and 81.111% for language aspects. This means that the developed module has been assessed by the validators and declared valid and feasible to be tested. Data validity categories are supported by modified validity levels (Julyal et al., 2014).

In the *one-to-one* and *small group* stages, students filled out a response questionnaire given by the researcher. From the results of the questionnaire, it can be known that in *the one-to-one stage, the average value* 84.44%

and in the *small group stage it is* 87.778%. This means that the modules that have been assessed by students meet the "Practical" category. The practical category is supported by the practicality level of the modification (Julial et al., 2014).

Furthermore, the trial was carried out on class X IPA students at SMA Negeri 3 Sungai Lilin which was carried out by 32 students. This stage is carried out to find out whether the product produced has practicality and potential effects for students. At this field test stage, the researcher assessed the results of increasing problem-solving abilities in students before (*pretest)* and after using the module *(post-test*). The average pretest score is 44.2563, while the *post-test average score i*s 83.9063.

The worksheets product based on *problem solving* assisted by *tracker software* are found to be valid, practical, and effective in increasing problem solving skills (Risa et al., 2021). This can be seen from the results of the validator's assessment, namely 90% in the material aspects, 87% language aspects, and 91% learning design aspects. Students' responses to students' worksheets obtained results in the agree category, so that it can be stated that students' worksheets is suitable for use in the Physics learning process. Then the equation of the previous research with this research is that both are based on *problem solving* and together they improve the students' problem solving skills.

Based on the explanation above, the conclusions that can be drawn are validity and practicality to determine whether or not a product is developed so that it can be used more widely or until the deployment stage (Deti et al., 2021).

In line with this, (Gitnita et al., 2018) states that the validation of teaching materials is determined to determine the quality of teaching materials in relation to measuring what should be measured. In addition to the validity of the practicality of the product is also used to determine the feasibility of a product. Practicality is the level of usability and implementation of teaching materials that have been revised based on the validators' assessment.

From the results of the research conducted, the researchers concluded that *the problem-solving-based development module* assisted by *tracker software* to improve students' problem-solving skills in high school is valid, practical, and effective to improve the students' problem-solving skills in high school. Therefore, problem solving-based development modules assisted by *tracker software* are appropriate for use in the learning process.

IV. CONCLUSION AND SUGGESTION

Problem solving-based learning modules assisted by *tracker software* to improve high school students' problem solving skills were declared valid according to the assessment of

experts who were assessed from several aspects. Problem solving based learning modules assisted by *tracker software* to improve students' problem solving skills in high schools. Based on the students' responses in one-to-one and small group students' questionnaire, the module products are very practical to use. In addition, the Problem solving-based learning modules assisted by *tracker software* is effective to increase the students' problem-solving skills.

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