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THE MODERN PHYSICS PRACTICUM MODULE IS EQUIPPED WITH VIDEOS TO TRAIN HOTS

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Abstrak

The challenges of the Industrial Revolution 4.0 can be faced by improving the quality of education. One of them is by increasing Higher Order Thinking Skills (HOTS) in learning that can be trained in practicum activities. This study aims to produce a practicum module that is equipped with a practicum video with the stages of HOTS training. This development research uses the Dick and Carey Model which is limited to the ninth stage. The research was assessed using a feasibility instrument that included the content, use of language, practicum module components, graphical aspects, ease of use, technical requirements, didactic requirements, and implementation of the HOTS process. So material experts, media experts, and learning experts stated that the modern physics practicum module on the photoelectric effect and property material is suitable for training students' HOTS stages.

Kata-kata kunci: Modern Physics, Practicum Module, HOTS, Photoelectric Effect, Millikan, Planck's Constant.

Abstract

Tantangan Revolusi Industri 4.0 dapat dihadapi dengan meningkatkan kualitas pendidikan. Salah satunya dengan meningkatkan Higher Order Thinking Skills (HOTS) dalam pembelajaran yang dapat dilatih dalam kegiatan praktikum. Penelitian ini bertujuan untuk menghasilkan Modul praktikum yang dilengkapi video praktikum dengan tahapan melatih HOTS. Penelitian pengembangan ini menggunakan Model Dick and Carey yang dibatasi hanya sampai pada tahap kesembilan. Penelitian dinilai menggunakan instrumen kelayakan yang mencakup penyajian materi, penggunaan bahasa, komponen modul praktikum, aspek kegrafikan, kemudahan penggunaan, syarat teknis, syarat didaktik, dan keterlaksanaan proses HOTS. Sehingga ahli materi, ahli media dan ahli pembelajaran menyatakan modul praktikum fisika modern pada materi efek fotolistrik dan milikan layak digunakan untuk melatih tahapan HOTS mahasiswa.

Keywords: Fisika Modern, Modul Praktikum, HOTS, Efek Fotolistrik, Millikan, Konstanta Planck.

PENDAHULUAN

The Industrial Revolution 4.0 is built on top of the Digital Revolution where technology and humans are interconnected [1, 2]. The challenges of the Industrial Revolution 4.0 can be faced by a country, one of which is by improving the quality of education [3]. Efforts that can be made to improve the quality of education are to increase Higher Order Thinking Skills (HOTS) in learning [4]. HOTS or higher-order thinking skills are a combination of critical and creative thinking skills. The context of critical thinking is that individuals are able to think about something in depth (deep

learning). Meanwhile, creative thinking is assumed to think out of the box [5]. HOTS that can be developed in learning include critical, analytical, problem-solving, and creative thinking skills in the learning process [6, 7]. One of the efforts to increase HOTS can be made through practical activities [8]. Practicum can familiarize students with practicing higher-order thinking skills and forming new knowledge [9]. Practicum is also carried out for the development, knowledge, and skills [10].

Modern physics practicum has several weaknesses, including complex practicum tools that make it difficult for students to implement their knowledge to determine the characteristics of each component of the tool [11]. n practicum activities, a practicum module is needed as a guide so that activities can run according to the procedure [12]. The practicum module contains procedures for preparation, implementation, data analysis, and reporting [13]. The practicum module used needs to be based on high order thinking skills to achieve practicum success [14]. The practicum module developed must contain components such as (1) an Introduction that contains the practicum title, motivation sheet, preface, and table of contents; (2) Content contains chapters, core competencies, basic competencies, and indicators, concept maps, core material/basic theory, exercises (discussions, and final tests); and (3) Conclusion which consists of answer keys, bibliography, and author profiles [15].

Based on the results of interviews conducted with physics education students class of 2021 in January 2023, it was found that trying it directly (practicum) could improve their theoretical understanding of Modern Physics courses. However, during its implementation, students find it difficult to assemble tools, process and analyze practicum data. Even though modern physics practicum is now equipped with practical modules. Students admit that it is difficult to understand the contents of the practicum module which only contains guidelines in the form of text, without pictures and/or videos as further directions in explaining work steps so they do not understand which parts must be operated.

So, based on the problems above, to achieve the objectives of learning physics in practicum activities, skills and supporting media are needed as learning facilities. Learning media is an important tool because, from an educational perspective, media is a very strategic instrument for determining the success of the teaching and learning process.

METODOLOGI

The model developed by Dick & Carey is the most widely used educational research and development model suggested by Borg & Gall in their book Education Research [16]. This model is also a complete development model because it has a complete sequence of steps in the procedure arranged systematically and clearly. This study aims to provide solutions to the problems encountered in the physics practicum process at universities through a practicum module equipped with video as a supporting medium. The method used in this study is Research and Development with the Dick & Carey stages which are limited to 9 stages. The steps taken are [17]:

1. Assess Needs to Identify Goal(s);
   This learning objective was prepared based on Peraturan Menteri Pendidikan Nomor 73 Tahun 2013 about Pedoman Capaian Pembelajaran (CP) for graduates of study programs in tertiary institutions, and CPL for Study Programs which are charged to the Practicum Physics course.
2. Conduct Instructional Analysis;
   Conduct learning analysis by referring to modern physics material from several references such as Modern Physics for Scientists and Engineers by Thornton et al, Modern Physics For Scientists and Engineers by John R, Taylor et al, Modern Physics 3rd Edition by Raymond A. Serway et al, Handbook of Physics by Walter Benenson et al, and Modern Physics by Kenneth Krane. Then determine the topic of the practicum that will be carried out.
3. Analyze Learners and Contexts (Menganalisis Peserta Didik dan Konteks;);
   Analysis of students and context, where the results of the analysis will be used as a guide in designing learning strategies.
4. Write Performance Objectives;

Write down learning objectives, especially in the form of practicum objectives that must be mastered after doing modern physics practicum.

5. Develop Assessment Instruments;
   Develop an assessment instrument that measures students' higher-order thinking skills (HOTS) after carrying out practicum activities with practicum tools.
6. Develop Instructional Strategy;
   Perfecting modern physics learning strategies with HOTS training stages which will be presented in the practicum module complete with practicum videos.
7. Develop and Select Instructional Materials;
   Developing a modern physics practicum module with HOTS training stages which will be presented in a practicum module complete with a practicum video.
8. Design and Conduct The Formative Evaluation Of Instruction; and
9. Designing and developing a feasibility test instrument for modern physics practicum modules. The feasibility tests were carried out such as material expert tests, media experts and learning experts.
10. Revise Instruction;
    Make revisions based on the results of the feasibility test obtained, so that it will produce books that can be used as practicum support tools in modern physics practicums.

Research Instruments

The instruments compiled and developed consisted of media expert test instruments, material expert tests, learning expert tests, and limited product trials by students.

1. Material Expert Instrument
   In this instrument, the aspects discussed include the presentation of material and the use of language.
2. Instruments of Media Experts
   In this instrument, the aspects discussed include practicum module components, graphical aspects, ease of use, and technical requirements.
3. Learning Expert Instrument
   In this instrument, the aspects discussed include didactic requirements and process implementation.

Statistical Analysis

Data analysis techniques from the results of due diligence by material experts, media experts, and learning experts use a scale of 1-4 to get the feasibility results of the practicum module with the HOTS stages which have four categories, namely assessment based on interpretation criteria. The interpretation value obtained is calculated based on the acquisition value of each item, with the following equation.

$$Interpretation\ Value = \frac{\sum Acquisition\ score}{\sum Maximal\ score} \quad (1)$$

This study uses a scale ranging from 1 to 4 so that the maximum score is 4 and the minimum score is 1. And the total capacity score is 4, so it can be calculated using.

$$Score\ Range = \frac{maximal\ score - minimal\ score}{score\ capacity} \quad (2)$$

$$SR = \frac{4-1}{4} = \frac{3}{4} = 0{,}75 \quad (3)$$

Then the eligibility criteria are obtained with a difference of 0.75 with a very low interpretation of 1.00 and the highest interpretation of 4.00. As seen in the following table.

TABLE 1 Eligibility Interpretation Criteria [18]

Scale	Score Interpretation Percentage	Interpretation
1,00 < IS < 1,75	25% < SI < 43,75%	Very Not Feasible
1,75 < IS< 2,50	43,75% < SI < 62,50%	Not Feasible
2,50 < IS< 3,25	62,50% < SI < 81,25%	Feasible
3,25 < IS< 4,00	81,25% < SI < 100%	Very Feasible

HASIL DAN PEMBAHASAN

This research produces a modern physics printed module product that is equipped with a video to train the HOTS stages. Products developed using Ms. software. Word, Canva, kinemaster, and AI Generator.

Practicum Module Content

This module contains photoelectric effect practicum and proprietary practicum with sub-materials covering the concept of proprietary drops, proprietary drip experiments, processing and calculation of data using the theory of deviance, Thomson's experimental concept, Thomson's experimental experiments, processing and calculating data using the least-square method.

The Resulting Product

The product produced is a modern physics practicum module with stages that train higher-order thinking skills (HOTS). The practicum module has preliminary activities, core practicum activities, and post-practicum activities, namely the activities of students building their own concepts in the high-level cognitive domain.

Preliminary Activities

In the preliminary stage, the module will develop steps that students must take before carrying out the practicum. This step in the module will present learning outcomes that must be mastered by students, practicum objectives to be achieved, and brief material about the concepts to be studied. From this data, it is hoped that students will have initial abilities before the practicum is carried out (FIGURE 1).

(a) (b) (c) (d)

(e) (f)

FIGURE 1 Display of Preliminary Activities in the Practicum Module (a) Cover (b) Preface (c) Table of contents (d) Rules of Procedure (e) Practicum Objectives (f) Basic Theory

Practicum Activities.

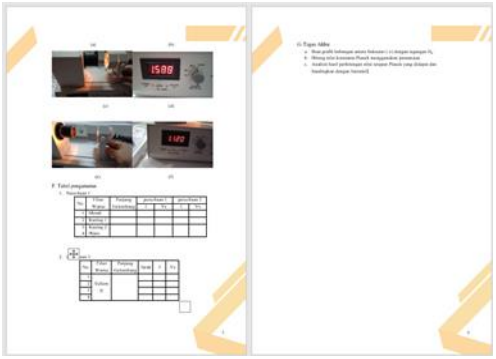
At this stage, the practicum steps that will be carried out by students will be presented, and the basic tables will be used. Analytical abilities, critical thinking skills, and students' creativity begin to be trained in this step. Students not only record observational data in tables but also have to modify the data as necessary so that it can be used in compiling concepts that will be built by students in accordance with the Learning Outcomes to be achieved (FIGURE 2).

(a) (b)

FIGURE 2 Display of Practicum Activities in the Practicum Module (a) tools and QR Code introduction to practicum tools, (b) Experimental Steps

Post Practicum

At this stage, students are directed to turn table data into meaningful graphs and interpret the graphs to get physics concepts that must be mastered and formulate these concepts in mathematical equations. This stage further fosters students' analytical, evaluation, and creative abilities in interpreting data obtained from observations of physical phenomena. This step is the essence of developing students' higher-order thinking skills.



(a) (b)

FIGURE 3 Display of Post Practicum Activities in the Practicum Module (a) Observation Table (b) Final questions

Feasibility Test Results

The practicum module product developed has carried out material feasibility tests, media feasibility tests, and learning expert feasibility tests. The results of the material feasibility test are presented in TABLE 1 below. From the data presented, the practicum module is said to be suitable for use in terms of content.

TABLE 2 Material Expert Feasibility test results

Aspect	Percentage	Results
Content	70%	Feasible
Language	81%	Feasible
Rating Average	75.5%	Feasible

The results of the media feasibility test are presented in TABLE 3 below. From the data presented, in terms of media, the practicum module is said to be suitable for use.

TABLE 3 Media Expert Feasibility test results

Aspect	Percentage	Results
Practicum Module Components	80%	Feasible
Graphic Aspects	75%	Feasible
Ease to Use	81%	Feasible
Technical Requirements	77%	Feasible
Rating Average	78.3%	Feasible

The results of the learning expert feasibility test are presented in TABLE 4 below. From the data presented, in terms of media, the practicum module is said to be suitable for use.

TABLE 4 Learning Expert feasibility test

Aspect	Percentage	Results
Didactic Terms	75%	Feasible
HOTS process implementation	70%	Feasible
Rating Average	72.5 %	Feasible

Discussion

In the post-practicum stage, several supporting HOTS skills are formed. Students are trained to change table data into graphs that see the effect of the independent variables on the dependent variable. Critical thinking skills and logical thinking are key at this stage. Practical data analysis to find the dependent variable and interpret the graphs is the key to both the experimental investigation phase and the grouping of data to compare relationships between variables. Here formed the stages of inductive thinking and deductive thinking to be able to do system analysis. At its peak, students are trained to be able to build physics concepts that are learned based on the relationship between data and facts found in practicum activities.

The video that is on the QR code in the practicum module strongly supports the implementation of practicum activities, namely observing, and observing activities are one of the HOTS criteria. QR Code which contains sources of information in the form of pictures and videos of practicum instructions can train student independence. Students can still carry out practical activities independently without the help of laboratory assistants. Based on all the stages designed in the practicum module, students will be trained in HOTS through practicum activities. The results of the Feasibility test results conducted by material experts, media experts, and learning experts with scores of 75.5%, 78.3%, and 72.5% with an average score of 75%. These results can be interpreted that the video-assisted modern physics practicum module being in the feasible category. These results indicate that the video-assisted Modern Physics practicum module to train HOTS students in educational glasses is considered good and feasible to use.

SIMPULAN

This research has produced a video-assisted Modern Physics practicum module with HOTS stages. The level of Higher Order Thinking Skills in the Basic Physics Practicum in this study consisted of eleven criteria which were divided into three stages, namely the preliminary stage, the practicum stage, and the post-practicum stage. The use of the QR Code in the practicum module can train students' independence to observe which is one of the HOTS criteria.

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