

Teacher and Student Perceptions of the Use of Virtual Laboratories in Science Learning

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Article Info

Article history:

Received 29-06-2026

Revised 17-07-2026

Accepted 21-08-2026

Keyword:

Perception, Teacher,
Students, Virtual
Laboratory

ABSTRACT

The laboratory plays a crucial role in science education, providing students with hands-on experiences essential for grasping scientific concepts. This piece emphasizes the significance of laboratories, highlighting their importance across diverse learning settings. Beyond physical confines, laboratories offer students opportunities to actively participate in experiments, fostering the development of fundamental skills and deepening their understanding of complex theories. Furthermore, laboratories ignite students' curiosity and passion for science by demonstrating practical applications of classroom teachings. Through laboratory work, students not only expand their knowledge but also establish connections between theoretical concepts and real-world scenarios, laying a solid groundwork for future scientific exploration. Moreover, laboratories promote principles of safety and ethics, instilling in students a sense of responsibility in scientific endeavors. In summary, laboratories serve as dynamic environments that enrich science education, empowering students and cultivating a new generation of innovative thinkers in the scientific community.



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INTRODUCTION

Science learning is a crucial component in the educational curriculum which aims to develop understanding of natural phenomena through experimental practice and observation. Along with advances in technology, the way science is taught has also changed, one of which is through the use of virtual laboratories. The virtual laboratory is a technological breakthrough that allows teachers and students to carry out experiments and observations through computer simulations. It is important to understand teachers' and students' perceptions of the use of virtual laboratories in science learning because this can influence the effectiveness of the learning process. By understanding how teachers and students respond to and interact with this technology, we can improve how it is used to more effectively support understanding of complex science concepts.

Education has undergone a profound transformation with the introduction of the concept of "freedom of learning" by the government. These changes have significantly changed the way learning is conducted at all levels of educational institutions. Teachers never previously imagined that they would teach students remotely without face-to-face interaction. Through the concept of "Learning from Home" or BDR, students are required to study independently in their home environment. Not only students feel confused, but teachers also face the same challenges, while parents also find it difficult to deal with this situation. This requires all parties involved in education to adapt to the new paradigm in distance learning and ensure that the quality of education is maintained even under different conditions Dewi Hariyanti, et al (2020).

The development of information and communication technology has changed many aspects of life, including education. One important innovation that has emerged from these advances is the virtual laboratory. Virtual laboratories provide an alternative to practicums that can be accessed online. They allow the simulation of various science experiments that are difficult or impractical to carry out in a physical laboratory. This is especially beneficial considering several constraints such as limited

resources and accessibility that are often faced in traditional laboratory settings. With virtual laboratories, students can access labs and experiments without space or time restrictions, increasing the flexibility and accessibility of science education as a whole. In the context of science learning, practicum is considered an important element that not only helps students understand theoretical concepts, but also develops practical and analytical skills. However, the implementation of practicums in physical laboratories is often faced with various obstacles, such as limited equipment and materials, high costs, and safety risks. Therefore, virtual laboratories are considered as a potential solution to overcome these challenges by providing a safe, flexible and more cost-effective environment.

The use of virtual laboratories in science learning has attracted interest from educators and researchers. Several studies show that virtual laboratories can improve concept understanding, student engagement, and critical thinking skills. However, the application of this technology also raises a number of challenges, such as the need for adequate technological infrastructure, training for teachers, and adapting the curriculum to suit the use of virtual laboratories. To understand how effective and challenging the use of virtual laboratories is in science learning, we need to explore the perspectives of two key stakeholders: teachers and students. Their perspectives provide important insights into the advantages, disadvantages, and factors that influence the successful use of virtual laboratories in science education. The teacher's perspective is very crucial because they act as the main director in the learning process. Apart from delivering material, teachers are also responsible for designing and managing student learning experiences. Therefore, teachers' views about the benefits, challenges and obstacles faced in using virtual laboratories will greatly influence the implementation and sustainability of this technology in science learning. By understanding teachers' perspectives, we can identify areas where additional support and training may be needed, as well as develop strategies to maximize the potential of virtual laboratories in improving students' understanding of science concept (Yuniarty dkk, 2022).

Teacher understanding also plays a major role in the effectiveness of implementing virtual laboratories in science teaching. Some teachers may feel less confident in adopting technology in the learning process, which can then influence their approach to delivering material and providing support to students. In addition, the level of technological knowledge and skills also impacts teachers' perceptions of the use of virtual laboratories. Teachers who have a good understanding of technology tend to be more open to the use of virtual laboratories in science learning, because they feel better able to integrate the technology effectively in their teaching.

The importance of student perceptions in adopting learning technologies such as virtual laboratories should not be overlooked. Students have a key role in the learning process, and how they accept and interact with new technology will influence the overall effectiveness of learning. Their understanding of the benefits, convenience, and experience of using virtual laboratories provides insight into the extent to which the technology meets their expectations and needs in learning science. Research has shown that virtual laboratories can increase students' motivation and interest in science. However, there are concerns that the lack of direct interaction with physical materials may detract from the development of the practical skills they would otherwise receive. Therefore, it is important to explore students' perceptions of the balance between the advantages and disadvantages of virtual laboratories in more depth.

Investigation of the use of virtual laboratories in educational contexts includes an understanding of how infrastructure, school culture, and educational policy play a role in the acceptance and use of this technology by teachers and students. By examining the perceptions of both parties, this research aims to provide a deeper understanding of the factors influencing the adoption and implementation of virtual laboratories in various educational settings. The researchers hope that the results of this research can produce valuable recommendations for the development and application of virtual laboratories in science learning. These recommendations will not only improve the quality of science education, but will also help prepare the younger generation to face the challenges and opportunities in the ever-evolving digital era. In other words, it is hoped that this research will be able to contribute important insights for educational progress in integrating new technology into the science curriculum.

RESEARCH METHODS

This article bases its research on library research methods, which are often referred to as library research, and has a qualitative approach. The qualitative approach is characterized by the exploration and explanation of descriptive data presented in narrative form, not just a collection of numbers or

statistics. For example, Bogdan and Taylor in Andri (2017) emphasize that the qualitative approach focuses on a deep understanding of social phenomena by collecting and analyzing data in the form of words, stories or images that describe complex realities. Apart from that, Creswell in Andri (2017) also emphasized that qualitative research tends to reveal information expressed in narrative form, paying attention to the context and meaning behind the phenomena observed. In this research, the researcher chose a qualitative approach to be able to explore in depth the social events being studied, providing space for in-depth interpretation and rich understanding of the observed phenomena. Thus, this article uses a qualitative approach to describe descriptive data and analyze it naturally, enriching understanding of the subject under study.

RESULTS AND DISCUSSION

According to the analysis results, both teachers and students responded positively to the application of virtual laboratories in science learning. Teachers recognize that the use of virtual laboratories allows them to illustrate difficult-to-understand concepts more clearly, as well as providing opportunities for students to conduct experiments without being limited by the constraints of time and space. From the students' perspective, virtual laboratories are considered to be an interesting and fun tool that helps them in understanding science concepts better than conventional learning methods. Thus, the adoption of virtual laboratory technology not only improves teacher teaching, but also provides a more effective and engaging learning experience for students.

A. Media Virtual Laboratory

The Virtual Media Laboratory is a system created with the aim of providing learning experiences and experiments similar to those that can be found in a physical laboratory, but carried out virtually via digital devices such as computers or tablets. Thus, this platform allows easier and more flexible access for various groups, including students, researchers and other individuals interested in exploring the media field. Compared with conventional laboratories, the Virtual Media Laboratory frees users from physical and time limitations, allowing them to carry out experiments and learning anytime and anywhere according to their needs. It can also reduce the costs and time required to set up and run experiments, thereby expanding accessibility and increasing efficiency in learning and research in the media field. The following are some of the main components and features that are usually included in Virtual Media Laboratory:

1. **Interactive and Realistic:** The Virtual Media Laboratory is designed to provide an experience similar to the real world, with the aim of providing realistic simulations, adequate visualization, and interactivity that allows users to interact with various elements in the virtual environment. By using advanced technology, this platform allows users to experience almost the same sensation as being in an actual physical environment. From environmental exploration to virtual experiments, the Virtual Media Lab provides a means for users to learn and create without geographic or time constraints. With immersive visualization and responsive interactions, users can explore concepts, processes, and phenomena in unprecedented ways, expanding their understanding of the world around us.
2. **Accessibility:** One of the main advantages of the Virtual Media Laboratory is the ease of access it provides. With internet connectivity, users can use it from various locations without having to be in the physical location of the laboratory. This allows students or researchers to study and conduct experiments according to their needs and time availability. In other words, the flexibility offered by this virtual laboratory allows users to access it whenever and wherever they are. This opens the door to effective distance learning and enables cross-regional collaboration in research and experimentation. Additionally, in the absence of physical space limitations, virtual laboratories can accommodate more users simultaneously without limiting their access. Thus, opportunities for scientific exploration and learning that are broader and open to anyone, wherever they are, become more possible with this virtual laboratory.
3. **Security:** The Virtual Media Lab provides users with the opportunity to conduct experiments in a safe and controlled environment. Here, they can run experiments without having to worry about safety risks or potential accidents that might occur in a physical laboratory. By using advanced simulation and visualization technology, users can interactively carry out various experiments without having to come face to face with hazardous materials or risky procedures. This allows users to conduct scientific exploration more comfortably and without obstacles,

and provides the opportunity for them to learn effectively without having to worry about basic safety aspects.

4. **Wide Range of Materials and Experiments:** Typically, these platforms offer a wide variety of materials and experiments across various mediums such as graphic design, animation, video production, and more. Users have the freedom to choose experiments that suit their interests or needs. In other words, the platform provides various resources that users can use to explore various creative fields according to their individual preferences and needs.
5. **Guides and Learning Materials:** Virtual Media Lab routinely presents comprehensive guides and in-depth learning materials to help users gain a solid understanding of the concepts involved in the experiments. These guides can be texts, videos, or other interactive tutorials, carefully designed to ensure an effective and engaging learning experience. By providing a variety of formats, the Virtual Media Lab ensures that users with different learning preferences can make optimal use of the resource. In this way, users can gain a deep understanding of the topics explained, and can apply their knowledge in experimental practice with more confidence.
6. **Collaboration:** A number of Virtual Media Lab platforms facilitate collaboration between users, allowing students or researchers to collaborate to run experiments or solve problems together. This creates a virtual environment where participants can interact with each other in real-time, share data, and even have live conversations. With features such as chat rooms, screen sharing, and direct access to instruments or simulations, this kind of collaboration allows users to expand their knowledge by leveraging different skills and perspectives. Additionally, the use of such platforms also facilitates broader accessibility to experimental resources and infrastructure, which can be key for individuals or groups who do not have direct access to physical facilities. Thus, the Media Virtual Laboratory platform plays an important role in expanding the possibilities of cross-disciplinary collaboration and research, as well as accelerating progress in various fields of science and technology.
7. **Analysis and Evaluation:** After undergoing experiments, the Virtual Media Laboratory usually offers data analysis tools and experimental results. Its function is to help users assess experimental results and gain a deeper understanding of the implications of the findings they obtain. Through this tool, users can analyze the resulting data, identify possible patterns or trends, and interpret the significance of the experimental results. Thus, the Virtual Media Laboratory not only provides a platform for conducting experiments, but also provides the resources necessary to understand and explore the information contained in the experimental data.
8. **Flexibility:** The Virtual Media Laboratory provides convenience in terms of time and space flexibility. Users are given the opportunity to carry out experiments repeatedly without being constrained by time constraints or the availability of equipment and materials in the physical laboratory. This means they can adjust the experiment schedule to suit their own needs, without having to worry about the constraints often inherent in conventional laboratory environments. With unlimited access to the virtual platform, users can optimize their learning experience by experimenting multiple times to deepen their understanding of the concepts being taught. This not only increases flexibility in learning, but also facilitates deeper exploration and better understanding of the subject matter.



Picture 1 The importance of technology in science learning

Sumber: pamelaexrid (2018)

B. The Urgency of the Laboratory as a Science Learning Media

According to the explanation in the Big Indonesian Dictionary, a laboratory is a room or building used for scientific research, experiments and tests. However, the laboratory concept is not limited to the physical room or building and the equipment in it. Along with development, the definition of a laboratory has expanded to include places of learning related to certain scientific fields. Apart from being a place equipped with various learning equipment, laboratories can also take various forms, such as campuses or classrooms, natural environments, social institutions, and even society as a whole. This indicates that the laboratory is not just a place, but also includes the concept of learning and exploration in various contexts that are relevant to knowledge and science. Laboratory indicators, as explained by Damayanti (2018), can be seen in three main aspects. First, a laboratory is a place that includes buildings, space and all the equipment needed to carry out scientific activities. In this context, laboratories are seen as part of the learning hardware, which is different from classrooms. Second, the laboratory acts as a medium that supports the teaching and learning process. In this case, the laboratory is considered as essential software in scientific activities, which complements classroom learning. Third, the laboratory is also defined as a center for scientific activities to discover scientific truths and apply them. As a place where scientific truth is discovered, the laboratory has a function as a barometer in evaluating the success of learning. Thus, the laboratory is not just a place or medium, but is also an important foundation in the learning process oriented towards the discovery and application of scientific knowledge.

1. **Hands-on Experience:** Labs provide an opportunity for students to experience science concepts firsthand, expanding their understanding gained in the classroom. By seeing the theories taught in practice, students can consolidate their knowledge thoroughly. Through experiments and direct observation, they can observe scientific phenomena with their own eyes, strengthening the concepts they learn. It also allows them to develop practical skills such as problem solving, observation, and critical thinking, which are important in science. Thus, the laboratory is not only a place to practice theory, but also a place where students can bridge the relationship between academic knowledge and its application in real life.
2. **Observation and Experimentation:** Laboratories provide opportunities for students to directly observe natural phenomena and conduct in-depth experiments. Here, they can collect data with their own hands and use appropriate tools for the purpose. With a controlled environment and the right equipment, students can conduct a series of experiments to understand complex scientific concepts. In addition, they can also observe changes that occur directly and identify patterns that may not be visible in everyday life. Thus, laboratories play an important role in students' learning, allowing them to develop analytical skills, deepening their understanding of science, and helping them hone their critical thinking abilities.
3. **Practical Skills Development:** By conducting hands-on experiments in the laboratory, students can hone practical skills that are crucial in science. They learn to take accurate measurements, observe natural phenomena closely, conduct controlled experiments, and analyze data rigorously. These skills not only provide a deeper understanding of scientific concepts, but also provide critical preparation for facing real-world challenges. Amid rapid advances in science and technology, the ability to make precise measurements, analyze data carefully, and thoroughly understand experimental results has become key to success in a career related to science and technology. Thus, through this practical experience, students not only gain knowledge, but also develop the skills necessary to become leaders in the scientific field in the future.
4. **Facilitates Problem Solving:** In the laboratory, students are given the opportunity to practice critical thinking skills and solve problems effectively. They are given situations in which they must design experiments, analyze the resulting data, and identify potential errors. This process not only helps them understand scientific concepts in more depth, but also develops strong problem-solving skills. Through these experiences, students learn to become more independent in solving complex challenges, strengthen their foundation in science, and prepare themselves to face real-world situations in the future.

5. **Strengthening Abstract Concepts:** Understanding abstract concepts in science is often challenging, especially through conventional learning in the classroom. However, by presenting hands-on experiments in the laboratory, students have a unique opportunity to witness these principles in action in real life. Through these hands-on experiences, once-elusive abstractions can be broken down into impressive concrete experiences, allowing students to relate theory to the physical phenomena they observe. For example, the concept of pressure can be understood by looking at how a ball bubbles in water, or the principle of gravity can be illustrated through free fall experiments with different objects. Thus, laboratory experiments not only strengthen students' understanding of scientific concepts, but also increase their motivation to learn by providing a more interesting experience and direct involvement in the learning process.
6. **Inspire Interest in Science:** With a variety of immersive hands-on experiences, labs have great potential to spark students' interest in science. Engaging in hands-on practical experiments allows students to experience the excitement and relevance of science in everyday life. By seeing the immediate results of theories learned in class come to life before their eyes, students often feel more motivated to learn further. Practical experiments also help students understand concepts that may be difficult to grasp just by reading or listening to explanations. Thus, through hands-on experience in the laboratory, students can strengthen their understanding of science, improve their practical skills, and even inspire them to pursue careers in science.
7. **Expanding Horizons:** Labs provide an opportunity for students to experience science concepts firsthand, beyond what they can learn from textbooks. There, they can dig deeper, test hypotheses, and see how the theories learned in class are applied in real situations. Additionally, laboratories also allow students to find practical applications of these concepts in the real world, strengthening their understanding holistically. Moreover, laboratory experiments often lead to new discoveries, allowing students to develop their own critical thinking and creativity in exploring science. Thus, the laboratory becomes an important space in science education, facilitating deep and continuous learning for students.
8. **Building Connections Between Concepts:** In a laboratory environment, students have a unique opportunity to deepen their understanding of scientific concepts. By seeing directly the relationship between the theories they learn and real practices, students can relate abstractions to reality. For example, they can observe how the laws of physics operate in the experiments they conduct, or how chemical principles are applied in the synthesis of chemicals. By directly experiencing the scientific process, students not only strengthen their understanding of certain concepts, but also develop practical skills such as observation, data analysis, and problem solving. This allows them to gain deeper insight into how science works as a whole, helping prepare them to face the complex challenges of the future.
9. **Safety and Ethics:** In a laboratory environment, students have a unique opportunity to deepen their understanding of scientific concepts. By seeing directly the relationship between the theories they learn and real practices, students can relate abstractions to reality. For example, they can observe how the laws of physics operate in the experiments they conduct, or how chemical principles are applied in the synthesis of chemicals. By directly experiencing the scientific process, students not only strengthen their understanding of certain concepts, but also develop practical skills such as observation, data analysis, and problem solving. This allows them to gain deeper insight into how science works as a whole, helping prepare them to face the complex challenges of the future.

Laboratories have great importance as a means of science learning because they provide opportunities for students to gain hands-on experience. By conducting experiments and observations in the laboratory, students can develop practical skills that are important in understanding scientific concepts. Apart from that, laboratories also help strengthen their understanding of concepts that may be difficult to understand abstractly through theoretical learning alone. This hands-on experience can also inspire students' interest in science, as they see real applications of what they learn in the classroom. Laboratories also allow students to broaden their horizons by seeing natural phenomena directly and building connections between the concepts they study. Additionally, the safety and ethical practices taught in the laboratory are important in teaching students about responsibilities and appropriate behavior in scientific practice. In this way, the laboratory is not only a place to test theories, but also a

space where students can hone skills, deepen their understanding, and build a strong foundation in science.

CONCLUSION

The conclusion of this research emphasizes the importance of laboratories as a means of learning science, both in physical and virtual form. Labs provide opportunities for students to directly apply scientific concepts through experimentation and observation, which helps hone their practical skills and deepen their understanding. Additionally, laboratories can also spark students' interest in science by demonstrating the relevance and practical application of concepts learned in class. Additionally, laboratories also play an important role in teaching responsible safety practices and scientific ethics. Thus, the laboratory is not only a place to test theories, but also a space where students can develop skills, deepen understanding, and build a solid foundation in science. The conclusions also highlight the importance of virtual laboratories as a complement to education, offering benefits such as cost savings, flexibility in time and location, and the opportunity to prepare students for real-world situations. Suggestions from this research, obtained from Murtadho (2020), include increasing the use of virtual laboratories by preparing human resources skilled in virtual technology, as well as supporting the development of learning models and massive content production to support the wider effectiveness of virtual education.

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