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Problem-Based Learning Guidelines for Optimizing Science Process Skills

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ABSTRACT
Teachers should be able to stimulate students' science process skills or be able to stimulate students' creativity. This study aims to develop a practical work guideline for Basic Electronics I based on Problem-Based Learning (PBL) designed to improve the science process skills of physics education students. This study uses a 4D development model, but is limited to the Develop stage, with a focus on a systematic planning process and the development of valid and practical teaching materials. The research data consists of expert validation and student responses regarding the practicality of the developed product. The instruments used were an expert validation sheet and a student response questionnaire, both using a Likert scale of 1–4. Data were analyzed quantitatively by calculating the average score and percentage, then broken down into levels of validity and practicality. The results showed that the practical guidelines were assessed as "very valid" by material experts (85%) and media experts (86%). Student responses to the practicality questionnaire also showed "very practical" with a score of 88.7% and a positive response of 81.3%. These findings indicate that the PBL-based Basic Electronics I practicum guidelines, which include Kirchhoff's Current Law, Ohm's Law, and voltage dividers, are valid and practical, making them suitable for use as alternative teaching materials to support practicum activities and optimize students' science process skills. Further researchers are advised to add learning outcome evaluation instruments to determine the direct impact of PBL-based practicum guidelines on students' conceptual mastery and critical thinking skills.

Keywords: *Problem-Based Learning; Practicum Guidelines; Science Process Skill; Basic Electronics*

INTRODUCTION
Science process skills are highlighted as an integral part of the subject matter, meaning they are just as important as science concepts. Learning science emphasizes providing direct learning experiences that develop these skills, enabling prospective physics teachers to explore and understand natural phenomena (Hasyim, 2018). Learning physics also requires a process that stimulates students to learn through various everyday problems. This approach aligns with Problem-Based Learning, a learning model that uses a scientific approach. According to research by Wirda et al. (2017), applying Problem-Based Learning improves students' scientific process skills and motivation to learn. Learning activities are carried out well when there are supporting learning tools. These tools include practical guidelines that support learning activities and help students develop process skills (Fajarianingtyas & Hidayat, 2020). Fitriani's (2019) research shows the importance of a practical guidebook oriented toward problem solving. A practical guidebook that follows the steps of general problem-based learning can make practical activities run more smoothly and purposefully.

Based on the results of the observations, it appears that the Physics Education students at KH. Wahab Hasbullah University (UNWAHA) has not yet mastered the scientific process. During Basic Electronics practicums, they struggle to make observations, interpret observations and inferences, plan experiments, and apply concepts. This is supported by interviews with lecturers who teach the course, who say that Physics Education students lack mastery of science process skills when conducting Basic Electronics practicums. In order to develop these skills, lectures on the Basic Electronics practicum should cover material from the practicum instructions, such as Kirchhoff's current law, Ohm's law, and voltage dividers. In line with Dimyati and Mudjiono's (2002:140) research, process skills consist of basic and integrated skills. Basic skills consist of six skills: observing, classifying, predicting, measuring, concluding, and communicating. Integrated skills include identifying variables, tabulating data, presenting data graphically, describing relationships between variables, collecting and processing data, analyzing research, formulating hypotheses, defining variables operationally, and designing research or experiments.

METHOD

This study adapts Thiagarajan's (1974) 4D development model (Define, Design, Develop, Disseminate). However, this study only went as far as the "Develop" stage and did not continue to the "Disseminate" stage. The main focus of the research is the design and development of valid and usable PBL-based Basic Electronics practicum instructions, so the Disseminate stage was not included. Therefore, this study does not extensively discuss the dissemination stage, but rather emphasizes the systematic process of product development to create a final product ready for use in a learning context. The research procedure is described and illustrated below :

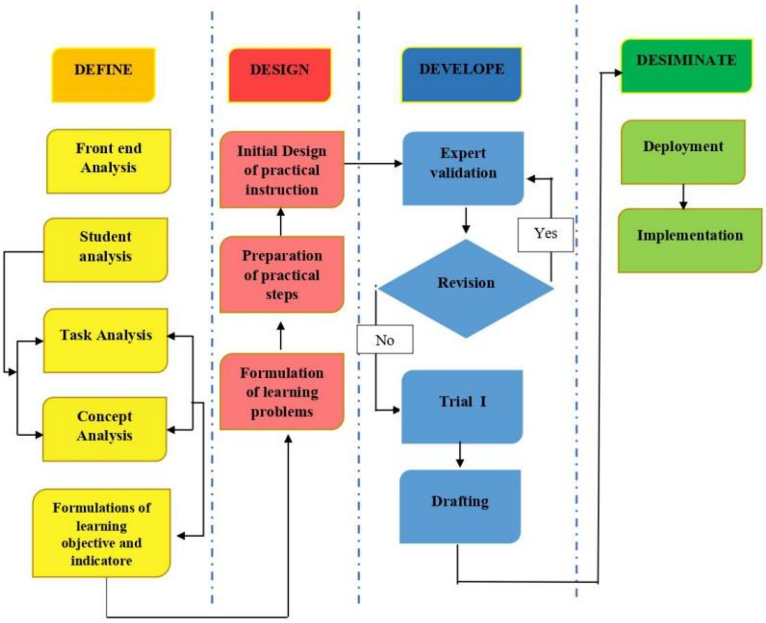

Figure 1 Development Flow of the 4D Model Adapted to This Study

In this research procedure, the defining stage begins with analyzing the needs and characteristics of students and determining the expected learning outcomes. This stage includes an initial analysis to identify learning development needs that can improve student motivation, participation, conceptual understanding, and thinking skills. Next, a student analysis is conducted, which includes academic abilities, learning experiences, and general characteristics of students. Next, a task analysis is used to examine the tasks that students must complete in the practicum to ensure their suitability with the learning outcomes. A concept analysis is also conducted to identify key concepts in the Basic Electronics I course, organize them systematically, and align them with learning needs. The entire series of analyses then ends with the formulation of learning objectives based on the learning outcomes in the Basic Electronics I practicum syllabus.

In the Design stage, the primary step is developing an instrument in the form of an observation sheet to measure the achievement of learning objectives. Furthermore, learning media appropriate to the PBL approach are selected, namely the Basic Electronics I practicum guidelines. The presentation format for the practicum material is also designed to suit student characteristics, making it easier to understand and applicable. As a final step, a PBL-based learning simulation was conducted using the initial product design to assess its feasibility and potential for implementation.

The Development stage is a development process involving expert appraisal by validators, consisting of expert lecturers. This assessment covers content design, material completeness, and the relationship between the lab content and electronics concepts. Furthermore, the validators assess the relevance of the lab problems to the concepts being studied. Based on the validators' input, revisions were made to the product to meet higher standards. Subsequently, a small-scale trial was conducted to obtain feedback and observe the effectiveness of the lab instructions in encouraging student engagement. The results of this trial served as the basis for further product revisions before its wider use.

The research data for this development phase consisted of two main types. First, validity data obtained from the validators' assessment of the suitability of the developed lab guidelines. Second, student response data obtained through a questionnaire following the small-scale trial served to assess the practicality of the lab guidelines. Thus, the collected data provided an overview of the product's quality in terms of both validity and practicality.

Data collection techniques were carried out using two main instruments. An expert validation sheet was used to evaluate the content, presentation, language, and suitability of the practicum guidelines for the PBL model. Meanwhile, a student response questionnaire was used to measure their perceptions of the product's practicality, including ease of use, clarity of instructions, and usefulness in practicum activities.

The research instruments used consisted of two forms. First, an expert validation sheet using a 1–4 Likert scale with categories ranging from very poor to very good. Second, a student response questionnaire also using a 1–4 Likert scale with categories ranging from very impractical to very practical. The use of this Likert scale facilitated quantitative data analysis and provided clear indicators of the quality of the product developed.

The data analysis technique was carried out in two stages. First, a product validity analysis involved calculating the average score from the validators for each aspect. The results of the analysis were then categorized according to specific criteria: 3.26–4.00 = very valid; 2.51–3.25 = valid; 1.76–2.50 = moderately valid; and 1.00–1.75 = less valid. Second, a practicality analysis was conducted based on student responses. The percentage results were calculated using a specific formula and then categorized as follows: 81–100% = very practical; 61–80% = practical; 41–60% = quite practical; and ≤40% = less practical. Through this analysis technique, the study clearly demonstrated the product's validity and practicality based on expert assessments and student responses.

RESULT AND DISCUSSION

Table 1 and Table 2 present the results of the validation of the PBL-based Basic Electronics I Practicum Guidelines for improving science process skills by subject matter experts and media experts.

Table 1 Shows The Subject Matter Expert Validation Results.

Aspect	Validity Score
Completeness of material	83
Depth and accuracy of material	79
Language	92
Presentation	88
Average	85
Category	Highly valid

Table 2 Validation Results by Media Experts

Aspect	Validity Score
Design	88
Visual quality	86
Typography	89
Problem-Based Learning	86
Science Process Skills	83
Average	86
Category	Highly valid

Based on Tables 1 and 2, the average assessment of the practicum instructions by subject matter and media experts is in the "highly valid" category, with validity scores of 86 and 85, respectively.

Table 3 Shows The Results Of The Practicum Questionnaire And Student Responses

Questionnaire	Validity Percentage (%)	Category
Practicality	88,7	Sangat valid
Student response	81,3	Sangat valid

Based on Table 3, the average practicality and student response results are in the highly valid category, with validity scores of 88.7% and 81.3%, respectively.

Thus, the results of the expert analysis of the validation data and student responses show that the Basic Electronics practicum guidelines, which are based on Problem-Based Learning (PBL) and aim to improve science process skills, are considered highly valid by subject matter and media experts, with validity scores of 85 and 86, respectively. Meanwhile, students' responses to the practicality questionnaire were considered highly valid, with a validity score of 88.7. These findings suggest that the PBL practicum instructions are suitable alternative teaching materials for supporting practicum activities.

CONCLUSIONS

The Basic Electronics I Practicum Guidelines, based on problem-based learning, were developed to improve the scientific process skills of physics education students in the Basic Electronics practicum. The practicum covers Kirchhoff's current law, Ohm's law, and voltage dividers. The material is systematically arranged according to the PBL learning steps: problem orientation, learning organization, investigation implementation, result presentation, reflection, and evaluation. Contextual problems related to everyday life are presented at the orientation stage. Subject matter and media experts assessed this product as highly valid, with validity scores of 85% and 86%, respectively. This makes it suitable for use in optimizing students' science process skills.

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