Designing PBL-Based Science Laboratory Handbook to Improve Student Laboratory Activities

D Susanti*, L Y sari¹, B Supriatno² and R Riandi†

¹Program Studi Pendidikan Biologi, STKIP PGRI Sumatera Barat, Jl. Gunung Pangilun, Padang 25173, Indonesia
²Departemen Pendidikan Biologi, Universitas Pendidikan Indonesia, Jl. Dr.Setiabudi No. 229, Bandung 40154, Indonesia

* dianasusantimpd@yahoo.co.id

Abstract. Introduction to laboratory technique course covers the supporting material of activities that carry out activities in the laboratory. In order to achieve the learning objectives, this course is equipped with practical activities supported by a handbook. The handbook used so far has not been complete in terms of the appearance and components of a handbook, the present content not yet reflected the overall coverage of the material, so there is a practical activity that does not cover learning materials. Overcome this, then developed a handbook oriented Problem Based Learning approach. This study aims to produce a handbook in accordance with the needs of students. This lab guide was developed using the 4D model. In this study only up to the define stage of student needs analysis and data obtained from the questionnaire of student needs analysis consisting of six aspects. Among the aspects of graphic and language structure, availability, components, materials and content, the implementation of practice and Problem Based Learning approach. The data were gathered by questionnaire and processed by using descriptive statistical analysis. The development of a handbook oriented guide Problem-based learning is necessary for the needs of students in introductory and laboratory techniques.

1. Introduction
The introduction and technique of the laboratory subject, discusses the introduction of a laboratory, laboratory type, laboratory equipment, laboratory safety and precautions, measuring instrument, optical instrument, acid-base synthesis indicator, acid-base acid indicator, determination degree of acidity, standard solution, solution concentration, preservation and dilution (FAA solution). All laboratory introductions and the use of laboratory equipment, materials and safety measures should be controlled by laboratory users. Starting from the readiness before doing practica activities, is doing practical activities, even after doing the activities, user laboratory must master what steps are done when working in a laboratory. To support student understanding, this subject is presented 16 times in class and followed by 8 times practica activities in laboratory. Before practica activities, students improve the basic knowledge to building their learning experience [1]. Practical activities undertaken during this time is supported by a handbook. A handbook is a sheet of works that contains tasks in the form of work instructions and steps to complete a task that must be done by learners. The handbook contains the title, basic competence, and the objectives to be achieved, the completion time, the equipment or materials needed to complete the task, the work steps, the tasks to be performed, and the report to work on [2]. The handbook used so far do not reflect the entire contents of the material taught...
during the lecture so that some students do not understand some activities that should be a provision of their understanding while doing in the lab. The material in handbook just, laboratory equipment, measuring instrument, optical instrument, acid-base synthesis indicator, determination degree of acidity, standard solution, solution concentration, and preservation. Much of the material that must be mastered has not been contained in the handbook. For example introduction of a laboratory, laboratory type, laboratory safety and precautions, acid-base acid indicator, and dilution (FAA solution). In addition, the components of the handbook contained in the guidance are not in accordance with the appropriate guiding component. The teaching material structure of the handbook is simpler consisting of six main elements, which include: title, work guide, basic competence, subject matter, supporting information, exercises, and assessment [3]. Whereas when viewed from the formats, the handbook contains at least eight elements, namely the title, basic competencies to be achieved, completion time, tools/materials needed to complete the task, brief information, work steps, tasks to be performed, and reports That must be done. In order to further increase students' understanding of the problems and achievements of learning at the time of carrying out practical activities, then developed a handbook-oriented by problem-based learning approach.

Problem-based learning is a learning approach that presents various real problems in the student’s daily life (which is contextual) so as to stimulate students to learn. And PBL is a learning that uses current issues [4]. Problem-based learning challenges students to learn how to learn, work in groups to find solutions to real-world problems [5]. By using this problem-based learning approach, students are expected to be able to learn and work in groups to find solutions to problems that match the learning achievements and make them active and creative when practicing. Because when viewed from the activities of Problem based learning, guiding students to work scientifically. The stages in Learning Problem-based learning is the student’s orientation to the problem, defining problems and organizing students to learn, mixing independent investigations and group investigations, developing and presenting works, reflections, and judgments [6].

Previous research that has implemented Problem-based learning approach such as Tika Zahara with the title of the development of module based on Problem-based learning for chemistry Class X Semester even and the results of his research showed that the development of the module based on Problem-based learning for chemistry class X even semester included in the good category that at [7]. And Seamus C. McLoone, et al, research’s about The Implementation and Evaluation of a Project-Oriented Problem-Based Learning Module in a First Year Engineering Programme can be conclusion that PBL model also provided the students with a valuable opportunity of experiencing a range of skills, including teamwork, leadership, communication, research, time management, and project management [8]. So the results of Othman, et al about Engineering Students: Enhancing Employability Skills through PBL show that student’s employability skills can be enhanced using PBL [4]. The purpose of this study is to see the needs of students towards the design of handbook oriented by Problem-based learning approach in introduction and laboratory techniques subject.

2. Experimental Method

This research is a development research using 4D model (define, design, develop and disseminate). The research focused on define stage. Subjects in this study were students of STKIP PGRI Sumatera Barat force 2016 which amounted to 30 people and this research was conducted in STKIP PGRI West Sumatra in the even semester of academic year 2016/2017. The data in this study were obtained from the questionnaire instrument of modified student needs from Sophia [9] which was assessed from 6 aspects. Aspects observed include aspects of availability, components, materials and content, graffiti and linguistic, the implementation of the practica and approach of Problem Based Learning.

3. Result and Discussion

Research related to the needs of practicum oriented problem-based learning, the material that will be presented include laboratory type, laboratory equipment, laboratory safety and precautions, measuring instrument, optical instrument, acid-base synthesis indicator, acid-base acid indicator,
determination degree of acidity, standard solution, solution concentration, preservation and dilution (FAA solution). On laboratory Safety materials, will discuss the handling of minor and severe accidents occurring in laboratories and hazardous chemicals. This is given so that they can work with caution and avoid accidents while working in the laboratory. Due to the lack of concern for safety in the laboratory, which has also received significant attention over the past few decades, especially after laboratory accidents or the introduction of new safety standards. Therefore, it is necessary to recognize the safety of work in laboratory in order to overcome accidents in this place [10]. One of the main causes of accidents is the lack of accuracy in the use of chemical devices and materials. The chemicals used usually cause some degree of danger with respect to reactivity, flammability, and or toxicity [11]. Some of the chemicals hazardous that are often used in laboratories are flammable materials, explosive chemicals, corrosive materials, toxic substances, and heat sensitive materials, oxidizing agents, gases under high pressure, water sensitive chemicals and radioactive materials [12]. Example for chemical hazard can be seen in figure 1.

![Figure 1](image-url)

**Figure 1.** Several Types Of Chemical Hazards Contained In Chemicals In The Laboratory [13].

Figure 1 shows that chemical hazards which is contained in materials often used in laboratories and examples. Chemical hazards help laboratory users avoid chemical accidents. Chemicals can be harmful and beneficial if used correctly [14].

On laboratory equipment subject discussing the type of device and how it’s handled. The importance of the use and handling of laboratory equipment will help the utilization of laboratory equipment to be used for a long time. Suppose the cleaning tool, if the handling is good then the tool used can work well. Proper laboratory equipment cleaning can determine the reliability of the measuring instrument (test) performed in the laboratory [15]. So the student's understanding of the handling and function of laboratory equipment should be given to the handbook. Some laboratory equipment and their functions show at Table 1.

| Name          | Functions                                      |
|---------------|------------------------------------------------|
| Symbol        | The Danger                                     |
| Explosive     | This container can explode if it's heated or punctured. Flying pieces of metal or plastic can cause serious injuries, especially to the eyes. |
| Corrosive     | This product will burn skin or eyes on contact, or throat and stomach if swallowed. |
| Flammable     | This product, or its fumes, will catch fire easily if it's near heat, flames or sparks. |
| Poison        | Licking, eating, drinking, or sometimes smelling, this product will cause illness or death. |
| Water repellent for shoes or boots in an aerosol container |
| Spray paint in an aerosol container |
| Toilet bowl cleaner |
| Oven cleaner |
| Contact adhesives |
| Gasoline |
| Windshield washer fluid |
| Furniture polish |

Table 1. Type Of Laboratory Equipment and Functions
Glass ware (ex. Test tube) To retain, mix, or small amounts of heat of solid or liquid chemicals, especially for qualitative experiments and tests.

Measuring instrument (ex. Scales) Microscope Measure the weight of the material to be used To see and observe objects that are very small (microscopic). Etc.

Images of the other laboratory equipment’s can be seen in figure 2.

![Laboratory Equipment](image)

**Figure 2. Laboratory Equipment's [16]**

From table 1 and figure 2 it is seen that the laboratory equipment has various functions and handling will the reliability of the tool will certainly vary according to the function and type of materials used.

For the preservation material, discussing to how make a preservative solution and its utilization.

Preservatives are made, usually used for plants and animals. The preservation of animals that have been discovered by anatomists is used to preserve biological specimens with side effects and retain at least their original features by soaking and storing them in chemical liquids [17]. In laboratory activities, 10% formalin is often used. Actually formalin can only maintain the specimen in some time, but it cannot retain the texture. Even soaked specimens will rapidly lose colour and their surface features worsen [18].

The result of questionnaire analysis of students' needs assessed from aspects of availability, components, materials and content, graffiti and linguistic, practice and Problem Based Learning approach obtained average 92.15%. The elaboration of the assessment indicators is a Table 2.

**Table 2. Results of Student Needs Assessment Analysis of Problem-Based Learning Handbook Development.**

| Aspects observed             | Average | Category   |
|------------------------------|---------|------------|
| Availability of the Handbook | 100     | Very good  |
| Handbook Components          | 97.77   | Very good  |
| Content and Material of Handbook | 90     | Very good  |
Table 2 shows the results of the questionnaire analysis of student needs on the development of Problem Based Learning handbook on introductory and laboratory techniques. Viewed from each aspect, the aspect of availability and components, as well as the content and material of the practicum guide obtained very good criteria for the development handbook. From the aspect of seen that the availability of handbook is needed when doing practica activities, this is because the guidance lab works to assist students in finding the results of activities that are practiced. Practica activities are scientific activities or scientific processes that can’t be separated with the skills of the science process. Bryce et al. (1990) say that science process skills include basic skills followed by process skills, as the highest skills are investigation skill [19]. So the willingness of handbook can help the student in finding the information given.

Viewed from the aspect of the handbook component belonging to the category very well, it shows that in making a handbook, must make all the components of a good handbook. The components of a proper laboratory handbook according that contains the title, basic competence, goals to be achieved, completion time, equipment or materials needed to complete tasks, work steps, tasks to be done, and reports to do [2]. And if seen from the content and the material contained in the handbook, the material and the guidance content presented must be in accordance with the purpose of the practicum that will be executed. This material is the basic or theoretical study listed in a handbook. Theoretical basis, is the material related to practica activities and used as a reference in practicum activities [20]. The material is expected to be useful to the practitioner at the time of preparing the practica report. The theoretical basis is presented explicitly and in writing in a concise, clear, comprehensive, interesting and challenging manner that serves to provide insight into the thinking knowledge that is expected to facilitate the practitioner in practicing and achieving the practical objectives.

Aspects of degrading and linguistic belonging to the good category give the meaning that the guidance developed must be in accordance with the Enhanced spelling in the Indonesian language. In addition, arrangement and color in the form of teaching and language structure used in accordance with the level of student development. In terms of language, printed medium should pay attention to the easy language that is the flow of vocabulary, clarification of sentences, clarification of sentences, and sentences that are not too long [21]. It holds that English can be understood in the language of a handbook. Seen from the aspect of practica implementation that shows good category, it means applying practica by using the handbook to make active and conducive learning atmosphere, in conducting practica activity, students can coordinate with group members and be active in finding what they do. The practice can also work well if supported by adequate facilities.

Aspects of the problem-based learning approach belong to the good category, it shows that the handbook using the PBL approach can make students active and creative. Besides, PBL is an approach that can make students act as scientists because they find and solve their own problems. In accordance with the syntax in the CIB is the student's orientation to the problem, defining the problem and organizing the students to learn, combining independent investigation or group investigation, developing and presenting works, reflections, and judgments [6]. Thus the students are encouraged to build their own knowledge of the problem given in accordance with the purpose lab. This also fits with the advantages of PBL is to provide a good enough technique to understand the content of a lesson, challenge the student's ability and give satisfaction to the discovery of new knowledge, increase learning activities, and help the student how to transferring his new knowledge to understand real-life problems[22]. And the strength of PBL approach is that it encourages student controlled learning [23].

4. Conclusion
The conclusion in this study is the need of students towards the development of handbook based on Problem Based Learning approach in laboratory subject is very good to be developed.

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