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Developing Guided Inquiry-Based Student Lab Worksheet for Laboratory Knowledge Course

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Abstract. The course of laboratory knowledge is an introductory course for biology students to follow various lectures practicing in the biology laboratory. Learning activities of laboratory knowledge course at this time in the Biology Department, Universitas Negeri Padang has not been completed by supporting learning media such as student lab worksheet. Guided inquiry learning model is one of the learning models that can be integrated into laboratory activity. The study aimed to produce student lab worksheet based on guided inquiry for laboratory knowledge course and to determine the validity of lab worksheet. The research was conducted using research and developmet (R&D) model. The instruments used in data collection in this research were questionnaire for student needed analysis and questionnaire to measure the student lab worksheet validity. The data obtained was quantitative from several validators. The validators consist of three lecturers. The percentage of a student lab worksheet validity was 94.18 which can be categorized was very good.

1. Introduction

The class of laboratory knowledge is an introductory class for biology student to conform to various lectures practicing in the biology lab. The learning outcomes of laboratory knowledge are students' own knowledge and skills, how to manage the laboratory, understanding about procedure to figure in a laboratory and having ability to keep their safety in the laboratory [1].

The learning of laboratory knowledge cannot go away from biology as a part of science that divided into two are product and operation. The attempt to realize biology characteristic as the product and operation of learning by doing practice. Inquiry is one of learning model that can be applied in practice. Learning strategies such as inquiry have long been reported to produce superior learning outcomes in teaching science education. Martin and Hansen [2] suggest that in inquiry-based learning, student conduct an investigation activity which resembles an experiment performed by the experts in the real word and state of [3] inquiry-based learning is focused on describing, explaining, predicting, and communicating scientific phenomena. The effects of inquiry-based learning implementation have investigated by [4] show that inquiry-based instruction can succesfully help students' to develop a deep comprehension of knowledge and scientific process skills which are vital to development of the students' literacy. Another research finding by [5] inquiry also encourage students science literacy.
According to [6] there are four levels of inquiry; 1) confirmation inquiry, 2) structured inquiry, 3) guided inquiry and 4) open inquiry. The kinds of inquiry that suitable for univ student is guided inquiry, because of guided inquiry is based on extensive studies of the Information Search Process

(ISP) in assigned research projects [7] and as a state of [6] guided inquiry is the third level of inquiry, the teacher provides students with only the research question, and the students design the procedure or method to test the question and the resulting explanation.

The steps of guided inquiry learning activities develops students' scientific activity by [8], [9], and [10] as follows: 1) identifiying problem, questions and issues; 2) formulating hypotheses; 3) collecting data; 4) analyzing the data; 5) drawing conclusions and generalizations. According to [11] learning by guided inquiry model can be implemented in the stages of observation, manipulation, generalization, verification and applications. However, [12] develops a guided inquiry learning cycle into five stages: orientation, exploration, concept formation or concept invention, application and closure.

According to [7] there are six characteristics of guided inquiry; 1) students learn by being actively engaged and reflecting on that experience; 2) students learn by building on what they already know; 3) students develop higher order thinking through guidance at critical points in the learning process; 4) students' development occurs in a sequence of stages; 5) students have different ways of learning; 6) students learn through social interaction with others.

A number of studies about the advantages of the use of guided inquiry based laboratory has been done by [13] inquiry-based gave students the ability to design, conduct, assemble, and troubleshoot an experiment that was not provided for them. Dwiyanti's research [14] showed that students' response to the implementation of the guided inquiry based student lab-worksheet on making pineapple flavoring were found very good. In line with these results, the study by [15] also states that development of guided inquiry based worksheet on colligative properties solution has very high validity, very high practicality and effectively used in the learning process.

The practice based on guided inquiry can be doing success if supported by student lab worksheet. According to the Ministry of National Education [15], the structure of the content of worksheet at least include: 1) the title or identity, 2) the instruction for learning; 3) the competence to be achieved; 4) learning materials; 5) the task or work step, and 6) evaluate.

Base of researcher observation, the laboratory practice class have not thoroughly established. This is caused have not a student lab worksheet to lead students' doing practical. If the practical do not accomplish it will be impacted to another course.

Established in the background, we will develop a practical guide for a laboratory practical course based on guided inquiry in the Biology Department, Faculty of Mathematics and Science Universitas Negeri Padang.

2. Method

The research was conducted using research and development (R&D) model. Development model that is used in this research is a Four-D model by [17]. The stages of Four-D models shown on Figure 1 below. The stages of research are as follows: 1) Define; 2) Design; 3) Develop and 4) Disseminate, although in this research the stages was limited to develop phase.

Sources of data in this study are two lecturers from a Biology Department and one lecturer from Language Department. The instruments used in the form of a sheet questionnaire for student needed analysis and questionnaire to measure the student lab worksheet validity. Measuring the validity of student lab worksheet contain of four aspects are didactic aspect, construct aspect, technical aspect and language aspect.

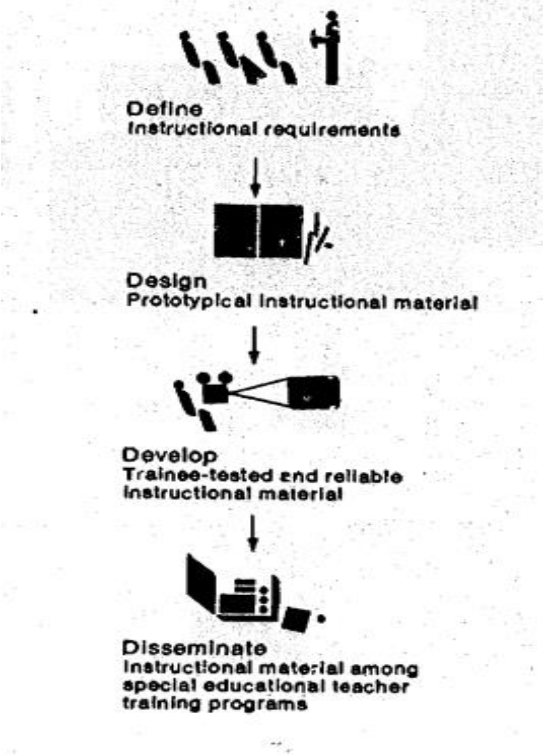

Figure 1. Four-D Models [17]

3. Results and Discussion

Development prosedure in this research is a Four-D models. The stages of research are as follows: 1) Define; 2) Design; 3) Develop and 4) Disseminate, although in this research the stages was limited to develop phase.

3.1 Define

The first stage of the procedure is define. The purpose of this stage is to stipulate and define instructional requirements. The steps of the stage are:

3.1.1 Front-end analysis

Based on interviews with leturers and students, it can be concluded that the basic problem is the laboratory practice class have not thoroughly established. Although the laboratory practise class is important to support the theory in the class. One of factor is caused have not a teaching material to lead students' doing practical.

3.1.2 Learner analysis

In this study students that will be served as a research subject is the first year univ students aged between 18-19 years. According to Piaget's theory of learning the way of thinking-age children in the formal operational stage of development intellectual that children are able to think logically, draw conclusions and interpret.

To get information about learner analysis by giving questionnaire for student needed. The information are students agree if lecturer will be develop a teaching material for laboratory knowledge course. They also want a teaching material is dominated by blue and green colour. For the kind of tulisan, the student choose Times New Roman and Comic S in the student lab worksheet.

3.1.3 Concept analysis

The way to analyze the concept is analysis the syllabus of laboratory knowledge course. Based on the syllabus, there are 12 (twelve) topics that should be learned by students for one semester: (1) Defenition, fungtion, lay out and equipments of laboratory; (2) Management of Laboratory; (3) Overview, fungtion, and procedure glasses, porselen and optical tools; (4) Overview, fungtion, and

procedure measuring and fisiology tools; (5) Overview, fungtion, and procedure ecology and microbiology tools; (6) Overview chemistry materials; (7) Maintenance tools and materials; (8) Safety work in laboratory; (9) Working in laboratory; (10) Solution, consentration and dilution technique; (11) A reagent solution; (12) Planning a proposal college field.

3.2 Design

The second stage of procedure is design. The purpose of this stage is to design prototype instructional material. The steps of the stage are:

3.2.1 Media selection

Based on matching the main problem in the front-end analysis, the characterictic of the students and student needed in learner analysis and 12 (twelve) topics that sould be learned by students in concept analysis, the researcher making decicion to design a teaching material like student lab worksheet based on guided inquiry for laboratory knowledge course.

3.2.2 Initial design

In this step is the presenting of the essential instruction through appropriate media. The design of student lab worksheet containing: 1) Cover of student lab worksheet; 2) Guiding for lecturer; 3) Guiding for student; 4) The rules of practical; 5) The title or identity of the experiments performed; 6) The purpose of experiment; 7) Background problem; 8) Formulating the problem; 9) Formulating the hypotheses; 10) Collecting the data; 10) Analysis the data; 11) Referral to make conclution.

From 12 (twelve) topics that should be learned by students for one semester. The researcher contructs to be 10 (ten) practical topic. The first and second topic include in one practical, and the last topic about planning to proposal college field is not include in the practical.

3.3 Develop

The purpose of this stage is to modify the prototype instructional material. Although much has been produced since the define stage, the results must be considered an initial version of the instructional material which must be modified before it can become an effective final version. In the development stage, feedback is received throughformative evaluation and the materials are suitably revised.

3.3.1 Expert appraisal

Expert appraisal is a technique for obtaining suggestions for the improvement of the material. A number of experts are asked to evaluate the material from instructional and technical points of view. On the basis of their feedback, the material is modified to make it more appropriate, effective, usable, and of high technical quality.

In this case, there are three experts, including two lecturers from a Biology Department and one lecturer from Language Department.Validators give a check mark in the column available in the validation sheet or questionnaire. They also give feedback or suggestion to the student lab worksheet. Measuring the validity of student lab worksheet contain of four aspects are didactic aspect, construct aspect, technical aspect and language aspect. The validation results are shown in table 1 below.

Table 1. The percentage of validity student lab worksheet

No.	Validator	Validity				**Average**	**Validity Criteria**
		Didactic Aspect	Construct Aspect	Technical Aspect	Language Aspect		
1	A	87.5	91.2	93.8	100	**93.1**	**Very Valid**
2	B	96.9	83.8	83.33	93.75	**89.4**	**Very Valid**
3	C	100.0	100.0	100.0	100.0	**100.0**	**Very Valid**
		92.2	**87.5**	**92.4**	**97.9**	**94.18**	**Very Valid**

Based on the Table 1, it can be seen overall the average score on student lab worksheet validity is 94.18 % which according to [17] can be concluded by very valid criteria. Van den Akker [18] states that the validity refers to the level of a design based on knowledge (content validity) and various components related to each other (construct validity). The experts also give feedback or suggestion to make the student lab worksheet more appropriate. The feedback or suggestion from the lectures are shown in Table 2 below.

Table 2. Validators suggestion for repairing guided inquiry-based student lab worksheet.

No	Aspect	**Validators Suggestion**
1	Didaktic	-
2	Construct	Please check again the numbering
		Please repair the layout of researcher identity in the worksheet cover
		Please change the position of microscope picture with researcher identity in the worksheet cover
		Please add the space for researcher identity in the worksheet cover.
		Please give the resources of the picture and be good if personal picture.
		Proporsional the size of picture.
3	Technical	-
4	Language	Please consistent for using greeting words (Anda or Kamu).
		Please attention for using pronoun (mahasiswa or praktikan).
		Writing of a word 'dibawah ini' could be 'di bawah ini'. Because prefix, should use spaces if show place or location
		Changing a word 'matakuliah' should be 'mata kuliah'.
		Notice the use of punctuation point and coma on paragraphs contained in the preface.

Based on the Table 2, it can be seen there are four aspects that valuing by experts. There are two aspects get more suggestions from lecturers. There are construct and language aspects. Revision of student lab worksheet is made based on their feedback. Suggestions and feedback are used to improve the product, so a proper student lab worksheet can be used.

4. Conclusion

The conclusion of this study is the quality of the student lab worksheet as a product development of the Four-D model is in the very valid criteria, in terms of aspect of the didactic, construct, technical, and language. All of these aspects meet a very good criteria.

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References

[1]. Ristiono, Syamsurizal, and Rahmi, Y.L. 2017. *A Syllabus Lecture Knowledge Laboratory*. Padang: Biology Department FMIPA Universitas Negeri Padang.
[2]. Martin and Hansen, L. 2002. Defining Inquiry, Exploring The Many Types of Inquiry in The Science Classroom. *The Science Teacher*,69(2),34-37.
[3]. Harrison, A.G. and Treagust, D.F. 2000. A Typology of School Science Models. *International Journal of Science Education*, 9, 1011-1026.

[4]. Chabalengula, V. M., Mumba, F., Lorsbach,T., and Moore, C. 2008. Curriculum and Instructional Validity of The Scientific Literacy Themes Covered in Zambian High School Biology Curriculum. *International Journal of Enviromental and Science Education*,3 (4), 207-220.
[5]. Trna, J. and Trnova, E. 2015. The Current Paradigms of Science Education and Their Expected Impact on Curriculum. *Procedia-Social and Behaviour Sciences*, 197 (February), 271-277.
[6]. Banchi, Heather and Randy Bell. 2008. The Many Level of Inquiry. *Science and Children :* 26-29.
[7]. Kuhlthau, C. C., Maniotes, L. M., and Caspari, A. K. 2007: *Guided Inquiry: Learning in the 21st Century*. Westport, Conn.: Libraries Unlimited.
[8]. Arends, R.I. 2012. *Learning to Teach*. New York: Mc Graw-Hill Companies, Inc.
[9]. Kuhn, D., Black, J., Keselman, A., and Kaplan, D. 2000. The Development of Cognitive Skills to Support Inquiry Learning. *Cognition and Instruction*, 18 (4), 495-523.
[10]. Kipnis, M. and Hofstein, A. 2008.The Inquiry Laboratory as a Source for Development of Metacognitive Skills. *International Journal of Science and Mathematics Education*. 2008 (September), Volume 6, Issue 3, 601–627.
[11]. Wenning, C.J. 2011 The Levels of Inquiry Model of Science Teaching. *J.Phys.Tchr.Educ.* 6(2), 9-16.
[12]. Hanson , David. M. 2005. *Designing Process-Oriented Guided-Inquiry Activities. In Faculty Guidedbook: A Comprehensive Tool For Improving Faculty Performance, ed. S. W.* Beyerlein and D. K. Apple. Lisle, IL: Pacific Crest
[13]. Sundararajan, S**.,** Faidley, L.E., and Meyer, T.R. 2012. *Developing Inquiry-based Laboratory Exercises for a Mechanical Engineering Curriculum*. American Society for Engineering Education. Iowa State University.
[14]. Dwiyanti, G. Suryatna, A. and Taibah, I. 2017. Development of Guided Inquiry-Based Student Lab Worksheet on the Making of Pineapple Flavoring. *Journal of Physics: Conf. Series 812 (2017) 012074.*
[15]. Irham, **S**.M., Oktavia, B. and Mawardi. 2016. The Development of Guided Inquiry-based Worksheet on Colligative Properties of Solution for Chemistry Learning. *Advances in Social Science, Education and Humanities Research (ASSEHR)*, volume 57. Atlantis Press.
[16]. Ministry of National Education. 2010. *Technical Guidelines for The Development of High School Teaching Materials*. Jakarta : The Directorate Guidance High School.
[17]. Thiagarajan, S. Semmel, D.S. and Semmel, M.I. 1974. *Instructional Development for Training Teachers of Exceptional Children: A sourcesbook*. Indiana University Bloomington, Indiana.
[18]. Riduwan, 2007. *The Scale of Measurement of The Study Variables.* Bandung: Alfabeta.
[19]. Van den Akker, J. 1999. *Design Approaches and Tools in Education and Training*. Dordrecht: Springer Science Business Media, B.V.