



Development of Oil Drops Practicum Guide Possession with Liquid Glycerol as Source of Oil Granules

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Abstract: This study aimed to develop a printed practicum guide for the Millikan oil drop experiment using glycerol liquid as a source of oil droplets and to determine its feasibility based on expert validation and student perceptions. The study employed a Research and Development (R&D) approach using the 4-D development model proposed by Thiagarajan, consisting of the define, design, develop, and disseminate stages. The research was conducted with 35 Physics Education students of the Faculty of Teacher Training and Education, University of Jambi, who were enrolled in the Physics Experiment course. Data were collected through observation, interviews, validation questionnaires, and student response questionnaires. The developed practicum guide was evaluated by material and media experts using a four-point Likert scale. The material validation results showed an average score of 3.8 with a feasibility percentage of 95%, indicating a very good category. The media validation results obtained an average score of 3.5 with a feasibility percentage of 88.3%, also categorized as very good. Furthermore, student perception data showed an average score of 3.51 with a percentage of 87.96%, indicating that the practicum guide was highly accepted and considered useful for supporting independent learning. These findings demonstrate that the developed practicum guide is valid, practical, and feasible to be used as a learning resource in physics experiment courses, particularly for the Millikan oil drop experiment using glycerol liquid.

Keywords: Practicum Guide; Millikan Oil Drop; Glycerol; Physics Education; 4-D Model

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Introduction

Physics learning is an educational process that aims to master and apply the concepts and laws of physics in daily life. This process emphasizes the active involvement of students in interacting with real objects (Koes, 2003). A distinctive feature of physics learning is the use of scientific methods, such as those carried out by scientists to understand processes, meanings, and relationships that focus on scientific products and attitudes (Wicaksono et al., 2017). One of the important materials in the physics experiment course is the Millikan oil drop practicum (Pratiwi et al., 2022). Physics learning is generally carried out directly with the support of

practicums. Practicum gives students the opportunity to observe, analyze, and deduce a phenomenon independently. In order for the implementation to be efficient, practicum guides are needed (Asif et al., 2018). This guide provides systematic guidance that helps students understand and execute experiments effectively. Therefore, the development of practicum guides is important to improve understanding, reduce errors, and support better learning outcomes.

The practicum guide aims to provide structured and clear guidance so that students are able to understand and carry out experiments or practical activities effectively. The development of this guide is

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very necessary because its existence helps students understand instructions, minimize errors, and improve learning outcomes. Practicum guides can be presented in various formats, both digital and printed (Alexander, A., Rahayu, H. M., & Kurniawan, A. D. 2018). Guides in printed form are physical teaching materials printed on paper, containing steps, materials, and instructions used by students during practicum activities. This print format supports self-paced learning because it does not require electronic devices or internet connections, reducing distractions from digital media. Therefore, printed guides are an effective alternative, especially in environments with technological limitations (Astro, R. B., Doa, H., & Meke, K. D. P. 2021).

In the physics experiment course, practicum guides are very important, especially in the implementation of the Proprietary Oil Drops practicum, which is one of the mandatory materials. The oil drop experiment conducted by Robert A. Millikan, known as the oil drop experiment, aimed to determine the basic charge value of an electron. In this experiment, Millikan sprayed a drop of glycerol oil into the space between the two conductor plates and observed its movement using a microscope. The working principle of this experiment involves a balance between the electric force and the gravitational force acting on the small oil droplets.

In this practicum, the material used is glycerol because of its high viscosity, which slows down the movement of droplets so that it is easier to observe and measure the speed of the rise and fall of droplets due to electric fields. In addition, glycerol has a low vapor pressure, so it is not easily volatile during the practicum (Ilamsyah, I., Rahayu, S., & Lisnawati, D. 2020). The implementation of this practicum really needs a practicum guide. This was strengthened by the results of an interview with the lecturer in charge of the physics experiment course, who stated that the practicum guide helps students in understanding the material independently because of its structured presentation.

The development of practicum guides is also supported by the results of the distribution of needs questionnaires that have been distributed to 35 physics education students in 2022. In addition to students' interest in trying, the Proprietary Oil Drops Practicum Guide with Glycerol Liquid is also very helpful in making it easier for lecturers to support students' independent learning through the use of the guide. The practicum guide itself is an educational document that serves as a reference in the implementation of laboratory activities, with the aim of helping to achieve maximum practicum results in the learning process (Jelita et al., 2021).

A practicum guide is a guide or instructions used to guide students in carrying out practicum activities. In order for the practicum to run perfectly, a practicum

guide is needed that is easy and clear to understand. The science process skills possessed by students can be developed through practicum that uses practicum guides (Darmajiet al., 2019). Practicum is one of the learning strategies that can attract students' interest in developing concepts, because practicum can provide direct experience to students to observe a phenomenon that occurs in such a way so that students can better understand the concepts taught (Dwi Sartikasari et al., 2021).

To achieve learning competencies in practicum, students must have science process skills, such as formulating hypotheses, formulating problems, defining variable operations, identifying variables and analyzing data, and drawing conclusions (Misbah, Wati, Rif'at, & Prastika, 2018). A practicum guidebook is a book that is compiled to assist the implementation of a practicum that contains the title of the experiment, objectives, theoretical basis, tools and materials, and questions that lead to the goal by following the rules of scientific writing. The practicum guide is a guide written with the aim that students can learn independently without the help of lecturers and lecturer assistants (Siahaan et al., 2019).

The term "practicum" refers to a type of Laboratory activity that allows students to gain real-world experience in which they can apply their scientific skills and attitudes. The benefits of practicums include that they can help students achieve the highest levels of their lessons, build better scientific work habits, and provide feedback to teachers on how to create more engaging and diverse learning plans (Mila Putri et al., 2018). The benefits of practicum include increasing interest in learning, developing basic experimental skills, and becoming a means of supporting subject matter (Rochmad, 2012).

The practicum guide includes (1) Rational, which will help students learn a particular chapter. (2) Objectives, which show the abilities that students will have after the practicum is completed. (3) Instruction, which gives direction to students. This directive should include whether students can work individually or work together in small groups (3-5 people) during the practicum. The assessment criteria are also listed in this section. (4) Theoretical description, providing a brief explanation of the theory underlying the practicum carried out by the students. (5) Steps of the activity, which can be carried out with or without the help of pictures. The steps are made thoroughly so that students can carry out practicum quickly and appropriately (S. Arlis, Amerta, S., Indrawati, T., Hendri, S., Fauziah et al, 2020).

Method

This research applies research and development methods. The steps in creating this learning guide follow the 4-D (four-D) model, which is based on product development steps. This 4-D research and development model is more comprehensive and rational, and can be applied to various types of product development, such as models, strategies, learning, media, and teaching materials. The development procedure in this R&D research uses a 4-D approach.

The development model used as a reference in this study is the Thiagarajan model. The Thiagarajan model, known as the 4-D development model, consists of four stages: define, design, develop, and disseminate (Thiagarajan et al., 1974). This 4-D development model was chosen in this research and development because it aims to produce a product in the form of a practicum guide. The practicum guide developed is then validated by expert lecturers and tested on students to determine the improvement of concept understanding and students' response to the practicum guide that has been developed.

The pilot development trial was carried out on 35 physics education students of FKIP University of Jambi class of 2022 who took physics experiment lectures. The sampling technique used, namely purposive samples, was used. According to Taherdoost (2016) explained that purposive means that each population is selected based on criteria that have been set by the researcher by considering certain factors. How the research is conducted and the data will be obtained, needs to be outlined in this section.

Result and Discussion

The results of the research began with observations made at the physics fkip laboratory of the University of Jambi, it was obtained that there was a proprietary oil drip practicum tool but a practicum guide was not yet available. Practicum guides are indispensable in carrying out practicum activities. This fact is strengthened by interview data conducted with one of the lecturers who teaches the physics experiment course which states that the existence of a practicum guide is very helpful for students to learn independently about the material of Proprietary oil drops.

This is because the guide has a structured structure. Based on research conducted by Suprihatiningrum (2016), practicum guides based on Science Process Skills are proven to improve problem-solving skills, so that students can achieve the desired concepts in learning achievement (Hendriyani, W., Hasnunidah, N., & Yolida, B., 2020). This stage in development follows the 4-D model, which consists of four formative processes: defining, designing, developing, and disseminating (Elzsa, S., Ai Teti, S.,

Purnama, S., & Solehayati, R. 2018). The first stage carried out in this study is the defining stage, which includes the distribution of initial observation questionnaires to students. Next, the design stage is carried out, which includes designing models or learning methods. This stage is similar to teaching and learning activity planning, which is a systematic process starting from determining learning objectives, designing teaching and learning activities, planning learning tools, to preparing learning materials.

The next stage is development, which can be seen from the results of validation by media experts and material experts, as well as assessments based on the perceptions of physics education students of the 2022 batch. Two validators, namely material experts and media experts, validated the practicum guide by filling out the assessment statement and suggestions on the validation questionnaire. The questionnaire validation material consists of 10 questions covering 3 assessment indicators, while the media validation questionnaire contains 15 questions from 3 assessment indicators. Ratings by subject matter experts and media members are explained using the Likert scale. According to Suwandi (2016), the Likert scale is used to measure the attitudes, opinions, and perceptions of individuals or groups towards social phenomena.

With this scale, the measured variables are described into indicators. The Likert scale instrument used has 4 categories, from very negative to very positive, with a rating: 1 point for strongly disagree (STS), 2 points for disagree (TS), 3 points for agree (S), and 4 points for strongly agree (SS). In Nengsi (2016), the validity of a product is assessed based on the validity of the content and the validity of the construction, while the criteria for the practicality of the product are measured by its implementation, and the effectiveness of the product is seen from its benefits in accordance with its function (Lawhon, D. 1976).

The results of initial observations made on students through the dissemination of Google Form links showed that 86.1% of students stated that they needed practicum guidance to support the learning process. After initial observation, the next stage is the collection of data that will be used as a basis for making practicum guidelines. After all the initial data has been successfully collected, the next stage is the design process, where the results of observation and analysis begin to be poured into a guide structure that is systematically designed according to the format of the practicum guide by creating a storyboard. Furthermore, the series in the storyboard is designed using Canva by setting the layout, arranging design elements, adjusting the use of language, and composing the text.



Figure 1. Cover of the practicum guide



Figure 2. There is a preface

After the practicum guide is designed, it will be validated by media experts and material experts by Unja physics education lecturers. Validation of the material by expert validators was analyzed using a Likert scale with four categories of assessments: excellent, good, not good, and very poor. In phase I, the average material validation results reached a score of 3.3 or equivalent to a percentage of 82.5%, which was classified in the good category. After the validation of the first phase of material experts, several improvements were found, such as simplification of sentences and numbering in each formula equation.

Furthermore, the second stage of validation was carried out by material experts. The results of this validation show that the material prepared has met the eligibility criteria in terms of content, learning, and language, with an average score of 3.8 and an average

percentage of 95%, which is classified as very good. Thus, the material is worth testing at a later stage. The following are the results of the validation of material experts.

Table 1. The value of the validation results of the subject matter expert

Total	Presentation	Average
38	3,8	95%

Media validation by media experts in phase I was analyzed using a Likert scale with four levels of assessment: excellent, good, not good, and very poor, with an average percentage of 75% which is also included in the good category. Based on input and comments from experts, the practicum guidance media still needs a number of improvements, including revision of the practicum guide design, color replacement to make it more attractive, color variation in the cover image between the title and the author's name, and simplification of the language in the experimental procedure section to make it easier to understand. Based on the validation results, the media used has met the feasibility standards of various aspects, such as the display of screen design, ease of use, and benefits, with an average score of 3.5 which is classified as very good, as well as an average percentage of 88.3% which also indicates the very good category. Therefore, according to validator II's assessment, the media in the practicum guide is considered suitable for use without the need for additional revisions. The following are the results of the validation of media experts.

Table 2. The value of the validation results of the subject matter expert

Total	Presentation	Average
53	3,5	88,3%

After the validation process by media experts is completed, the researcher proceeds to the product development test stage in the form of a physics experiment practicum guide on Proprietary oil droplet material to calculate the source of oil granules.

Table 3. The value of the results of the dissemination of the perception questionnaire

Total	Presentation	Average
49,26	3,51	87,96%

This development test was carried out on students of the Physics Education study program class of 2022 at FKIP University of Jambi. The following is the value of the results of the distribution of student respondent questionnaires distributed through the google form link.

Based on the results of the distribution of the google form guide for the Proprietary drops practice, this is supported by an average score of 3.15 which is also included in the very good category, with an average percentage of 87.96%. These results show that the practicum guide of Physics Experiment and Proprietary Drops material to calculate the source of oil granules that have been developed can be used as additional teaching material in Physics Experiment lectures.

Conclusion

This research produced a product in the form of a printed practicum guide that includes material on Possession drops with glycerol liquid to calculate the source of oil granules. This practicum guide is designed using three stages of the 4D model, namely define, design, and development. The first stage (definition) consists of five steps, namely front-end analysis, student analysis, concept analysis, task analysis, and the formulation of learning objectives. The second stage (design) includes four steps, namely the preparation of test standards, media selection, format selection, and initial design. The third stage (development) consists of two steps, namely product validation and development trials. This practicum guide will be available in the Physics Education Laboratory (FKIP) for students to access. The practicum guide on oil drops with glycerol liquid to calculate the source of oil granules has gone through a validation process, where the media validation results reached 88.3% and the material validation results reached 85%. Based on the results of the validation, this practicum guide is categorized as "Very Feasible" to use.

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