Contribution of Physics Learning Laboratory on Laboratory Management Course

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Abstract. This research aims to determine the contribution of physics learning laboratories to laboratory management courses. The method used in this research is descriptive quantitative and qualitative. The qualitative research process is circular in nature and quantitative is linear. The results of this study indicate that the learning laboratory owned by the Physics Education Study Program, Universitas Negeri Jakarta obtained a percentage of 100% for five categories: minimal area, capacity, lighting, cleanliness and tidiness, and infrastructure, while 87.5% for the room facilities category. The value of 87.5% was obtained because there were some components that did not fit the criteria of a good learning laboratory. The contribution to laboratory management courses shows that four of the five basic competencies (laboratory administration, standardization of physics laboratories, operation of laboratory support equipment and laboratory work safety) are carried out in an integrated manner with physics learning laboratories, while laboratory competence and functions can be done theoretically in class. Based on the results and discussion above, it can be concluded that the physics learning laboratory of the Physics Education Study Program, Universitas Negeri Jakarta has quality with a very decent category and has a major contribution in supporting laboratory management lectures.

1. Introduction
Physics Education study program students who will take the School Field Practice program (Field School Practice / PLP) must be able to follow the development of education in schools. High school education is currently experiencing very rapid development, 2013 Physics curriculum demand to bring up the critical and creative thinking skills of students. To fulfill students' abilities according to these demands, students who will carry out PLP must be prepared in lectures, not only capable of teaching skills but must also be able to have skills in managing school laboratories. A laboratory is an inseparable tool for learning in the fields of science, social and technology.

The laboratory is in principle a place of observation, experimentation, training and testing of concepts of knowledge and technology. School and university laboratories are expected to support the teaching and learning process in order to achieve learning objectives. The laboratory also needs experts who are called scientific and management laboratory assistants. One of the courses that teach prospective
teachers to have physics laboratory management skills is available due to an effort to improve the quality of lectures in physics education study program, FMIPA Universitas Negeri Jakarta. To facilitate quality improvement, facilities are provided in the form of physics learning laboratories.

Physics learning laboratory in accordance with Government Regulation No. 19/2005 concerning National Education Standards and elaborated in Minister of National Education Regulation No. 24/2007, the laboratory is a place to apply scientific theory, theoretical testing, proof of research trials, and so on by using tools that are complete from facilities with adequate quantity and quality. Physics education students are teacher candidates who are prepared to become learning agents. A teacher not only teaches in class but also as a facilitator in laboratory activities at school [1].

The usefulness of the functions of the physics learning laboratory greatly contributes where it can be seen that routine learning activities are carried out in the laboratory. The smooth activity in the physics learning laboratory is inseparable from good laboratory management, it covers administration management, layout of rooms and tools, availability of tools and materials as well as setting laboratory use schedules that are consistent with Government Regulation no. 19 of 2005.

Learning will be effective when it is supported by several factors, namely adequate facilities to support all practicum activities in the laboratory, which means realizing the importance of the effectiveness of direct learning in practice [2]. In previous studies, the planning of the physics learning laboratory work program was carried out intensively and effectively so as to provide maximum contribution and optimal benefits for laboratory management courses. Good planning supports planning competence of lectures according to those listed in the laboratory management plan [3].

Based on the explanation above, it appears that the physics learning laboratory is integrated with several education courses. Laboratory management is a process of utilizing resources effectively and efficiently to achieve an expected target optimally by taking into account the sustainability of the resource function. Management should be carried out in accordance with the elements or functions of management, namely planning, organizing, giving commands, coordinating, and controlling [1].

In order to optimize the use of laboratory facilities in learning physics, a teacher/prospective physics teacher must have the knowledge and skills to work in a laboratory. Prospective physics teachers must be given learning experiences that can improve their competence in empowering laboratories [4]. The dimensions of laboratory management courses consist of laboratory organization, laboratory administration (inventory of laboratory equipment and facilities, administration of laboratory use, administration of laboratory equipment lending, administration of laboratory equipment maintenance), and work safety in the laboratory [5].

In previous studies, there was a laboratory contribution in terms of supporting plates that could help protect chemical subjects. 82% of the tools can be used to facilitate learning activities and teach chemistry subjects [6]. With the existence of physics learning laboratory facilities, the lecture activities for laboratory management courses can be carried out and the facilities therein can support the material contained. So the laboratory can contribute to the physics education program laboratory course. By seeing the many benefits of the laboratory to the lecture the contribution of the laboratory can be seen, it can be evaluated in laboratory facilities and performance, as a material for future laboratory management planning. It is hoped that the results of this study can be used as a laboratory evaluation material.

This research is directed to study the factors that can influence the learning process externally. Based on the description above, several questions emerge that will be studied in this study, the main questions are arranged in the form of problem form as follows: (1) What is the description of the management of physics learning laboratories in the Physics Education Study Program, FMIPA Jakarta State University?; (2) How much does laboratory management contribute to the learning process in laboratory management course?

### 2. Method

There are four keywords that need to be considered, they are the scientific way, data, purpose, and usability. The research method used descriptive quantitative and qualitative. The qualitative research
process is circular in nature and quantitative is linear. Both of these methods can be used together because this study is conducted on the same object, but with different goals. The qualitative to find hypotheses while the quantitative to test hypotheses [7].

Data collection is through direct interviews, indirect observation and documentation. A structured interview is a data collection technique if the researcher knows exactly what information is obtained so that the researcher has prepared a research instrument in the form of written questions for which alternative answers have been prepared. Indirect observation is a data collection technique from researchers that is not present directly in the midst of respondents. Documentation is a data collection technique about things or variables in the form of notes, transcripts, pictures, books, and agendas [7].

The data generated will be analyzed using data validity techniques, namely the criteria for the degree of trust and information. The criterion of trustworthiness is by examining source triangulation techniques. Source triangulation is testing the validity of the data by checking data that has been obtained from several sources. While the information criteria are detailed description checking techniques [8].

This research will be conducted in physics learning laboratory, FMIPA Universitas Negeri Jakarta, which was selected using a purposive sampling technique, which is a sampling technique chosen based on specific objectives [6]. Based on the problems in this study, the subject of the study were all physics education students of FMIPA Universitas Negeri Jakarta who were taking physics education students, amounting to 39 students. This research was conducted in 2018 even semester.

3. Results and Discussion
Learning laboratory is one of the infrastructures that is owned by the physics education study program, FMIPA UNJ. By category, educational laboratories are included in the basic laboratories category. The learning media laboratory has standards that can be seen as a whole in Figure 1.

![Figure 1. Physics Learning Laboratory Condition.](image)

Based on Figure 1, the condition of the Physics learning laboratory has a good percentage of 100% for the four categories, namely minimum area, capacity, lighting, cleanliness and tidiness, and educational equipment. The space facility has a value of 87.5% because it has a number of lacking factors.

In line with previous research, it was stated that the effectiveness of school learning is better if it is supported by good school facilities such as available laboratories and its facilities [5] [9]. In this case, the learning laboratory meets the laboratory requirements in terms of minimum area, capacity, lighting, cleanliness and tidiness, and educational equipment.

Minister of National Education Regulation No. 24 of 2007 has assigned 2.4 m² for one person. While the physics learning laboratory area is 100 m², it can accommodate a maximum of 40 students. For lecture-laboratory management courses, it is divided into 2 sessions. So, in the intensity of 1 session, there are 20 students, in this category the laboratory is very feasible in terms of area and capacity so that it should indeed score 100%.
In terms of lighting the learning laboratory in the category is very good with value 100%. Located on the 5th floor of the building and has 7 large active windows that support lighting. There are 16 long tube-shaped points of lights that function well. This is in line with previous research that the lamps were installed using tube-shaped lamps [10].

Window dimensions 1 x 1.5 meters per unit. The window can be opened manually and uses an aluminium frame so that it is safe from corrosion or termites. The window is also equipped with a lock so that it cannot be opened from the outside. The glass used is 5 mm thick so that if it rains or there is a loud noise when carrying out learning in the laboratory enough to muffle the sound from outside.

The facilities and infrastructure of the learning laboratory were directly observed by researchers and colleagues with skilled PLP equipment obtained in Table 1.

Table 1. The facilities and infrastructure of Learning Laboratory.

| No | Type                        | Standard Ratio | Real Ratio                                                                                   | Suitability |
|----|-----------------------------|----------------|--------------------------------------------------------------------------------------------|-------------|
| 1  | Tool storage cabinet        | Tools category 1, 2, 3 are in a glass/metal cabinet where it is easy to open/close | There are 2 large metal cabinets, 2 component tool kit racks, 3 small metal cabinets, and 20 demonstration table drawers for storing materials. Because it includes the basic laboratory of education, the material used is included in category 1. All categories of tools are safe sliding doors. There is a closet for bags and shoes. | Appropriate|
| 2  | Chair                       | 1 chair/student, 1 chair/lecturer, 1 chair/PLP | There are 20 student chairs, 1 leather chair for lecturers, 2 leather chairs for consultation, 2 leather chairs for PLP. | Appropriate|
| 3  | Table                       | 1 table/7 students, size 1 x 1.5 m, 1 lecturer table, 1 PLP table | There are 5 tables for 20 students, 1 table for lecturers, and 1 table for PLP. There is 1 laboratory registration table. There are 2 special tables of sensors with a length of 15x1 m. High table size 1 x 1 m for solar cell devices. | Appropriate|
| 4  | Demonstration table         | 1 table/laboratory | There are 4 demonstration tables on physics props | Appropriate|
| 5  | Preparation table           | 1 table/laboratory | There is no standard preparation table | Not Appropriate|
| 6  | Washtub                     | 1 tub/2 groups and 1 at the preparation table | The washtub is outside the laboratory | Not Appropriate|
| 7  | Ventilation                 | There is good ventilation | There are 6 window points for air ventilation | Appropriate|
| 8  | First aid kit and hydrant   | There are 1 first aid kit and 1 hydrant/laboratory | There is a complete first aid kit for first aid, medicine and hydrant that has not been expired | Appropriate|
| 9  | Trash can                   | 2 pieces/laboratory | There are 2 trash bins outside the lab so as not to disturb the air inside the lab. | Appropriate|
| 10 | LCD                         | There is 1 unit/laboratory | There is a colourful LCD 1 piece | Appropriate|
| 11 | Whiteboard                  | 1 unit/laboratory | There is a large whiteboard size 3 m x 1.5 m | Appropriate|
| 12 | Electrical socket           | 9 units/laboratory | There are 20 portable power sockets | Appropriate|
| 13 | Clock                       | 1 unit/laboratory | There is 1 wall clock in front | Appropriate|
| 14 | Door                        | 2 pieces/laboratory (in and out) | There is 1 door with 2 openings | Not Appropriate|
| 15 | Lamp                        | 6 pairs/laboratory | 16 points each with 3 tube bulbs | Appropriate|
| 16 | Switch                      | 2 switches | 4 switches with good condition | Appropriate|
From the results of space facilities observations, physics learning laboratories have excellent facilities to support the practice courses of school physics laboratory management. Room facilities are in accordance with the physics laboratory at the school. There are some inappropriate aspects such as a sink that is not located in the laboratory, a door that has no in and out marker, and a preparation table that is not in the lab because the preparation table is used to put physics teaching aids. This shows that physics learning laboratories in terms of laboratory facilities deserve a score of 87.5%. Educational equipment in the learning laboratory is directly observed by researchers and colleagues with skilled PLP devices obtained in the school. There are some inappropriate aspects such as a table that is not located in the laboratory, a door that has no in and out marker, and a preparation table that is not in the lab because the preparation table is used to put physics teaching aids. This shows that physics learning laboratories in terms of laboratory facilities deserve a score of 87.5%. Educational equipment in the learning laboratory is directly observed by researchers and colleagues with skilled PLP devices obtained in Table 2.

Table 2. Educational equipment in the learning laboratory.

| No   | Type                              | Total   | Feasibility | No   | Type                              | Total   | Feasibility |
|------|-----------------------------------|---------|-------------|------|-----------------------------------|---------|-------------|
| 1    | High School Mechanics KIT         | 3 KIT   | Feasible    | 29   | Aquades                          | 1 L     | Feasible    |
| 2    | Electromagnetic KIT               | 3 KIT   | Feasible    | 30   | Vinegar                          | 1 bottle| Feasible    |
| 3    | Solar System KIT                  | 1 KIT   | Feasible    | 31   | Glycerine                        | 1 bottle| Feasible    |
| 4    | Sun, Earth, and Moon KIT          | 1 KIT   | Feasible    | 32   | Hose bottle                      | 1 bottle| Feasible    |
| 5    | Solar KIT                         | 3 KIT   | Feasible    | 33   | Ether                            | 1 bottle| Feasible    |
| 6    | Mechanics KIT                     | 4 KIT   | Feasible    | 34   | Gas Lighters                     | 3 pieces| Feasible    |
| 7    | High School Electromagnetic KIT   | 1 KIT   | Feasible    | 35   | Aluminium Foil                   | 1 pack  | Feasible    |
| 8    | Digestive System KIT              | 1 KIT   | Feasible    | 36   | Plastic Pipe                     | 8 pipes | Feasible    |
| 9    | Animal KIT                        | 1 KIT   | Feasible    | 37   | Iron Bar                        | 8 bars  | Feasible    |
| 10   | Energy KIT                        | 1 KIT   | Feasible    | 38   | Copper Bar                       | 8 bars  | Feasible    |
| 11   | Nutrition KIT                     | 1 KIT   | Feasible    | 39   | Glass Bar                       | 8 bars  | Feasible    |
| 12   | Optics KIT                        | 2 KIT   | Feasible    | 40   | A3 Battery                       | 5 set   | Feasible    |
| 13   | Magnet KIT                        | 1 KIT   | Feasible    | 41   | A2 Battery                       | 2 set   | Feasible    |
| 14   | Light KIT                         | 1 KIT   | Feasible    | 42   | A23 Battery                      | 5 set   | Feasible    |
| 15   | Electromagnetic KIT               | 1 KIT   | Feasible    | 43   | Box of 9V Battery                | 2 set   | Feasible    |
| 16   | Earth KIT                         | 1 KIT   | Feasible    | 44   | Butane Gas                       | 2 packs | Feasible    |
| 17   | Coal and Oil KIT                  | 1 KIT   | Feasible    | 45   | Portable Butane Gas              | 1 pack  | Feasible    |
| 18   | Mineral KIT                       | 1 KIT   | Feasible    | 46   | Methane                          | 1 L     | Feasible    |
| 19   | Kinetic Gas KIT                   | 2 KIT   | Feasible    | 47   | Student Worksheet of Newton's Law| 1 set   | Feasible    |
| 20   | Thermodynamic and Wave KIT        | 1 KIT   | Feasible    | 48   | Student Worksheet of Harmonic Motion| 1 set | Feasible    |
| 21   | Hydrostatic and Heat KIT          | 1 KIT   | Feasible    | 49   | Student Worksheet of Static Fluid | 1 set | Feasible    |
| 22   | Straw                             | 1 pack  | Feasible    | 50   | Student Worksheet of Phywe        | 1 set   | Feasible    |
| 23   | Skewers                           | 5 pieces| Feasible    | 51   | Student Worksheet of Jeulin       | 1 set   | Feasible    |
| 24   | Gloves                            | 2 set   | Feasible    | 52   | Student Worksheet of Wave         | 1 set   | Feasible    |
| 25   | Latex Gloves                      | 2 pack  | Feasible    | 53   | Student Worksheet of Tool         | 1 set   | Feasible    |
| 26   | Face Mask                         | 1 pack  | Feasible    | 54   | Student Worksheet of Direct Current Electricity| 1 set | Feasible    |
| 27   | Safety Glasses                    | 2 pieces| Feasible    | 55   | Student Worksheet of Basic Physics Practicum| 1 set | Feasible    |
| 28   | Laboratory Coat                   | 1 piece | Feasible    | 56   | Student Worksheet of Kinematic    | 2 set   | Feasible    |

From the results of observation of educational equipment, physics learning laboratories have excellent facilities to support the school physics laboratory management practice courses. Educational equipment is in accordance with the physics laboratory at school.

From the results of the lecture administration analysis, there are several courses integrated with the learning laboratory where at the beginning of the semester the supervisor will coordinate with the person in charge of the laboratory regarding the scheduling of the use of physics learning laboratories.
One of these courses is laboratory management, it is to conduct activities in the laboratory to train laboratory organizing skills, know the category of tools, use of tools/kits for physics teaching aids, learn about the proper procedures for managing tools/kits for physics. As stated in previous studies of educational laboratories (specifically at tertiary institutions), are academic support units at tertiary institutions, which are used for educational, research and community service activities; by using 1) equipment and 2) materials, 3) certain scientific methods [11].

Meanwhile, to find out how much the laboratory can facilitate learning, namely by analyzing the lecture devices/semester lecture design (RPS) and observing the use of the laboratory for one semester. For laboratory management courses wherein the course, there are basic competencies including (1) Laboratories and their functions, (2) Laboratory administration (3) Physics laboratory standards (4) Operation of laboratory support equipment, (5) Laboratory work safety (see Table 3).

### Table 3. Laboratory Management Lecture Activities.

| No | Competence | Status | Explanation |
|----|------------|--------|-------------|
| 1  | Laboratory and Functions (class) | This material can be presented classically by lecture method or powerpoint presentation | In the initial material, students are given an explanation in class for the first meeting for 2 hours. Students are not divided into 2 sessions for the first meeting in class. In class, students divide groups and are explained systematically and lecturing principles. |
| 2  | Laboratory administration (physics education learning laboratory) | Presented in the laboratory at the 2nd and 3rd meeting | At the 2nd and 3rd meetings, students protected the administration and inventory of the laboratory. the example provided is in the form of laboratory administration. then they work in groups to make administration and inventory based on physics learning laboratories |
| 3  | Physics laboratory standards (Physics education teaching school and school) | At meetings 4 and 5, students survey the school laboratory | At the 5th meeting, the students surveyed the school laboratory to view and observe group field facts. The 6th and 7th meeting of the students made a map and observatory laboratory standards and compared laboratory standards according to Government Regulation No.24 of 2007 |
| 4  | Operation of laboratory support equipment (physics education learning laboratory) | At meetings 6 to 13 | At meetings 6 through 13, students learn to operate a physics device based on a tool category. Tools in the form of KIT and instruments for heat, mechanical, electrical and optical materials. 1 group consists of 4 people, each group must try all the tools and KIT according to the 4 themes above including the measurement tools. |
| 5  | Laboratory work safety (physics education learning laboratory and in-class) | At meeting 14 | At the 14th meeting, students understood the safety of basic laboratory work. Handling of minor work accidents. There is a similarity that every student must understand and do as a group |
| 6  | Presentation (Class) | At meeting 15 and 16 | At the 15th and 16th meeting, students presented the results of lectures and observations in groups. There are 8 groups that will change their presentations in class. |

Learning activities of laboratory materials and their functions can be done in theory in class. Laboratory administration materials can be learned by understanding the administrative formats that are already available in the laboratory such as laboratory rules, student attendance lists, daily activity books, timelines and equipment usage lists, inventory tools, materials and goods, maintenance schedules and equipment repairs, request/submission of tools, materials and goods, equipment lending forms, materials and goods, tool replacement cards, tool delivery cards, list of results of practicum submission, list of
practicum values, manuals for using tools and KIT, maps of materials and tools. Good standard laboratory material can be done in theory or direct observation in physics learning laboratories. Material for supporting laboratory operations can practice in the laboratory using kits/teaching aids that are available with mechanical, electrical, heat, wave, optical, magnetic materials and in accordance with the purpose of the pursuit. Material for laboratory safety can be studied in theory or observation/practice directly in the laboratory.

The contribution of physics learning laboratories is very much in line with the results of previous studies which state that the skills in using, managing laboratory tools and materials are indispensable to support the successful process of learning science. With the meaning of lectures conducted as a provision to face the reality of learning in school [12].

Of the five basic competencies, four of them are laboratory administration, operation of laboratory support equipment and laboratory work safety are carried out in an integrated manner with physics learning laboratories.

The above results are in accordance with previous studies, namely the role of educational laboratories, especially in the field of student skills, including: (1) Training students to be skilled in carrying out practical technical skills activities for various skill sub-fields, (2) Assembling and installing laboratory equipment / equipment for technical skills, (3) Conducting experimental activities to check, test and examine the laboratory equipment, technical skills, provisions and standardization that has been made, (4) forming specific component designs in various expertise using laboratory facilities, (5) serving students and the public in conducting educational practice through laboratory equipment as a technical medium and (6) caring for and repairing equipment / laboratory equipment in technical skills [13].

To find out the use of the laboratory for one semester by processing data from the results of laboratory user books and student interviews in Figure 2.

![Figure 2](image)

**Figure 2. Total of Usage per Month.**

Laboratory management has a credit load of 2 credits, i.e. 2 hours/week 16 meetings in March to June. So, 1 week there is 1 time meeting for 2 hours. But in this case, students are divided into 2 learning sessions, namely Tuesday and Thursday. Each session consisted of 19 and 20 students.
So, the physics learning laboratories is used 8 times a month. In other words, the total hours used is 4 hours/week for a course outside of theoretical hours. Thus, the use of physics learning laboratories greatly supports lectures on laboratory management courses.

This is in line with previous studies which state that the use of laboratories in the learning process has a significant contribution to the learning process [14] [15] and has an influence on students’ critical and creative thinking skills [16]. Not only for students, but high school physics laboratories can be utilized in supporting the learning process of physics effectively and efficiently, after management and administration of the laboratory are addressed, making it easier for teachers and students [17]. Seeing the laboratory experience in the context of what happened before and after, as well as other learning, the use of the laboratory can indeed increase the potential of current learning [18]. This is in line with the statement which states that the laboratory is a source of learning science [19]. Because by allowing students to learn a piece of knowledge from experience in the laboratory will be much better [20].

4. Conclusion
Based on the discussion that has been explained, it can be concluded that the physics learning laboratory of the Physics Education Study Program, FMIPA Universitas Negeri Jakarta has quality with a very decent category in terms of minimum area, tamping power, lighting, room facilities, as well as cleanliness and tidiness. The existence of physics learning laboratory Physics Education Study Program, FMIPA Universitas Negeri Jakarta has a major contribution in supporting laboratory management lectures.

This research has clearly explained the quality of physics learning laboratories and their contribution to laboratory management lectures. However, due to limited time and manpower, this research only focuses on the physics learning laboratory of the Physics Education Study Program, FMIPA Universitas Negeri Jakarta. Therefore, this can be input for further research that is similar to evaluating the relationship between physics learning laboratories with other laboratories, as well as their contribution to laboratory management courses or similar courses.

In technological development, the implementation of physics learning laboratories can be improved, including by developing virtual labs. The use of virtual lab can improve the ability of scientific literacy, problem solving skills, and teacher creativity. By utilizing real lab and virtual lab (blended learning), students, and teachers can benefit from the use of both types of laboratories.

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