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Development of an Inquiry-Based Practicum Guide to Improve Scientific Work Skills and Science Literacy

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Abstract. This study aims to develop an inquiry-based laboratory practicum guide and discover the increase in scientific work skills and literacy. The research took place in two stages: the development stage of the practicum guide using the Research and Development (R&D) method and the implementation stage using the research design pretest-posttest control group design. Material experts carry out feasibility testing. The development phase trial was carried out in 2 stages: a small-scale test using ten students and a large-scale test using 30 students. The implementation results were analyzed using the Independent N-Gain score T-test. The assessment results show that the eligibility validation of material experts is 93.38% (excellent). In limited trials, the average value obtained was 90.17% (excellent category), and in the results of large-scale trials, the average value obtained was 95.40% (excellent category). Based on the results Test Independent N-Gain Score, scientific work, and literacy skills obtained Sig. (2-tailed) is 0.00 < 0.05. The author concludes that the results of developing an inquiry-based practicum guide for animal development have met the standards. The developed guide can also improve the scientific work skills and literacy abilities of students who participate in animal development practicums in a meaningful way.

Keywords: Inquiry-based practicum, scientific work skills, scientific literacy

INTRODUCTION

Biology of animal development is one of the courses offered to students of the biology education study program. This course requires students to understand several competency standards, essential competencies, indicators, and predetermined learning objectives. One of the Learning Outcomes (CP) in this course is that after students take this course, students are able and responsible for planning, implementing, and evaluating research work in the field of Animal Development. However, in reality, there are still many students who experience difficulties in understanding concepts in animal development, for example, in gametogenesis and organogenesis material. Iswadi (2018) argues that a common understanding of science concepts is often associated with learning activities that do still oriented towards memorizing (retention) activities, learning methods are still conventional, and students study the level of difficulty of the material. One way to facilitate the concepts taught is by bringing students into practicum activities. Practicum can function in clarifying concepts through direct contact with tools, materials, or natural events, improving students' intellectual skills through observation or searching for complete and selective information that supports practical problem solving, training in problem-solving, applying knowledge and skills to situations encountered, train in designing experiments, interpreting data (Sagala, 2005; Wenning, 2010). Practicum can also bridge students' difficulties in understanding science concepts in textbooks. In addition, students who carry out science experiments will further explore and understand events that occur in nature (Budiastra, & Purwoningsih, 2004).

Rustaman (2005) argued that practicum plays an essential role in science education because it can provide scientific method training to students by following the instructions detailed in the instruction sheet. By doing practicum, students also become more sure of one thing than just receiving from teachers and books, which can enrich the experience and develop a scientific attitude, and learning outcomes will last longer in memory (Adistiara & Kustiyaningsih, 2018). Animal development practicum activities in the previous semester used conventional practicum guidelines. Still tend to the experimental stages that have been determined (conventional). The conventional practicum implementation model is all things related to the practicum, starting from the practicum instructions to the standard tools and materials provided by the laboratory assistant (Subali, 2010). This condition causes learning in the laboratory not to train students to think critically in investigations and discoveries. Besides that, the implementation of practicum in the laboratory faces obstacles, including limited time, laboratory facilities, and completion of practicum reports which are so tight that it makes practicum participants experience pressure and boredom. Sumintono et al. (2010) argue that various practicum materials generally only reveal scientific facts and scientific theories. However, it is a pity that most practicums are only carried out through detailed activity stages and only need to be followed by students, like food recipes. Overcoming this problem requires thinking to improvise practicum activities that hone scientific thinking and work skills. One of these activities is inquiry-based laboratory practicum activities.

Munandar (2017) His research concluded that inquiry-based practicum learning through modeling, design, and implementation (MPPBI-PPI) could improve the ability to plan, use learning media and evaluate learning for prospective biology teacher students (Rising & Cogan, 2009) also in his research concluded that inquiry-based learning in lectures can improve "mind-on" skills. So is Tessier (2018) suggested that the use of inquiry-based laboratories in teacher education program students could improve their inquiry abilities in future learning.

The inquiry-based practicum module equips students with training to have an excellent scientific attitude through investigative activities in laboratories that use scientific methods. Students with a high scientific attitude will be more productive in learning in class and the laboratory.

METHOD

The research method used is research and development (R&D) with the ADDIE model consisting of five stages: Analysis, Design, Development, Implementation, and Evaluation. (Sugiyono, 2015). Material experts carry out product feasibility testing. The development phase trial was carried out in 2 stages: a small-scale test using ten students and a large-scale test using 30 students. The research phase begins with needs analysis, data collection, product design, validation by experts, stage 1 revision, small-scale test, stage 2 revision, large-scale test, stage 3 revision, and product implementation. After carrying out large-scale trials, it continued with the implementation of experiments in the laboratory using products that have gone through large-scale trials, at the product implementation stage using a research design pretest-posttest control group design (table 1) (Ruseffendi, 2010).

Table 1. Pretest Posttest Control Group Design Experiment Research Design

Group	Pretest	Treatment	Posttest
Class A (Experiment)	OA1	X1	OA2
Class B (Control)	OB1	X2	OB2

Information:

OA1= experimental group pretest OB1= control group pretest X1= experimental class treatment (Practicum using inquiry-based guidelines) X2= control class treatment (conventional practicum)

OA2=experimental group posttest OB2 = control group posttest.

To determine the increase in the use of inquiry-based practicum guides on students' scientific work skills and scientific literacy abilities using inquiry-based guides with those using conventional guidelines used, normalized

N-Gain and score categories (table 2) (Hake, 1998).

$$\% N - Gain = \frac{S_{Post} - S_{Pre}}{S_{max} - S_{Pre}} x\ 100\%$$

Information: SPre=Pre Test Score, SPost=Post Test Score, Smax=Maximum Score

Table 2. Categorization of N-Gain Scores/Gain Index

Range	Category
N-Gains ≥ 0.7	Tall
0.3 ≤ N-Gain < 0.7	Currently
N-Gain < 0.3	Low

It was analyzed using an independent T-Test preceded by a normality test using the Shapiro-Wilk to determine the increase in scientific work skills and literacy. Data were analyzed using IBM SPSS Statistics version 25 and continued with the product implementation stage using a research design *pretest Posttest Control Group Design*.

RESULTS AND DISCUSSION

Result

The results of research on the development of inquiry-based animal development practicum guidelines to improve scientific work skills and scientific literacy of FKIP biology education students are presented as follows:

Product development stages

Product development stages include product design, expert validation, and small-scale and large-scale product trials. The resulting product design results can be seen in Figure 1 below.

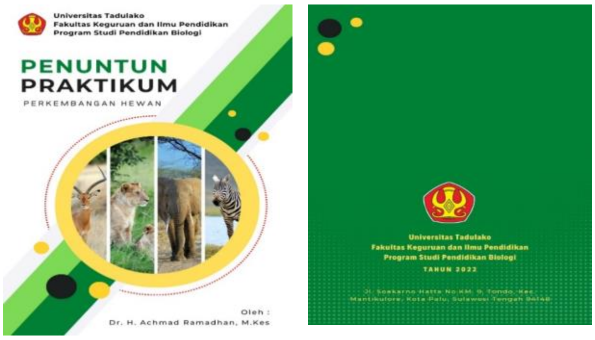

Figure 1. Display of the front and back covers of the practicum guide

Furthermore, the validation of the resulting product is carried out. The following results of product development trials are presented in Figure 2.

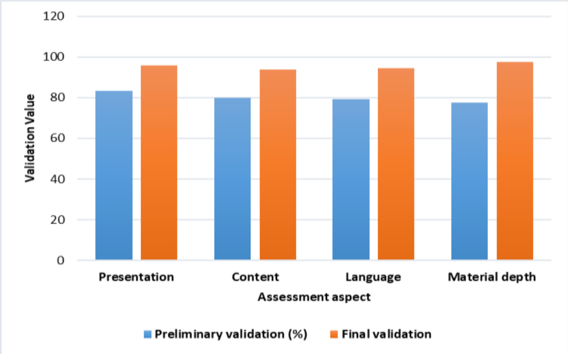

Figure 2. Material expert validation results

Based on Figure 2, the initial validation assessment by material experts on the presentation aspect obtained a percentage of 83.33%, the content assessment aspect was 80%, the language aspect was 79.39%, and the material in-depth aspect was 77.5%. The average initial assessment of material expert validation obtained a percentage of 79.31% with suitable criteria. The percentage of material expert validation assessment after revision (final validation) has increased, namely in the presentation aspect of 95.83%, content aspect of 93.75%, language aspect of 94.44%, and material in-depth aspect of 97.5%. The average result of the material expert validation assessment after revision obtained a percentage of 95.38% with excellent criteria.

Small-scale trials were carried out to determine the effectiveness of improving practicum guidelines after repairs were made. The trial was conducted on ten students programming animal development courses at the FKIP University of Tadulako's biology education laboratory. The results of the small-scale trials can be seen in Table 4.

The results of small-scale trials showed that in the presentation aspect, the percentage obtained was 87.50%, the material content aspect was 96.25%, the language aspect was 91.94%, and the material depth aspect was 95%. The average percentage of the assessment of the four aspects is 90.17% in the excellent category. Thus it is feasible to proceed to large-scale trials.

The large-scale trial was conducted on 30 biology education students. The trial was carried out by filling in a student response assessment questionnaire. The results of large-scale trials are shown in table 5.

Table 4. Results of small-scale trials on students

No	Rated aspect	The average value of each aspect	Percentage (%)
1	Guide Presentation	3.50	87.50
2	Fill in the Practicum Guide	3.45	86.25
3	Language	3.68	91.94
4	Depth of Practicum Guidance Material	3.80	95
	Average	3.63	90,17
	Category		Very good

Description: Criteria/category: 81% - 100%=Very good, 61% - 80%=Good,

Table 5. Results of large-scale trials on students of the Biology Education study program

No	Rated aspect	Average value every aspect	Percentage (%)
1	Guide presentation	3.76	94.03
2	Fill in the guide	3.81	95.25
3	Language	3.93	98.15
4	Depth of practical material guide	3.79	94.17
	Average	3.82	95.40
	Category		Very good

Table 5 shows the results of a large-scale trial conducted on 30 students. In the presentation aspect, the percentage is 92.58%, the material content aspect is 92.30%, the language aspect is 93.44%, and the material depth aspect is 94.60%. The average percentage of the assessment of the four aspects is 93.23% in the excellent category.

Product Implementation Stage

The stages of product implementation in practicum activities are carried out to determine the application of inquiry-based practicum guidelines for increasing scientific work skills and literacy. Based on the calculation of the N-Gain score test, it shows that the average value of the N-Gain Score for the Experiment class (given an inquiry-based practicum guide) is 63.57 or 63.57% included in the quite effective category with an N-Gain score a minimum of 16 and a maximum of 90. Meanwhile, the average N-Gain score for the control class (not using inquiry-based practicum guidelines) is 13.51 or 13.51%. This percentage is included in the ineffective category, with a minimum N-Gain score of 0 and a maximum of 31%. Next, an Independent T-Test was performed for the N-Gain Score. Table 6 presents the results of the independent T-test.

Table 6. Independent T-Test for N-Gain Score

	Class	Kolmogorov-Smirnova			Shapiro-Wilk		
		Stat	df	Sig.	Sta	df	Sig.
Ngain	Exp	.135	30	.172	.951	30	.182
Percent	Control	.125	30	.200*	.899	30	008

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Referring to the results of the data normality test on Shapiro-Wilk, one of the data shows that the distribution is not normal, namely the control class data has a sig value of 0.008 <0.05. Thus, the significance test uses a non-parametric test, namely the Mann-Whitney Test. The test results can be seen in the following table 7.

Table 7. Results of the Mann-Whitney Test for scientific literacy skills.

	Ngain_Persen
Mann-Whitney U	1,000
Wilcoxon W	466,000
Z	-6,646
asymp. Sig. (2-tailed)	.000

a. Grouping Variables: Class

Based on the data in table 8 above, the Sig. (2-tailed) value is 0.00 <0.05, so it can be concluded that there is a difference in the average scientific literacy ability of students who use inquiry-based practicum guides and those who do not use inquiry-based (conventional) practicum guides.

Discussion

This research develops teaching materials in the form of inquiry-based practicum guides. The practicum guide developed is used for animal development courses in the biology education study program at FKIP Tadulako University. This practicum guide was developed to improve scientific work skills and students' scientific literacy abilities concerning the needs analysis that had been carried out by distributing questionnaires to 30 students who were programming animal development courses. The results of the student questionnaire analysis stated that the practicum guide made should make it easier for students to understand the material/theory that has been given in lectures and can improve scientific work skills. In addition, the developed practicum guide must also be equipped with several aspects of science process skills such as asking questions, formulating hypotheses, observing, planning experiments, interpreting, and communicating.

Based on the needs analysis results, an inquiry-based practicum guide was prepared by designing it starting from the front cover of the guide, which contains the practicum guide title, logo, and the name of the person in charge of the course, as well as an image. The page contains text, experimental topics, pictures, materials, practicum objectives, problem information, general instructions, tools and materials, work procedures, research results tables, analysis questions, and conclusions columns.

Based on the validation results carried out by content experts and media experts, the overall results of the final validation were declared valid and suitable for use as a practicum guide (Figure 2). The practicum guidelines developed are by the standards for evaluating learning materials, such as the layout of photos, pictures, illustrations, and designs that look clear and attractive as guidelines for writing teaching materials (Prostowo, 2011). According to Samsu et al., (2017), in his research, with a practicum guide, students would get an overview of the objectives, benefits, and process of the practicum activities. Trianto (2010) says that the developed media provides accurate information. Thus, the practicum guideline has generally fulfilled the didactic, construct, technical, and language requirements.

In the testing phase of the practicum guide product that experts have validated, made improvements (revised), and declared feasible by the validator, small-scale and large-scale trials are carried out. The results of small-scale trials showed that the presentation aspect was 87.50%, the content aspect was 96.25%, the language aspect was 91.94%, and the material depth aspect was 95%. The average percentage of the assessment of the four aspects is 90.17% in the excellent category. In the large-scale trial conducted on students of the biology education study program, a total of 30 students showed that the presentation aspect obtained a percentage of 92.58%, the content aspect was 92.30%, the language aspect was 93.44%, and the material depth aspect was 94.60%. The average percentage of the assessment of the four aspects is 93, 23% with excellent category. Sardiman (2006) suggests that good learning media can be used to stimulate students' thoughts, feelings, concerns, and interests in such a way that the learning process can occur. Thus the results of developing this guide are expected to stimulate students to learn actively with the help of tools and materials and guidance from lecturers.

The N-Gain analysis of students' scientific work skills scores shows that the average N-Gain Score for the Experiment class (given an inquiry-based practicum guide) is moderately effective (63.57). Meanwhile, the average N-Gain score for the control class (not using inquiry-based practicum guidelines) is in the ineffective category (13.51). The data obtained were then processed using statistical analysis to see the significance of the difference. Based on the pretest data in both classes, a homogeneity test was carried out using the Levene test in SPSS 25.0. Based on the output table, it is known that the Sig. in Levene's Test for Equality of Variances is 0.00 <0.05, it can be concluded that the variance of the N-Gain data (%) for the experimental class and control class data is not homogeneous. Thus, the Sig guided the independent T-test for the N-Gain score. They were contained in the Equal variances, not assumed table. Based on the table above, Sig's value is known. (2-tailed) is 0.00 < 0.05. Thus, it can be concluded that there is a significant difference between classes that were given inquiry-based practicum guidelines and classes that were not given inquiry-based practicum guidelines in improving students' scientific work skills in a practicum in animal development courses. These findings indicate that inquiry-based practicum guides effectively improve students' scientific work skills. The results of this study are in line with research conducted by Prabowo et al., (2017) that the application of inquiry learning modules combined with virtual laboratory applications allows students to understand concepts by studying the material in modules and understand the basic principles of experiments or observations in actual conditions through virtual laboratories. Hassard (1992) states that the ability to think scientifically or develop science process skills will develop if students do scientific work. Sarlivanti et al., (2014); Hermansyah et al., (2015) and Furqan et al., (2016) also suggested that the guided inquiry learning model positively impacted students' scientific processes and critical thinking skills.

Based on the calculation of the N-Gain Test score for scientific literacy ability, it shows that the average value of the N-Gain Score for the Experiment class (given an inquiry-based practicum guide) is 63.56 or 63.56% included in the reasonably practical category with an N value -Gain score of at least 16 and a maximum of 90.48. The average N-Gain score for the scientific literacy ability of the control class (not using an inquiry-based practicum guide) is 24.24 or 24.24%. The normality test results with Shapiro-Wilk showed that the control class data did not usually distribute with a sig value of 0.008 <0.05. Based on the non-parametric test using the Mann-Whitney Test, the Sig. (2-tailed) value is 0.00<0.05, and there is a difference in the average scientific literacy ability of students who use inquiry-based practicum guides and those who do not use inquiry-based practicum guides (conventional). Thus it can be concluded that using inquiry-based practicum guides can improve students' scientific literacy abilities. The results of this study are also in line with research conducted by Saputra et al. (2017) that the virtual laboratory-based inquiry learning model can significantly improve the science literacy skills of prospective physics teacher students in dynamic electricity material. Rakhmawan et al., (2015) also stated that inquiry-based scientific literacy learning in laboratory activities increased high school students' scientific literacy in terms of content, context, processes, and science attitudes. Suparno (2001) suggests that practicum activities are a form of manifestation and learning strategies that require students to use the knowledge that the scientific process has obtained. For this reason, scientific meetings are closely related to aspects of the scientific literacy concept contained in the practicum module so that carrying out an aspect of the practicum learning process goes with aspects of the context related to everyday life.

CONCLUSIONS AND SUGGESTIONS

The results of developing an inquiry-based practicum guide for animal development have met the standards, so it is very suitable to be used as an inquiry-based practicum guide. The guide used can also improve the scientific work skills and scientific literacy abilities of students who take part in animal development practicums in a meaningful way.

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