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Optimizing Educational Laboratories for Institutional Development in Indonesia

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Abstract

The use of educational laboratories in the higher education learning process plays a crucial role in facilitating practical understanding of complex concepts. Factors such as equipment availability, faculty lecturers' expertise, and technology have influenced the effectiveness of educational laboratories. For educational institutions to improve their laboratory effectiveness, it's crucial to have well-coordinated planning in alignment with the curriculum. This study aims to develop the concept of optimizing educational laboratories at the Faculty of Education Sciences, State University of Surabaya, Indonesia. This study used descriptive qualitative research with a case study approach. Data were collected through observations, interviews, and document analysis and analyzed using qualitative descriptive analysis techniques. The research results show that the facilities and infrastructure of the laboratories at the Faculty of Education, State University of Surabaya, are adequate, with quality supervision and maintenance. The development of laboratory products, including usage guidelines, standard operating procedures (SOP), and training instrument packages, has provided practical guidance and enhanced students' learning experiences. All of these products play a crucial role in improving the efficiency, effectiveness, and quality of educational laboratory utilization. Thus, the development of educational laboratories at the Faculty of Education Sciences, State University of Surabaya, Indonesia, has positively contributed to the enhancement of higher education quality in Indonesia and has prepared students to face real-world challenges.

K*eywords:* *Optimization; Laboratory; Education; Institution*

Introduction

The use of educational laboratories in the learning process can help students understand difficult concepts in a more practical way (Potkonjak et al, 2016). According to Jammeh et al, (2023), factors that influence the effectiveness of educational laboratories include the availability of equipment, the ability of lecturers, and the use of technology in learning. Optimizing the use of educational laboratories as a means of institutional development requires careful planning and integration with the curriculum (Okori & Jerry, 2017). According to Conner & Sliwka (2014), effective learning requires a well-structured and organized learning experience. Therefore, it is important to have standard Operational Procedures (SOP) for laboratory use, as well as identifying existing laboratories to ensure concrete use (Barbe et al., 2016).

Apart from that, there is also a need for support and training to improve lecturers' abilities in integrating educational laboratories with the curriculum and utilizing technology in learning.

One of the problems found was the limited laboratory facilities and infrastructure available. Apart from that, the use of educational laboratories is not yet optimal and there is no standard SOP for their use. This can influence the effectiveness of using educational laboratories in improving the quality of education (Robinson, 2013). Another problem is that there is still no concrete use of laboratories and there needs to be a thorough identification of existing laboratories. Therefore, descriptive research is needed to determine the optimization of faculty laboratories.

Furthermore, the role of lecturers is crucial for the effectiveness of educational laboratories (Heradio et al., 2016). lecturers must be able to manage the laboratory effectively, explain experiment procedures to students, and guide them throughout the learning process (Acar & Tarhan, 2013). They should also be able to address student queries and provide clear instructions. Enhancing instructors' capabilities in this regard is imperative, and regular training and professional development can be beneficial. Moreover, the use of technology in education can improve the effectiveness of educational labs. With the right technology, students can efficiently collect data, analyze results, and create reports (Martin et al., 2017). Technology can also facilitate distance learning, which is particularly relevant in the context of education during the COVID-19 pandemic (Parikesit et al., 2021).

It's important to remember that the use of educational laboratories isn't just about providing physical facilities but also about careful planning and seamless integration with the curriculum (Pastor et al., 2020). This means that education should be an integral part of the study program, and activities within them should closely align with established learning objectives (Lunneta, Hofstein & Clough, 2013). Additionally, identifying existing laboratory is a crucial step in ensuring their practical utilization. Educational institutions should evaluate the existing laboratory to ensure equipment and facilities are adequate and decide whether there's a need to enhance or update the labs. Identification also aids in resource allocation (Purnomo et al., 2020).

This study focuses on optimizing educational laboratories in higher education to improve learning quality and institutional goals (Benavides, 2020). This study aims to make education more efficient and aligned with the applied curriculum. The study explores how educational laboratories can best support institutional goals and mission, including a thorough assessment of their impact on educational quality. One of the benefits that extends beyond academic advantages is the optimization of laboratories in each program, which prepares graduates to tackle real-world challenges in their chosen fields. Thus, the research seeks to develop the concept of optimizing education laboratories into higher education institution development.

Research Method

1. Research Design

This study used qualitative descriptive approach with a case study methodology (Zucker, 2016). The data were collected and qualitatively and analyzed using coding techniques to identify key themes (Williams & Moser, 2019). Data were integrated to gain a deeper understanding of the effectiveness of educational laboratories and the strategies applied to optimize it. In this research, the focus is on the development of educational laboratories within a single educational institution. Therefore, the case study method is appropriate for use. Here is the research procedure that will be followed:

a. Preparation Stage

1) Setting research objectives and formulating research questions.
2) Creating a theoretical framework and literature review.
3) Determining data collection methods and techniques.

b. Data Collection Stage

1) Observing the educational laboratories.
2) Conducting interviews with students, professors, and staff involved in the use of educational laboratories.
3) Gathering documentary data, such as laboratory usage guidelines and records.

c. Data Analysis Stage

1) Organizing data and transcribing interviews.
2) Creating codes for thematic categories emerging from the data.
3) Classifying data based on themes and comparing it with the theoretical framework and previous research.
4) Analysing data using qualitative descriptive analysis techniques.

d. Conclusion and Recommendations Stage

1) Summarizing research findings and comparing them to previous research.
2) Providing recommendations for the development of educational laboratories as a means of enhancing the educational institution.
3) Presenting research findings and recommendations in the form of a research report.

2. Research Subject

The research subjects in this study were students and faculty members who used the educational laboratories in Faculty of Education at Universitas Negeri Surabaya (UNESA).

3. Data Collection Techniques

Data were collected through observation, interviews, and document analysis. Observation was conducted to directly assess the condition of educational laboratories, their usage by students and faculty, as well as the challenges faced. Interviews with students and faculty members were conducted to obtain deeper insights into their experiences and opinions regarding the use of educational laboratories. Documents, including guidelines, schedules, and reports, were reviewed to gain a comprehensive understanding of educational laboratory usage and associated challenges.

4. Data Analysis Technique

Qualitative descriptive analysis was used to analyze data from observations, interviews, and document analysis systematically, focusing on all obtained information. Data were organized and categorized according to research objectives, followed by qualitative analysis to identify patterns and relationships, incorporating relevant theories from the literature. The results were used to answer research questions, objectives, and inform conclusions and recommendations.

Results and Discussion

1. Results

a. Facilities and Infrastructure of Educational Laboratories

The facilities and infrastructure at the Faculty of Education, UNESA are important for effective and innovative learning. These facilities are in good condition and customized to meet the needs of the various study programs within the faculty. Each study program has different requirements and objectives for the use of educational laboratories, and these laboratories have been specifically developed to meet those needs.

To preserve the quality of laboratory facilities and infrastructure, faculty of education conducts regular monitoring. The institution takes measures to ensure that laboratory equipment operates at its best, promptly addressing any damage, and maintains a clean and conducive environment for teaching and learning activities. Overall, condition of educational laboratory facilities and infrastructure is deemed satisfactory and conducive to the advancement of knowledge and learning in the education field. Supervision and maintenance of existing facilities in educational laboratories show commitment of the faculty to maintaining high and sustainable education quality.

b. The Analysis of the Current Use of Educational Laboratories

The analysis of current educational laboratory usage at the faculty of Education, UNESA highlights the emphasis on efficiency and quality. Detailed steps and program-specific Standard Operating Procedures (SOPs) are in place for each laboratory.

Step 1. Lecturer Fills in the Laboratory Use Form

The process starts when a lecturer planning a practicum completes the Laboratory Use Form, which includes details about the practicum schedule and required equipment.

Step 2. Laboratory Coordinator Checks Readiness

The laboratory coordinator receives the form provided by the lecturer, checking the practicum schedule, equipment availability, and the chosen laboratory room.

Step 3. Laboratory Assistant Prepares Equipment and Room

After the coordinator confirms readiness, the laboratory assistant is responsible for preparing all the equipment needed for the practicum. This must be done a maximum of one hour before the practical activity begins. The laboratory assistant also checks the condition of the laboratory room.

Step 4. Lecturers and Students Fill in the Practical Journal Book

During the practicum, lecturers and students work together to fill in the practicum journal. This includes notes regarding the practicum process, results obtained, as well as observations and reflections.

Step 5. Doing Practicum and Filling in Student Worksheets

Lecturers and students do practical activities. After the practicum is finished, they fill in a student worksheet that records the activities and results of the practicum that has been carried out.

Step 6. Laboratory personnel check and clean up

After the practicum is complete, laboratory staff check the equipment, materials and room. If something is damaged or inappropriate, a report is made to the laboratory coordinator within a maximum of 1 hour after use.

The Last Step.

After the process of using the laboratory is complete, all related parties have the responsibility to maintain the cleanliness of the room according to the laboratory rules and regulations.

c. The Educational Laboratory Product Development Process

The process for developing educational laboratory support at the Faculty of Education UNESA starts with identifying needs, involving students, lecturers, and the curriculum. This results in a Standard Operating Procedure (SOPs) that covers consistent product use and maintenance. The SOP includes usage instructions, maintenance schedules, and protocols for addressing technical issues. These SOPs guide lecturers and students in effective and efficient product use, maintaining lab quality, and ensuring long-term sustainability. Standardized SOPs help institutions align lab usage with development goals and objectives.

Next, the product concept is designed and executed in prototype form. Key users evaluate this prototype. The evaluation results are used to make improvements to the product. After the product meets the desired standards, it is implemented in the learning process in the laboratory. The next stages involve ongoing monitoring, maintenance and evaluation to ensure the product continues to support the effectiveness of learning in educational laboratory. This process focuses on improving products to improve the quality of education in institutions.

Results of Educational Laboratory Product Development in the Learning Process

In supporting the learning process at the Faculty of Education, Surabaya State University, developing educational laboratory products has become an important step to ensure the effectiveness, efficiency and quality of the use of these facilities. Several products that have been developed and play a central role in supporting laboratories at FIP UNESA include laboratory use guides, Standard Operating Procedures (SOP) for laboratory use, as well as training package instruments provided by educational laboratories.

Laboratory Use Guide: An educational laboratory use guide is a guide that provides detailed information about laboratory use, including practical guidelines, learning objectives, steps for using equipment, as well as rules and regulations that lecturers and students must follow. With this laboratory use guide, learning in the laboratory can take place in a more structured and efficient manner.

SOP for Laboratory Use: Each laboratory has a Standard Operating Procedure (SOP) that has been determined in accordance with the needs and specifications of the study program it covers. This SOP outlines the technical steps that must be followed in laboratory use, including procedures for using equipment, handling hazardous materials, equipment maintenance, and safety measures. SOPs are the main guidelines for laboratory coordinators, laboratory assistants, lecturers, and students in carrying out each stage of laboratory use safely and according to standards.

Training Package Instrument: The educational laboratory has also developed a training package instrument specifically designed to support the learning process. This package can contain interactive learning modules, digital teaching materials, simulations, and various other innovative learning tools. This instrument is designed to provide a more in-depth and interactive learning experience for students, as well as supporting a technology-based learning approach.

Through the development of this product, the educational laboratory has taken important steps to improve the quality of learning. Manuals provide clear direction, SOPs ensure consistency and safety, while training package instruments enable more engaging and innovative learning approaches. In this way, students can experience direct benefits from the use of laboratory facilities that are more targeted and effective in supporting understanding of concepts and the development of skills.

2. Discussion

In supporting the learning process at the Faculty of Education, Surabaya State University, the development of educational laboratory products has had a significant positive impact. Several products that have been developed, such as laboratory use guidelines, Standard Operating Procedures (SOP) for laboratory use, and training package instruments, have helped improve the efficiency, effectiveness and quality of use of laboratory facilities.

Guidelines for laboratory use are an important guide for lecturers and students. This guide outlines practical steps in utilizing laboratory facilities, offers clear learning objectives, and provides rules and regulations that must be followed. Guides for laboratory use help minimize errors in laboratory use and ensure consistency in learning methods (Haymood & McCudden, 2021).

SOPs for laboratory use also have a crucial role. Each laboratory has an SOP that is tailored to the study program in question. Specific SOPs help ensure the use of equipment and materials according to safety and quality standards (Schmidt & Pierce, 2016). SOPs regulate technical details, such as procedures for using tools, handling hazardous materials, and equipment maintenance (Reason, 2016). In this way, the learning process takes place more safely and structured. The training package instrument is a product that encourages interactive and innovative learning (Zhong et al, 2021). The interactive learning modules, simulations and digital teaching materials contained in this package create a deeper and more interesting learning experience (Vitaharju et al, 2021). Based on research by Johnson et al. (2019), the use of technology and innovative learning tools can motivate students to be more active in the learning process (Bali et al, 2021).

Therefore, the products developed in the educational laboratory at Faculty of Education have a positive impact on the student learning experience. References to practical guides, structured SOPs, and innovative training package instruments refer to guidelines that have been recognized in educational literature. With these products, at Faculty of Education has taken a step forward in ensuring effective, efficient and high-quality laboratory use.

Conclusion

The process of enhancing the utilization of educational laboratories at the Faculty of Education, Surabaya State University, has yielded significant positive outcomes through the development of laboratory resources. These efforts have resulted in well-maintained laboratory facilities and infrastructure that support effective learning, demonstrating a commitment to educational excellence through consistent supervision and upkeep. The implementation of standardized laboratory procedures via appropriate Standard Operating Procedures (SOPs) tailored to each study program ensures uniformity, safety, and efficiency in laboratory use. The development of laboratory resources, including user guides, SOPs, and instrument training materials, has played a vital role in providing practical guidance, streamlining technical aspects, and enhancing the overall interactive learning experience for students. Consequently, these initiatives have bolstered the quality of education at FIP UNESA, facilitated institutional progress, and equipped students with the skills needed to navigate the real-world challenges within their respective fields of study. This research represents a valuable contribution to the ongoing efforts aimed at improving higher education in Indonesia and serves as a foundation for the further development of efficient and high-quality educational laboratories.

References

Acar Sesen, B., & Tarhan, L. (2013). Inquiry-based laboratory activities in electrochemistry: High school students' achievements and attitudes. *Research in Science Education*, *43*, 413-435.

Bali, M. M. E. I., Baharun, H., Madanibillah, A., Muali, C., Lukman, N. K. A., & Bon, A. T. (2021, March). Innovative learning media based on e-learning in the new normal era. In *Proceedings of the 11th Annual International Conference on Industrial Engineering and Operations Management*.

Barbé, B., Verdonck, K., Mukendi, D., Lejon, V., Lilo Kalo, J. R., Alirol, E., ... & Jacobs, J. (2016). The art of writing and implementing standard operating procedures (SOPs) for laboratories in low-resource settings: review of guidelines and best practices. *PLoS neglected tropical diseases*, *10*(11), e0005053.

Benavides, L. M. C., Tamayo Arias, J. A., Arango Serna, M. D., Branch Bedoya, J. W., & Burgos, D. (2020). Digital transformation in higher education institutions: A systematic literature review. *Sensors*, *20*(11), 3291.

Conner, L., & Sliwka, A. (2014). Implications of research on effective learning environments for initial teacher education. *European Journal of Education*, *49*(2), 165-177.

Haymond, S., & McCudden, C. (2021). Rise of the machines: artificial intelligence and the clinical laboratory. *The journal of applied laboratory medicine*, *6*(6), 1640-1654.

Heradio, R., De La Torre, L., Galan, D., Cabrerizo, F. J., Herrera-Viedma, E., & Dormido, S. (2016). Virtual and remote labs in education: A bibliometric analysis. *Computers & Education*, *98*, 14-38.

Jammeh, A. L., Karegeya, C., & Ladage, S. (2023). Application of technological pedagogical content knowledge in smart classrooms: views and its effect on students' performance in chemistry. *Education and Information Technologies*, 1-31.

Lunetta, V. N., Hofstein, A., & Clough, M. P. (2013). Learning and teaching in the school science laboratory: An analysis of research, theory, and practice. In *Handbook of research on science education* (pp. 393-441). Routledge.

Martín-Gutiérrez, J., Mora, C. E., Añorbe-Díaz, B., & González-Marrero, A. (2017). Virtual technologies trends in education. *Eurasia journal of mathematics, science and technology education*, *13*(2), 469-486.

Okori, O. A., & Jerry, O. (2017). Improvisation and utilization of resources in the teaching and learning of science and mathematics in secondary schools in Cross River state. *Global Journal of Educational Research*, *16*(1), 21-28.

Parikesit, H., Adha, M. M., Hartino, A. T., & Ulpa, E. P. (2021). Implementasi teknologi dalam pembelajaran daring di tengah masa pandemik COVID-19. *Jurnal Pendidikan Kewarganegaraan Undiksha*, *9*(2), 545-554.

Pastor, R., Tobarra, L., Robles-Gómez, A., Cano, J., Hammad, B., Al-Zoubi, A., ... & Castro, M. (2020). Renewable energy remote online laboratories in Jordan universities: Tools for training students in Jordan. *Renewable Energy*, *149*, 749-759.

Potkonjak, V., Gardner, M., Callaghan, V., Mattila, P., Guetl, C., Petrović, V. M., & Jovanović, K. (2016). Virtual laboratories for education in science, technology, and engineering: A review. *Computers & Education*, *95*, 309-327.

Purnomo, M. R. A., Anugerah, A. R., & Dewipramesti, B. T. (2020). Sustainable supply chain management framework in a higher education laboratory using intuitionistic fuzzy cognitive map. *Journal of Industrial Engineering and Management (JIEM)*, *13*(2), 417-429.

Reason, J. (2016). *Managing the risks of organizational accidents*. Routledge.

Robinson, J. K. (2013). Project-based learning: improving student engagement and performance in the laboratory.

Schmidt, R. H., & Pierce, P. D. (2016). The use of standard operating procedures (SOPs). In *Handbook of hygiene control in the food industry* (pp. 221-233). Woodhead Publishing.

Viitaharju, P., Yliniemi, K., Nieminen, M., & Karttunen, A. J. (2021). Learning experiences from digital laboratory safety training. *Education for Chemical Engineers*, *34*, 87-93.

Williams, M., & Moser, T. (2019). The art of coding and thematic exploration in qualitative research. *International Management Review*, *15*(1), 45-55.

Zhong, B., Kang, S., & Zhan, Z. (2021). Investigating the effect of reverse engineering pedagogy in K-12 robotics education. *Computer Applications in Engineering Education*, *29*(5), 1097-1111.

Zucker, D. M. (2016). How to do case study research. In *Teaching research methods in the social sciences* (pp. 171-182). Routledge.

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