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Digitalisation Of Classrooms: Perception Of Pre-Service Teachers Towards Virtual Labs

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Abstract

Virtual laboratories have emerged as an innovative tool in contemporary education that provides an interactive environment for simulations and experimentation without actually setting up physical laboratories. This research examines the perception of pre-service teachers about virtual labs, including awareness, challenges, limitations, and scope for the future in education. The results reveal that although most pre-service teachers are familiar with virtual labs, a significant portion lack in-depth understanding and direct experience with them. The main issues are technical, such as connectivity problems with the internet, poor accessibility, and inadequate curriculum integration. In addition, most respondents also complained of poor training, which prevents them from incorporating virtual labs effectively in teaching processes. Though with such limitations, there is strong consensus regarding the potential of virtual labs to make learning more student-centric, economically viable, and a substitute to conventional lab settings. The study calls for planned training programs, enhanced technological setup, and quality curriculum integration for ensuring maximum productivity of virtual labs. By solving these issues, virtual labs have the potential to revolutionize education, facilitating hands-on learning in a more accessible and streamlined manner.

Keywords: Virtual Labs, Pre-service Teachers, Contemporary Education, Edtech, Teacher Training, Technology

Introduction

Technology has an active role to play in extending pedagogy and learning technique within modern-day schools. Virtual labs (VLs) are recent technological improvements. Virtual laboratories, or simulated computer spaces, model actual laboratories in which the students can perform experiments, tweak variables, and view results within virtual space. Such simulations provide digital hands-on learning without physical limitations, safety issues, or geographical restrictions. Pre-service teachers utilize virtual labs properly since they are part of contemporary classrooms.[1].

Virtual labs have various benefits compared to conventional physical labs. With a connection to the internet, students from all over the world can conduct many experiments at any time, thanks to complete accessibility and full flexibility. V-labs are particularly beneficial to schools with insufficient laboratory facilities as they allow all students to participate in an active learning experience at low cost without physical equipment.[2] Active learning is accomplished by students with more understanding of complex concepts and repeated practice leading to mastery and confidence. Most of the virtual labs include multimedia features such as animations, simulations, and interactive tests to stimulate participation and deepen conceptual understanding.[1].

However, despite the numerous advantages, some problems come along with virtual labs. There is the main difficulty of not having immediate, bodily experience, especially in those areas that need touch manipulation of the materials and the equipment. Simulation in virtual form cannot always be made equal to the experience of real experimentation by most teachers and learners.[3] Technical issues like compatibility of software, connectivity, and training on specialized software to use them efficiently may arise. Virtual labs are successful only when there is available technological infrastructure and teachers are willing to implement them in the pedagogy.[4]

The study seeks to explore in depth the attitudes, perceptions, and experiences of pre-service teachers regarding virtual labs and what drives their adoption of this technology. This research aims to fully examine pre-service teachers' attitudes towards virtual labs, their perceptions and experiences, as well as the determinants of their acceptance of the technology. This study isolates issues with virtual labs, providing implications for teacher preparation programs to prepare teachers to more effectively teach in technology-based learning spaces. This study will greatly contribute to future teachers in using virtual labs effectively while teaching, and blending technology with pedagogy.

Literature Review

Virtual labs are now an important part of education, offering many benefits and fixing some problems linked to regular hands-on labs. A number of students can access several interactive experiments, simulations and data collection opportunities in one secure, regulated digital space. Virtual labs are viewed more and more as possibly able to fundamentally change science education as technology improves.[5]

Many studies have looked at how virtual labs compare to regular labs regarding student learning, interest, and satisfaction. Educators can understand all the strengths and weaknesses of every method through comparative analyses, which helps with choosing how to incorporate virtual labs into lessons. Govender studied how V-Labs affected all teaching and self-regulated learning among students. The research stressed that V-Labs improve learning experiences. However, their success in encouraging independent learning is somewhat restricted. According to the results, V-Labs could play an undeniably major role in easing truly meaningful learning as well as during times of social distancing, such as during the COVID-19 pandemic [6].

Virtual labs require well-designed teaching methods and instructional design for full integration into education. Students can get hands-on experience and the specific perks of virtual labs through a hybrid method that joins standard labs with very interesting virtual settings. [7] To implement virtual labs successfully, all teachers and students require adequate training and ample support. Understanding teachers' opinions of digital simulations in addition to virtual labs is important for integrating them effectively. Looking into how teachers use resources and what influences whether they use them could help shape ideal ways to train teachers and help their careers. [4]

Teachers generally agree that virtual lessons increased student motivation, autonomy, interest, and confidence. Liu C. also examined how teacher demonstrations and student evaluations improved V-Labs. Integrating V-Labs with organized instructional methods increases pre-service teacher's scientific literacy, according to their research. V-Labs, when used alongside active learning methods, may not always be sufficient; however, they always can be improved [8].

Many studies show that teachers mostly have positive views of virtual labs (VLs). Virtual labs are especially helpful for teaching complex biology concepts like nerve cell structure and function. They also support various learning methods, including the inverted classroom approach [9]. Byukusenge C. has deeply investigated if V-Labs and animations considerably aid student comprehension regarding challenging concepts in biology. The results indicated that technology-improved instruction, such as V-Labs, extensively increases both understanding and knowledge retention among pre-service teachers [10].

Virtual labs provide convenience and accessibility via internet access, letting students do experiments in full and build skills at their speed from anywhere. This will prove particularly useful for all students encountering location or scheduling challenges when attempting to attend physical labs. Virtual laboratories can help classrooms improve conceptual understanding. Students in virtual labs demonstrated learning outcomes similar to those in traditional labs [6].

Virtual systems allow all schools and universities to provide lab experiences in a completely cost-efficient way. Some schools can lower expenses with virtual labs as they provide an alternative to costly labs. Virtual laboratories should encourage students to explore, experiment, and make decisions, mirroring the nature of scientific practice. Akay and Incik have studied the relationship between techno-pedagogical education competency and opinions on educational technology, offering a wider perspective on pre-service teachers' attitudes regarding technology integration. The research revealed that pre-service teachers held overwhelmingly favourable views of technology, but they were entirely unsure that they could skilfully use digital tools. Even though virtual labs are helpful, this finding aligns with challenges. The concern is that V-Labs' success depends on teachers' training and digital skills [11].

Many students had a better learning experience with virtual biotech labs. Several pre-service teachers have claimed that virtual laboratories in science lessons assist many students to gain experience, in addition to building key thinking along with research skills. The relationship between each cognitive and social presence in active learning is assessed through the study's analyses of the effect of virtual labs on student users. Furthermore, Colaco and Antão have examined multiple experiences of pre-service teachers in lesson planning, pointing out that digital tools can be very helpful, provided that each tool is quite easy to use while also promoting sufficient collaborative learning. The usability and integration of V-Labs into current teaching practices determine how accepted they have become in recent times [12].

Virtual labs let many students participate in inquiry-based classes, substantially interact with them, implement and analyse their experiments, and learn by using virtual objects and apparatus. The use of virtual activities improves learning methodologies however, it would not be a tool used in place of face-to-face learning activities in labs with hands-on work. Xu T also explored social media's major role in pre-service teachers' professional development, stressing that specific guidance is important for digital platforms' incorporation into formal education, though they are commonly used [13] Even with their advantages, virtual labs possess challenges that include a need for technical infrastructure as well as digital literacy in addition to changes in teaching methods. Amankwah reported that insufficient teaching aids and support caused pre-service teachers to have common difficulty in their teaching practices. Tactile experiences are necessary, so the missing physical aspects of normal labs are a key concern [14]

In general, the existing literature suggests that pre-service teachers view virtual labs quite favourably since they acknowledge the potential for virtual labs to greatly improve learning. Nevertheless, multiple factors determine their degrees of effectiveness, such as digital competence, instructional design, and institutional support. To best use virtual labs in teaching approaches, pre-service teachers need specific skills. Therefore, future studies should focus on developing several training programs to give them these skills. Many well-thought-out pedagogical strategies are needed to integrate virtual laboratories and maximize educational benefits.

Methodology

This study enlists a qualitative research approach on the perception of pre-service teachers towards virtual labs. A survey was conducted among pre-service teachers of different organizations to gather data systematically. The study aims to analyze the experiences of pre-service teachers towards virtual labs and the frequency of usage of virtual labs by them in their teaching. The study also aims to explore the challenges faced by teachers in incorporating Virtual labs in the curriculum and also to analyze the future scope. The study was mainly focused on pre-service teachers of different institutions. A structured questionnaire was designed by the researchers to collect data from the participants. The questionnaire consists of 33 questions, which includes both objective and subjective questions.

The questionnaire was mainly focused on assessing participants' familiarity with virtual labs, knowledge and awareness regarding the same, the challenges faced in incorporating virtual labs into the teaching and learning process, and the future scope of virtual labs. Moreover, it evaluated participants' opinions on the effectiveness of virtual labs, their potential uses, and recommendations for improvement. The questionnaire uses the Likert scale, rating, and closed and open-ended questions to assess pre-service teachers' responses. The methodology describes the organized strategy employed to explore views of pre-service teachers towards Virtual Labs. Through a survey-based approach and thorough data analysis, the research seems to provide meaningful insights into the existing status and future scope of virtual labs in the teaching and learning process.

Analysis And Result

The main aim of this study was to evaluate the degree of awareness and knowledge among pre-service teachers about virtual labs, investigate the challenges and limitations they encounter while using these online tools in the curriculum, and examine their role in the future of education. By gathering these responses, this study aimed to provide meaningful insights into the current state of virtual labs in the educational sector and offer recommendations for their effective integration.

Virtual labs are recognized broadly among pre-service teachers, based on the survey, and suggest that the concept has been well recognized academically. Some of the respondents used virtual labs in teacher preparation programs, which suggests they are increasingly being used in professional development. Yet, despite widespread knowledge, a gap is perceived in the extent of knowledge of pre-service teachers. While some are confident to utilize virtual labs effectively, others admit insufficient training to incorporate them in their practices. This implies that there need to be more formal training programs to make the educators familiar with the features and uses of virtual labs.

One of the most striking problems raised by respondents is the technological challenges with virtual labs. For many teachers, students' ability to use such technologies is undermined by erratic internet connectivity and platform availability. Also, certain virtual lab locations are difficult to navigate, and that becomes immensely frustrating for the instructors and the students.

Coordinating virtual labs with pre-ordained curriculum is also a general issue. While the majority of teachers agree that virtual labs promote conceptual understanding as well as increased engagement, some believe they do not truly replace the extent and hands-on nature of regular laboratory experiments. It generates a critical debate on whether virtual labs should be provided as an extension tool rather than a complete substitute for lab experiments.

Table 1.1: Responses from participants regarding their awareness, usage, and perceptions of virtual labs in education.

Questions	Yes (%)	No (%)
Are you aware of the concept of virtual labs?	85.42	14.58
Have you ever used virtual labs in your teacher training program?	54.17	45.83
Do you face any technical difficulties while using virtual labs?	56.25	43.75
Do you find the user interface of virtual labs intuitive?	60.42	39.58

Have you faced any issues related to internet connectivity while using virtual labs?	68.75	31.25
Do you feel confident guiding students in using virtual labs?	66.67	33.33
Do you think virtual labs will become an integral part of education in the future?	95.83	4.17
Do you think virtual labs can enhance collaborative learning among students?	87.5	12.5
Do you think the government or educational institutions should invest more in virtual lab development?	83.33	16.67
Do you prefer yourself using virtual labs in your future teaching career?	81.25	18.75

Accessibility is also an issue, with many of the respondents noting that virtual labs are not always student-friendly for the disabled. Inclusive features such as screen readers or alternative navigation are not always provided, and due to this, some students do not get equal access to these electronic resources. Additionally, the teachers have also suggested the need for huge quantities of supporting materials and training sessions to allow them to implement virtual labs more effectively in their teaching. Without proper training and support, the entire potential of virtual labs can never be realized, and they would turn into increasingly ineffective tools for teaching within the classroom.

Despite such challenges, there is high enthusiasm regarding future integration of virtual labs in the learning system. A majority of the respondents agree that virtual labs will form part of the contemporary learning environment. A majority of the teachers perceive their potential to enable students to experience hands-on learning, especially in schools where laboratory equipment availability is poor. Moreover, virtual labs are an eco-friendly and economically viable alternative to physical labs as they cut down on the use of toxic chemicals and dispense with the need for costly laboratory facilities.

Conclusion

This study sheds light on increasing recognition and uptake of virtual labs among pre service educators, but technical access, curriculum alignment, and teacher skill remain to mold their uptake. Although virtual labs hold tremendous scope for education-changing innovations, it is their implementation that depends upon overcoming some of their limitations. One such critical step is offering strong technical infrastructure to optimize virtual labs to their best. Schools and institutions will have to invest in better internet connectivity and make sure virtual lab locations are optimized well to work smoothly on all devices.

The developers also need to concentrate on making interfaces simpler in order to improve accessibility to all students including disabled students. Curriculum developers must collaborate with teachers in a way that virtual lab experiments are associated with learning outcomes to facilitate the incorporation of virtual labs into mainstream education.
Instead of viewing virtual labs as a replacement for traditional laboratory practice, they should be used as an additive tool to complement theoretical knowledge and provide students with hands-on and experiential learning.

In addition, teachers need to be provided systematic professional development classes to gain confidence in the proper utilization of virtual labs. Peer collaboration time, certification courses, and workshops can provide pre-service teachers with a capability to include digital tools into their teaching practices. Ultimately, increased institutional and governmental investment in virtual laboratory technology is required.
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Schools need to be encouraged to spend on training, technical assistance, and ongoing virtual lab software maintenance. Schools and policy makers need to work together in order to create virtual labs a viable, productive, and accessible learning tool for students. By overcoming the above challenges and making necessary modifications, virtual labs can be an effective learning aid for improving scientific learning and in preparing learners to meet the needs of technology-centred education.

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