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Development of Plant Physiology Practicum Guidelines Based On Learning by Research for Biological Education Students

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ABSTRACT

Universities are currently focusing on the development of two aspects, namely being a learning college and a research college. Scientific attitudes, scientific processes, and scientific products are special characteristics of the research learning process. Therefore, as the first step in student learning, lecturers should be able to innovate and be creative in utilizing existing resources for example by the preparation and implementation practice based on learning by research model. The purpose of this study is to know the process of developing a practical guide to Plant Physiology based on Learning by Research. To produce practical products of plant physiology that are valid, and practical for use in the Biological Education Program of Muhammadiyah University Makassar. This research is Research and Development (R&D) with using a plot development model. The results of the research are the practice guidelines of Plant Physiology based on Learning by Research developed meets validity and practical criteria. The validation result of the guide is obtained the average value of the Content Validation Coefficient of 0.88 or has high relevance. While the practicality test is in the category of 'overall implemented' with a value of 3.56 with Content Validation Coefficient of 0.88 or has high relevance. While the practicality test is in the category of 'overall implemented' with a value of 3.56.

Keywords: Biology Practicum, Practicum Guidelines, Learning by Research

INTRODUCTION

Universities are currently focusing on two aspects of development, namely becoming a learning college and a research college. However, changing the duties and functions of universities and their stakeholders in implementing the tri dharma. The difference between the two focuses of higher education development is only in the choice of priorities in the implementation of the tri dharma. Colleges of learning prepare students' skills to enter the workforce very well, having skills that match the needs in the field. Even have general skills that can be accepted by government and private agencies. So that learning universities position the implementation of the dharma of learning as being prioritized over the dharma of research and community service.

The leadership of the Muhammadiyah University of Makassar through the LP2AI institution provides workshops for lecturers to implement and develop research-based learning so as to support the institution to become a research university. Biology Education Study Program is one of the Education Study Programs at the Teacher Training and Natural Sciences Faculty (FKIP) which should be able to respond to (answer) these demands. The response was intended as an effort to realize the vision of the University, but more importantly to improve the Biology Education Study Program as the basis for developing knowledgFollowinge. In accordance with Permenristek Dikti No.44/2015 concerning Graduate Learning Outcomes (CPL) on Attitudes, General Skills and Special Skills of graduates as the fulfillment of study outcomes for study programs.

Scientific attitudes, scientific processes, and scientific products are special characteristics of the research learning process. The three components of research learning are developed by educators both teachers and lecturers to the maximum in practical activities in the laboratory (Wijaya, 2012). Through practicum activities, students can prove theories received during lectures or discover new facts that have not been patented by other inventors. Students will gain direct experience through practical activities and gain knowledge when proving theories and concepts (Ali, 2017). The implementation of practicum activities so far is still in the form of simple theory testing in the laboratory, so with the Learning by Research-based Plant Physiology practicum guide, students are needed to form scientific skills and attitudes by making mini-research. Students are also trained in carrying out activities systematically and scientifically when carrying out work procedures in a practicum guide. Therefore, as the first step in student learning, lecturers must be able to innovate and be creative in utilizing existing resources, for example by preparing and implementing Learning by Research-based practicum guidelines in learning. The implementation of the practicum will be managed properly and regularly if it has a practical manual/guide (Prasetyo, 2016).

METHODS

Development Model

The type of this research is research and development (Research and Development) and as research subjects are students of the Biology Education Study Program, FKIP University of Muhammdiyah Makassar. The research product that will be developed is a Plant Physiology practicum guide based on Learning by Research. This research uses the Plomp research and development model (2013), consisting of 5 stages, namely: (1) Investigation phase (Preliminary Investigation), (2) Design phase (Design), (3) Realization/construction phase (Realization/Construction), (4) Test, evaluation, and revision (test, evaluation, and revision) phase, (5) Implementation phase.

Investigation phase (Preliminary Investigation)

The investigative phase was carried out in this study to determine the basis of the problems encountered to develop a practical guide. In the investigation phase, analysis of practicum topics, student analysis, and analysis of facilities and infrastructure is carried out by collecting and analyzing supporting information to plan further activities. The three analyzes can be described as follows.

1. Practicum topic analysis.

Analysis of practicum topics is carried out to select and determine, as well as systematically arrange topics or practicum units according to the needs to be practiced. The selection of topics is carried out by considering the suitability of the topic/practical unit with the composition of teaching materials in the Semester Program Plan (RPS) of the Biology Education study program, FKIP University of Muhammadiyah Makassar. Then, the topic/practical unit will be selected and systematically arranged in the guide which is developed to be interconnected with each other to support the implementation of learning in the form of delivering theory and practice courses.

2. Student analysis.

In the process of student analysis, this analysis examines the characteristics of Biology Education Study Program students according to the design and manufacture of practicum guides.

3. Analysis of facilities and infrastructure.

This analysis is carried out to see and examine the availability of tools and practicum materials that support the implementation of the procedures/workings of each topic/unit in the practicum guide.

Design Phase

In the design phase, a practicum guide was designed which aims to obtain a prototype of a Plant Physiology learning product based on Learning by Research. In addition, the required research instruments in the form of validation instruments and practicality test instruments were also made when using a practicum guide.

Realization/ Construction Phase (Realization/ Construction)

Furthermore, the Practical Guide that has been made in the design phase is referred to as Prototype I.

Test, evaluation, and revision phase (test, evaluation, and revision)

In the test phase, evaluation and revision are carried out in two stages, namely:

1. Practical guide validation stages

The prototype I as a product in the realization phase was consulted and discussed in the research team. Then validated by a team of validators that have been determined, namely two internal lecturers of the Biology Education Study Program. Based on the results of the validation by the validator team, if there are still improvements that require revision, the research team rearranges the prototype I practicum guide to Prototype II after being revised. Furthermore, prototype II, which has been concluded to meet the valid criteria, can be used for the trial phase of the practicum guide.

2. Practicum guide trial stages

The trial stage aims to determine the extent to which the Learning by Research-based practicum guide is implemented in Plant Physiology learning. After carrying out the trial phase, it is expected to obtain suggestions and improvements to the practicum guide that has been prepared so that it becomes more complete.

Research Subject

The practicum guide that has been made will be tested on a limited basis to students of Biology Education, the University of Muhammadiyah Makassar in the fifth semester of the Academic year 2020-2021.

Research Instruments

The research instrument used in this study was a validation sheet, and a practical observation sheet in implementation when carrying out plant physiology practicum activities. Validation sheets are given to a team of expert validators to assess the achievement of the eligibility criteria for the developed practicum guide. The validation team was carried out by two Plant Physiology lecturers. The assessment by the expert team was then analyzed based on content validation by Gregory in Ruslan (2009), which can be seen in Table 1.

Table 1. Content validation analysis

Val 2 Val 1	Irrelevant Score (1-2)	Relevant Score (3-4)
Score Relevant (1-2)	A	B
Relevant Score (3-4)	C	D

Content Validation Coefficient = $\frac{D}{A+B+C+D}$

Description:
A: Validators I and II disagree/relevant (1-2)
B: Validator I agree/ relevant (3-4) and Validator II disagree/ relevant (1-2)
C: Validator I disagree/ relevant (1-2) and Validator II agree/ relevant (3-4)
D: Validators I and II agree/relevant (3-4)

The practical guide is said to be valid if validators I and II provide high relevance/ agreement (3-4) with a content validation coefficient of >75% (Ruslan, 2009). For the criteria for the practicality of the device, the research team gave an Observation sheet on the practicality of the implementation of the practicum guide to three lecturers as observers. The average value of the three observers is adjusted according to the following implementation categories.

T 1	: Not Implemented
1< T 2	: Executed a small part
2 < T 3	: Mostly implemented
3 < T 4	: Overall Implemented

The practical guide is said to meet the practical criteria if the minimum T value is in the "Mostly Implemented" category (Arif & Maya, S, 2019).

RESULTS AND DISCUSSION

Research on the development of a Learning by Research-based Plant Physiology practicum guide conducted at Biology Education FKIP Muhammadiyah University of Makassar for fifth-semester students uses the research and development model from Plomp (2013). This model

consists of 5 phases, namely: (1) the investigation phase (Preliminary Investigation), (2) the design phase (Design), (3) the realization/construction phase (Realization/Construction), (4) the test, evaluation, and revision phase. (test, evaluation, and revision), and (5) the implementation phase (Implementation). The practicum guide that has been developed is valid and practical based on the assessment of the validator and implementation observer. Validated by 2 lecturers and practicality by 3 lecturers.

The stages of the process of developing a Plant Physiology practicum guide that has been carried out, along with the results of the analysis obtained are described as follows.

Investigation Phase (Preliminary Investigation)

A. Student Analysis

The results of student analysis through the investigation process when students carry out Plant Physiology practicums are found that the practicums carried out are still merely proving the theories put forward by scientists so that students have not fully acquired scientific skills.

1. Practical Topic Analysis

The results of the analysis of practicum topics through the observation process found that the topics or practicum units in the practicum guide which for the last 3 years since the opening of the Biology Education Study Program at the Muhammadiyah University of Makassar were not in accordance with the teaching materials arranged in the Semester Program Plan (RPS). Plant Physiology practicum topics that have been practiced so far are topics that are considered representative.

2. Analysis of Facilities and Infrastructure

The results of the observation of facilities and infrastructure found that the Biology Laboratory of the University of Muhammadiyah Makassar only had one room. Where one room is used for practicum of all courses that have practice in turns. So it is very visible that this room is very narrow because it is filled with tools and materials for all practicums. The practicum tools are irregular based on the group/cluster of subjects. Likewise, there are practicum materials that have expired, are out of stock, and are not arranged neatly.

Design Phase

In this design phase, researchers have designed a product in the form of a guide cover, and a practical topic (unit) based on the RPS from the Plant Physiology course.

1. Cover Design

Cover The Plant Physiology practicum guide is designed in such a way that it is very different from the cover of the previous guide. The cover design was chosen with a green color combination of yellow with a leaf motif that is very identical to Biology, especially Plant Physiology, and added some practicum photos from Biology Education students at the Muhammadiyah University of Makassar when doing a practicum in the laboratory. This practical guide cover is designed using the Pixellab application.

2. Practical Topic Design

The Plant Physiology practicum guide that has not been developed consists of 6 topics or practicum units, and will be developed into 9 practicum topics. The addition of practicum topics is adjusted to the arrangement of teaching materials in the Plant Physiology RPS and also adjusts to the tools and practicum materials in the Biology Laboratory. Although the practicum topic is still relatively simple in assembly and implementation, it includes all

teaching materials in Plant Physiology. The practical topics that will be developed are as follows.

Unit 1 : Osmosis
Unit 2 : Plasmolysis
Unit 3 : Imbibition
Unit 4 : Water and Land Relationship
Unit 5 : Respiration
Unit 6 : Ingenhous Experiment
Unit 7 : Sachs Experiment
Unit 8 : Plant Movement
Unit 9 : Seed Germination Hormone

Each Plant Physiology practicum unit is prepared and developed based on Learning by Research with the following main components (Table 2). There are seven components covered in the practicum guide.

Table 2. Components of the practicum unit

No	Items	Description
1	Practicum Title	describe activities
2	Basic theory	contains a brief theory that explains the practical unit.
3	Practical Purpose	the goal to be achieved after carrying out the practicum which usually directs students to think at higher levels
4	Practical Tools and Materials	list of tools and materials used during the practicum
5	Procedure	systematic, measurable, and traceable steps that will be carried out during the practicum to achieve the practicum objectives.
6	Observation result	made in a column or table whose shape is adjusted to the data from the results of the practicum. If the data is in the form of images or graphs, then a column is created. Meanwhile, if the data is in the form of numbers then it is made in the form of tables. The results of observations during the practicum are made first in the form of a temporary report by directly filling in the table or column of the observations After the new practicum will be made in the form of a complete report
7	Discussion	After carrying out the practicum students answer and discuss the exercises/questions in each practicum unit

Realization Phase

In this realization phase, researchers have made all forms of planning and design in the design phase, either in the form of cover designs or adding topics or practicum units complete with

a description of the components of each practicum topic. Hereinafter referred to as Prototype I. Prototype I is a product that will be validated by the validator team in the test, evaluation, and revision phases.

Test, evaluation, and revision phase (test, evaluation, and revision)

In the test phase, validation of the Plant Physiology guide that has been made or called Prototype I is carried out by the validation team. The guide validation activity aims to make the guide product feasible to be tested on students. The Prototype I validation team consisted of 2 expert lecturers and had or temporarily taught Plant Physiology Courses. The validator's assessment of the guiding product is done by filling out the instrument validation sheet. The evaluation results from the 2 validators become suggestions for improvement and references in revising Prototype I. After the validation and guidance activities have been revised, the next activity is the pilot product trial phase to measure practicality.

Validity

The results of the assessment from the validator by looking at aspects of the writing format, content, and language and writing of the guide as the prototype I product that has been made are presented in Table 3.

Table 3. Validation results of the Plant Physiology Practicum Guide

No	Aspect	Validator	
		I	II
1	Practicum Guide Format	3.6	3.6
2	Contents	2.8	3.5
3	Language and Writing	3.6	3.4

Content validity coefficient = $0.88\frac{D}{A+B+C+D}\frac{15}{2+0+0+15}\frac{15}{17}$

Based on Table 3, the data from the results of the validation assessment of the Plant Physiology practicum guide obtained a content validation coefficient of V = 0.88 or V = 88%. The guide is said to be valid if the content validation coefficient is > 75%, while V = 88% > 75%. So it can be interpreted that the practicum guide developed is valid and has high relevance. Both validators gave a general assessment of the practical guide that the guide could be used with minor revisions. The suggestions from the two validators can be seen in Table 4.

Table 4. Suggestions from expert validators and their revisions

No	Validator Suggestions (before revision)	Follow-up (after revision)
1	Adding the dose/number of tools and materials that will be used for each unit.	Has added the number of tools and the number of practicum materials that will be used in each unit.
2	Change some command words into verbs that are in the procedure/way of working.	All statement items in work procedures use verbs.
3	We recommend changing the numbering format	The numbering format in writing always uses

	with the symbol ( ) to the number one (1).	numbers instead of symbols.
4	Add a description of the sections on each experimental image.	Each experimental picture is equipped with a description of the parts of the picture.

Suggestions from the two validators were followed up by revising. The revised results are then referred to as Prototype II. The guiding product in the form of prototype II will be tested on a limited basis to students of the Biology Education Study Program, University of Muhammadiyah Makassar. The trial aims to measure the practicality of the Plant Physiology practicum guide that has been developed. We can see the implementation of the device after measuring the practicality of the practicum guide developed based on Learning by Research in learning.

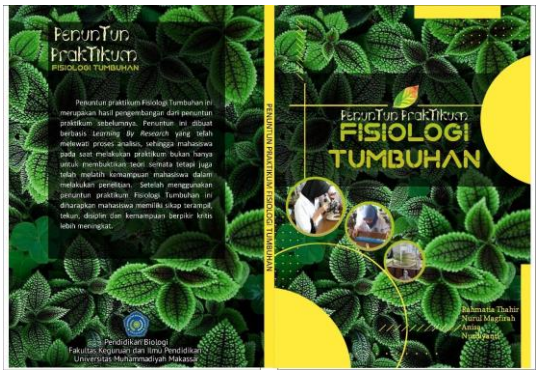

Figure 1. Practicum Guide Cover

Practicality

Practical trials of practicum guides as a form of product implementation are used during practicum in the laboratory. Observation of the practicality of the product was carried out by three observers. Each observer gave an assessment by filling out a questionnaire on the practicality of the Learning by Research-based Plant Physiology practicum guide.

Based on the results of the observer's observations and providing an assessment of the implementation of the product, which is summarized in table 5.5 above, it shows that the Learning by Research-based Plant Physiology practicum guide is in the Overall Implemented assessment category with a T value equal to 3.56. Category 3 < T 4 = Overall implemented, then 3 < 3.56 4 = Overall implemented

CONCLUSION

The Learning by Research-based Plant Physiology Practicum Guide uses the Plomp development model which consists of 5 phases, namely: (1) investigation, (2) design phase, (3) realization/construction, (4) the test, evaluation, and revision phase, and (5) the implementation phase has met the valid and practical criteria. Thus, it can be tested for the effectiveness of the guidebook in the next research.

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