Virtual Laboratory: Awareness and Attitude among Prospective Physics Teachers

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Abstract- *Theory and Practical are both parts of the learning process and complement each other. The absence of either of these two may hamper the learning process. The pandemic situation makes it further complicated. Efforts are being made to provide online classes for theory papers. But few arrangements were made for practical learning and laboratory activities, especially for school students. Many schools have no laboratory arrangement, and if the laboratory is available, the instruments and infrastructure are dilapidated or scarce. In view of this, an innovative educational programme launched by Amrita CREATE (The Center for Research in Advanced Technologies for Education) at Amrita Vishwa Vidyapeetham in collaboration with CDAC, Mumbai; funded by the Ministry of Electronics and Information Technology has already been initiated in December 2015 and established a virtual science lab for school-going students named OLabs, by the Government of India, which is free to access upon registration. The vision behind OLabs is to provide high-quality educational technology to students in all schools, especially those with minimal resources. Rural India does not have access to a physical laboratory and equipment related to the experiment because it is scarce or expensive. OLabs is premised on the idea that lab experiments may be taught more efficiently and cost-effectively using the internet and is hosted at www.OLabs.edu.in.*

Although most teachers, prospective teachers, and students are still unaware of virtual laboratories, the study investigated the awareness and attitude among prospective physics teachers towards integrating virtual laboratories into the teaching-learning process. A quantitative descriptive survey study was adopted, and a multi-stage sampling technique was used to access the sample. One hundred prospective physics teachers were selected as a sample enrolled in B.Sc. B.Ed. and B.Ed. A self-made questionnaire was used to gather the data, and the data were analyzed by simple frequency counts and percentages. The study revealed that the level of awareness is low among prospective physics teachers, and attitudes are positive among prospective physics teachers towards integrating Virtual laboratories in the teaching-learning process. The need to utilize virtual laboratories is even more felt in online teaching than ever before. Therefore, the study suggested that the teacher education institution should be prepared to incorporate the basic idea and utilization of virtual laboratories into the practical part of the curriculum. Prospective physics teachers should also be motivated and trained during their micro-teaching by their supervisors' or mentors' usage of virtual laboratories for experiments in physics for their teaching practice. Aside from this, teacher education institutions should organize workshops and training programs on virtual laboratories for their teachers and prospective teachers.

***Keywords*:** Virtual Laboratory, Experiment, Prospective Physics Teacher, OLabs and Teacher Education.

Introduction:

Understanding science, technology, and mathematics are essential for any nation's development. Science is a subject that provides an organized form of knowledge to enable learners the acquisition of different abilities and skills. Science teaching at the level of school is based upon the understanding of biological, chemical, and physical concepts in a comprehensive way. The physics concept involves studying substance and its motion from space and time, along with the concepts of force and energy. It is necessary to understand the theoretical and practical parts of these concepts. Because theory and practice are both parts of the learning process and complement each other, the absence of any of the two may hamper the learning process. Most physical concepts and their relationships may be illustrated or understood through experimental inquiry, which shows the realities encountered during the investigation, and the laboratory is the place that provides an environment to experiment. But the appropriate number of laboratories and apparatus should be available in the schools to conduct experiments effectively so that no child is deprived of this activity.

Schools and other educational institutions around the country were closed amid pandemics and trapped in uncertainty. The pandemic situation made it further complicated. Efforts were being made to provide online classes for theory papers. But no arrangements were made for practical learning and laboratory activities, especially for government and rural school students. If we see schools with the performances of valuable knowledge and laboratory activities before the pandemic, there is no arrangement of laboratories inconsiderable number of schools. If the laboratory is available in the school, then thereat infrastructure is dilapidated, or if the infrastructure is in good condition, there is a scarcity of apparatus according to the number of students. Given these situations and needs, an innovative educational programme launched by Amrita CREATE (The Center for Research in Advanced Technologies for Education) at Amrita Vishwa Vidyapeetham in collaboration with CDAC, Mumbai; funded by the Ministry of Electronics and Information Technology has already been initiated and established a virtual science lab in December 2015 for school-going students named OLabs, by the Government of India which is free to access. The vision behind OLabs is to provide high-quality educational technology to students in all schools, especially those with minimal resources. In rural India, students have no access to a physical laboratory and equipment related to the experiment because it is scarce or expensive. OLabs is premised on the idea that lab experiments may be taught more efficiently and cost-effectively using the internet.

The vision behind OLabs is to provide high-quality educational technology to students in all schools, especially those with minimal resources. Rural India has no access to a physical laboratory and equipment related to the experiment because it is scarce or expensive.

OLabs

The nationwide dissemination of Online Labs as a virtual science lab for experiments in schools called "OLabs" was started by Shri Ravi Shankar Prasad, Minister of information and communication technology (IT), in December 2015 on Good Governance Day. OLabs has been

selected as one of the leading initiatives of Digital India for the empowerment of the Good Governance category. It is an innovative educational programme launched by Amrita CREATE (The Center for Research in Advanced Technologies for Education) at Amrita Vishwa Vidyapeetham in collaboration with CDAC, Mumbai; funded by the Ministry of Electronics and Information Technology, Government of India.

The OLabs provide high school students with access to Physical, Chemical, and Biological Science experiments that are in line with the content of the National Council of Educational Research and Training (NCERT), the Central Board of Secondary Education (CBSE), and the State Board of Education. However, ICSE board students will benefit because of topics covered across the boards are almost similar. Recently 9th and 10th-grade levels of English and Mathematics lessons have been added to OLabs, which are developed by CDAC Mumbai. OLabs is hosted at www.OLabs.edu.in, and School-going students can freely access it upon registration. An OLabs cannot be the same or equivalent to a conventional laboratory. However, OLabs are equally beneficial to the learner because they accommodate various learning styles and provide a more flexible and open-ended inquiry environment. Access to the experiment at OLabs is not limited; the students can do it at anytime and anywhere on devices like tablets/iPad/Android without wasting expensive materials or exposing themselves to harmful chemicals to overcome the time restrictions associated with having limited access to the physical laboratory. Students will be able to develop confidence in their results by taking advantage of the fact that online responses may be repeated quickly and easily. OLabs provides a 'learning-enabled assessment' for measuring learning of students' progress by the teachers in the three key areas: their ability to follow procedures and manipulate materials, their understanding of the experiment's central ideas, and the clarity with which they can report and interpret their findings.

The virtual laboratory can be used to support another type of learning environment that does not require a physical laboratory. It helps the student connect the theoretical and practical aspects of the subject without using paper and pens. It is electronically designed on digital devices to imitate real-world laboratory experiments. This virtual lab may give learners a study and learning environment comparable to a physical lab. Additionally, it provides learners with tools and lab sets via the internet and digital devices that enable them to conduct experiments subjectively or in groups.

The application of technology in the teaching-learning process has played an important role in enhancing students' enrolment and achievement. For example, the usage of artificial educational settings in teaching-learning, including the use of simulations and virtual reality, is becoming more common and has been confirmed that beneficial in the teaching of science (Babateen, 2011). ICT has provided opportunities to enhance and enrich the skills of students, to encourage and engage students, to assist students, to connect their school experience to work practices, to establish cost-effectiveness for tomorrow's workers, and to improve instruction (Yusuf, 2005).In the field of engineering and science, virtual labs have emerged as an additional or supplementary tool for laboratory experiments (Mahmoud and Zoltan, 2009). Problem-solving skills, the ability

of creativity, critical thinking, scientific skills, conceptual understanding, laboratory skills, interest, motivation, and learning outcomes can all be enhanced among students from the use of a virtual laboratory (Ramadhan and Irwanto, 2017).

The virtual laboratory provides an interactive environment that does not include real laboratory equipment and it is usually used to create and conduct simulated experiments (Babateen, 2011; Keller and Keller, 2005). Virtual laboratories can developlearners' spatial-Visualisation skills (Herga, Cagran and Dinevski, 2016). Virtual labs help students to understand how the subjects and real-life events are linked (Asiksoy and Islek, 2017). The usage of virtual labs has been shown to improve the achievement of students and attitudes toward learning science (Singhai, 2018). Pupil teachers found the Virtual Lab to be simple to use and beneficial in teaching and understanding physics concepts in secondary school (Falode, 2018). The use of a virtual laboratory develops the student's conceptual understanding (Gunawan, et al, 2018). Virtual Science Lab isastimulating, beneficial, and enjoyable place to learn for middle school students (Aljuhani, Sonbul, Althabiti, and Meccawy, 2018). To promote meaningful learning, learning by doing, and discovery learning among students' teachers should promote virtual laboratories (Onuh and Okigbo, 2019). Primary school Students' science process skill has been developed with the use of virtual laboratory (Pramono1, Prajanti, and Wibawanto, 2019). While Biology teachers' awareness of virtual laboratories was low and showed ignorance of the idea of virtual lab impact on the attainment of practical skills in biology (Oladipo and Ebabhi,2020). The use of virtual laboratories in physics learning efficiently promotes figural, verbal, numerical, and creativity among students (Gunawan et al, 2018). However, during covid-19 virtual laboratory has enabled the students to experimentin the comfort of their home (Vasiliadou, 2020). So, Virtual labs may play a significant role in activity-based and self-guided learning that doesn't require a lot of help from a teacher, which may be important for enhancing skills and planning tools online for post-COVID-19 teaching-learning environments (Radhamani, et al, 2021). As a result of the foregoing, mostof the previous studies conducted in developed countries indicate that a virtual laboratory may be an effective instructional tool for improving students' performance/achievement, creativity, critical thinking, spatial visualization, and conceptual understanding of science. However, most of the teachers, prospective teachers and students are still not aware of virtual laboratories. Although researchers have proven the positive effects of virtual labs on the teaching-learning process, very littleresearchhas been found on awareness of virtual laboratories among prospective teachers. Therefore, this study will investigate the level of awareness and attitude among prospective physics teachers toward the Integration of Virtual Labs in the teaching-learning activity.

Research Questions:

- Are prospective physics teachers aware of the usage of the virtual labs?
- What attitude do prospective physics teachers hold toward the Integration of Virtual Labs in the teaching-learning process?

The objective of the study:

- To investigate the level of awareness among prospective physics teachers about the usage of virtual labs.
- To know the attitude of prospective physics teachers toward the Integration of Virtual Labs in the teaching-learning process.

Methodology:

A quantitative, descriptive survey study was used for the data collection. The multi-stage probability sampling technique was used to access the sample. In the first sampling stage, the Central University of South Bihar, and Maulana Azad National Urdu University (Darbhanga) were selected randomly from Bihar. Then, in the second stage, one hundred prospective physics teachers were selected voluntarily as a sample enrolled in B.Sc. B.Ed. and B.Ed. programme sessions (2018-2022) and (2020-2022), respectively. Prospective physics teachers, 50 from B.Sc. B.Ed. and 50 from B.Ed. have been selected for the study and have recently completed their school internship in virtual mode. A self-made questionnaire was distributed by Google Forms to gather the data, and simple frequency counts and percentages were analysed.

The questionnaire was divided into three sections, first section consists of basic information about the virtual laboratory, the second is basic knowledge about the virtual laboratory and what it provides for experiments and the third is the attitude of prospective physics teachers towards the Integration of Virtual Labs in the teaching-learning process.

Descriptive Analysis and Interpretation of the data:

Research Question 1: Are prospective physics teachers aware of the usage of virtual labs?

Objective 1: To investigate the level of awareness among prospective physics teachers about the usage of virtual labs.

Awareness among prospective physics teachers of the usage of the virtual labs.

Table1: Item 1: Do you know about virtual labs for school students?

Programme	Male	Female	Yes	No	Total
B.Sc. B.Ed.	25	25	29 58%	21 42%	50 100%
B.Ed.	25	25	28 56%	22 44%	50 100%

Table 1 and responses of item 1 (Do you know about virtual labs for school students?) show that out of 50 B.Sc. B.Ed. prospective physics teachers, 29, i.e. (58%) of them know about the virtual lab, while 21, i.e. (42%) do not know, and out of 50 B. Ed. Prospective physics teachers, 28, i.e. (56%), know about the virtual lab, while 22, i.e. (44%) do not.

Table 2:
Item 2: How did you come to know about the virtual lab?

Programme	Male	Female	Knows about Virtual Lab			Do not know	Total
			with the help of teachers	with the help of YouTube	with the help of social media		
B.Sc.B.Ed.	25	25	6 12%	15 30%	8 16%	21 42%	50 100%
B.Ed.	25	25	4 8%	11 22%	13 26%	28 56%	50 100%

While analysing Table 2, responses from item 2 (How did you come to know about the virtual lab?) reveal that out of 50 B.Sc. B.Ed. 6 i.e., 12% of Prospective physics teachers came to know about the virtual lab with the help of teachers, 15 i.e., 30 % of Prospective physics teachers came to know about the virtual lab with the help of YouTube and 8 i.e., 16 % of Prospective physics teachers came to know about the virtual lab with the help of social media.

Table 3: Item 3: virtual lab for school students is initiated by?

Programme	Male	Female	Knows about Virtual Lab		Do not know	Total
			The virtual lab is a government initiative	The virtual lab is a private initiative		
B.Sc.B.Ed.	25	25	29 58%	10 20%	11 22%	50 100%
B.Ed.	25	25	28 56%	09 18%	13 26%	50 100%

While analysing table 3, responses from item 3. indicate that out of 50 B.Sc. B.Ed. only 29 i.e., 58% of Prospective physics teachers know that the virtual lab for school students is a

government initiative, and out of 50 B.Ed. only 28 i.e., 56% of Prospective physics teachers know that virtual lab is a government initiative.

Item 4: write the name of the virtual lab for school-going students.

Item 4 was open-ended, where out of 50 B.Sc. B.Ed. Prospective physics teachers who know about the virtual lab are 29 i.e., (58%), and among them, only 10 i.e., 20 %have written the name of OLabs. Furthermore, out of 50 B. Ed. Prospective physics teachers, 28 i.e. (56%) of them know about the virtual lab and among them only 6 i.e., 12 %have written the name of OLabs. The rest of the prospective physics teachers have written they do not know.

Table 4: Item 5: In a Virtual Laboratory?

Programme	Male	Female	Lab experiments can be done		Do not know	Total
			without the internet more efficiently and less expensively.	with the internet more efficiently and less expensively.		
B.Sc.B.Ed.	25	25	17 34%	10 20%	23 46%	50 100%
B.Ed.	25	25	13 26%	07 14%	18 36%	50 100%

While analysing table 4, responses for Item 5, indicate that out of 50 B.Sc. B.Ed., Prospective physics teachers 17 i.e., 34 % know that virtual Lab experiments can be done without the internet more efficiently and less expensively while 10 i.e., 20 % know that virtual Lab experiments can be done with the internet more efficiently and less expensively. Whereas out of 50 B.Ed., Prospective physics teachers 13 i.e., 26 % know that virtual Lab experiments can be done without the internet more efficiently and less expensively while 07 i.e., 14 % know that virtual Lab experiments can be done with the internet more efficiently and less expensively.

Table 5: Basic Knowledge of Prospective Physics Teachers about Virtual Laboratory (OLabs)

S.No.	Items	Agree	Undecided	Disagree	Total
1.	I used the Virtual lab (OLabs) to experiment with the physics concept.	0%	0%	100%	100
2.	The virtual lab (OLabs) is easy to use.	0%	90%	10%	100
3.	virtual lab (OLabs) available through Pc/Laptop/Tablet/Smartphone.	90%	0%	10%	100
4.	A virtual lab (OLabs) provides remoteaccess to the simulation-based lab.	60%	25%	15%	100

While analysing the responses regarding basic knowledge of prospective physics teachers about virtual laboratory (Olabs) from table 5. in item 1. (I used the Virtual lab (OLabs) to experiment with the physics concept) none of the prospective physics teachers have used virtual lab (OLabs) to experiment with the physics concept.

In item 2. (The virtual lab (OLabs) is easy to use), most prospective physics teachers, i.e., 90 %, were undecided about whether using a virtual lab (OLabs) is easy, and 10 % disagreed. However, in item 3 (Virtual lab (OLabs) available through PC/Laptop/Tablet/Smartphone), out of 100, the maximum number of prospective physics teachers, i.e., 90 %, agreed.

Furthermore, in item 4. (A virtual lab (OLabs) provides remote access to the simulation-based lab), most prospective physics teachers, i.e., 60 %, agreed that a virtual lab (OLabs) provides remote access to the simulation-based lab, whereas 25% were undecided whether the virtual lab (OLabs) provides remote access to the simulation-based lab.

Table: 6: Virtual Laboratory (OLabs) Provides for Experiment

S.No.	Items Virtual Laboratory (OLabs) provides	Agree	Undecided	Disagree	Total
1.	Theory related to the experiment.	20%	60%	20%	100
2.	Detailed procedure of experimenting.	10%	75%	15%	100
3.	Animated demonstrations related to the experiment.	05%	82%	13%	100
4.	Simulation for the experiment.	08%	79%	13%	100
5.	Viva-voce related to the experiment.	03%	87%	10%	100
6.	Resources related to the topic and experiment.	01%	92%	07%	100
7.	Feedback is required after the completion of the experiment.	04%	86%	10%	100

While analysing the responses regarding basic knowledge of prospective physics teachers about what Virtual Laboratory (OLabs) provides for the experiment from table 6.

In item 1. (Theory related to the experiment), out of 100, more than 50% of prospective physics teachers, i.e., 60 %, were undecided about whether the Virtual Laboratory (OLabs) provides theory related to the experiment. On the other hand, 20 % of prospective physics teachers agreed that the Virtual Laboratory (OLabs) includes theory related to the experiment.

In item 2. (Detailed procedure of experimenting), out of 100, 75 % of the prospective physics teachers were undecided whether the Virtual Laboratory (OLabs) provides detailed procedures for experimenting. At the same time, only 10% of prospective physics teachers agreed.

In item 3. (Animated demonstrations related to the experiment) from table 6, most prospective physics teachers, i.e., 82 %, were undecided whether the Virtual Laboratory (OLabs)

provides animated demonstrations related to the experiment. Besides this, only 5 % of prospective physics teachers agreed.

In item 4. (Simulation for the experiment), out of 100, 79 % of prospective physics teachers were undecided whether the Virtual Laboratory (OLabs) provides simulation for the experiment, but 8 % of prospective physics teachers agreed that the Virtual Laboratory (OLabs) provides simulation for the experiment.

In item 5. (Viva-voce related to the experiment), responses of prospective physics teachers reveal that, out of 100, 87% were undecided about whether the Virtual Laboratory (OLabs) provides viva-voce related to the experiment. In contrast, only 03% of them agreed that the Virtual Laboratory (OLabs) provides viva-voce related to the experiment.

In item 6. (Resources related to the topic and experiment), from table 6. Out of 100, 92 % of prospective physics teachers were undecided whether the Virtual Laboratory (OLabs) provides resources related to the topic and experiment. In contrast, only 01% of them agreed that the Virtual Laboratory (OLabs) provides resources related to the topic and experiment.

In item 7. (Feedback is required after the completion of the experiment), from table 6. Out of 100, 86 % of prospective physics teachers were undecided about whether Virtual Laboratory (OLabs) feedback is required after the completion of the experiment. In contrast, only 04% of them agreed that Virtual Laboratory (OLabs) feedback is needed after the completion of the experiment.

Discussion: Prospective physics teachers are unaware of Virtual Labs (OLabs). Most of them have not even heard the name Olabs for school-going students. They may not have been exposed to the virtual teaching-learning process and virtual lab experiments before the pandemic in the field of teacher education. However, prospective teachers found the Virtual Lab simple to use and beneficial in teaching and understanding physics concepts in secondary school (Falode, 2018). The maximum number of prospective teachers has been undecided about what Virtual Laboratory (OLabs) provides for the experiment. They may have ignored it because they did not have basic knowledge about Virtual Laboratory (OLabs).

Research Question 2: What attitude of prospective physics teachers hold toward the Integration of Virtual Labs in the teaching-learning process?

Objective 2: To know the attitude of prospective physics teachers toward the Integration of Virtual Labs in the teaching-learning process.

The attitude of Prospective Physics Teachers Toward the Integration of Virtual Labs in The Teaching-Learning Process

Table:7

S.No.	Items **Virtual Lab (OLabs)**	Agree	Undecided	Disagree	Total
1.	It will enthuse students & teachers to experiment by arousing their curiosity	73%	18%	09%	100
2.	It will help in learning basic and advancedconcepts through remote experiments.	87%	03%	10%	100
3.	It will increase student interest in the teaching-learning process.	83%	03%	14%	100
4.	It will improve the effectiveness of online as well as offline teaching.	87%	4%	09%	100
5.	It will revolutionize face-to-face as well as virtual internship programmesfor teacher education.	71%	11%	18%	100
6.	I will include experiments through virtual labs in my teaching practice.	92%	06%	02%	100

While analysing table 7, the attitude of prospective physics teachers toward the integration of virtual labs in the teaching-learning process, Item 1 (Virtual lab (OLabs) will enthuse students and teachers to experiment by arousing their curiosity) out of 100, 73 % of prospective physics teachers were agreed about that if the virtual labs integrated with the process of teaching-learning and it will enthuse students and teachers to experiment by arousing their curiosity. However, 09% of prospective physics teachers disagreed.

Responses from item 2. (Virtual lab (OLabs) will help in learning basic and advanced concepts through remote experiments) Of 100, 87 % of prospective physics teachers agreed that if the virtual labs are integrated with the process of teaching-learning, it will help them learn basic and advanced concepts through remote experiments. In contrast, 10 % of prospective physics teachers disagreed.

In item 3. (Virtual lab (OLabs) will increase student interest in the process of teaching-learning) Out of 100, 83 % of prospective physics teachers agreed that if the virtual labs are integrated with the process of teaching-learning, it will increase student interest in the process of teaching-learning. However, 14 % of prospective physics teachers disagreed.

Table 7. Item 4. (Virtual lab (OLabs) will improve the effectiveness of online as well as offline teaching) Shows that out of 100, 87 % of prospective physics teachers agreed that if the

virtual labs are integrated with the teaching-learning process, it will improve the effectiveness of online as well as offline teaching. However, 09 % of prospective physics teachers disagreed.

In item 5. (Virtual lab (OLabs) will revolutionize face-to-face as well as virtual internship programmes for teacher education) Out of 100, 71 % of prospective physics teachers agreed that if the virtual labs are integrated with the process of teaching-learning, it will revolutionize face-to-face and virtual internship programmes for teacher education. At the same time, 18 % of prospective physics teachers disagreed.

The last item, i.e., item 6, (I will include experiments through virtual labs in my teaching practice). Out of 100, 92 % of prospective physics teachers agreed that they would include experiments through virtual labs in their teaching practice. At the same time, 02% of prospective physics teachers disagreed.

Discussion:

The attitude of prospective physics teachers toward integrating virtual labs into the teaching-learning process is positive. They may find it interesting to do experiments without going to a physical lab because laboratory arrangements are not found in many schools when they go for teaching practice in schools. The instruments and infrastructure are dilapidated or scarce if the laboratory is available. Students and prospective physics teachers can learn while experimenting and get involved during the process of teaching-learning.

Conclusion:

The result of the study reveals that the level of awareness is low among prospective physics teachers, and none of them used the virtual lab to experiment. Even some prospective physics teachers do not know that the internet is necessary for using a virtual lab (OLabs). Some were unaware that Virtual lab (OLabs) is a government initiative. However, most know that virtual lab (OLabs) is available through PC/Laptop/Tablet/Smartphone and provides remote access to the simulation-based lab, although they do not find it easy to use. At the same time, attitudes are positive among prospective physics teachers towards incorporating virtual labs into the teaching-learning process. They have a positive attitude that virtual lab (OLabs) will help in learning basic and advanced concepts through remote experiments, improving the effectiveness of online and offline teaching. It will also revolutionize face-to-face and virtual internship programmes for teacher education. They have decided to incorporate experiments through virtual labs into their teaching.

Suggestions:

The need to utilize virtual laboratories is even more felt in online teaching. Therefore, the study suggested that the teacher education institution should be prepared to incorporate the basic idea and utilization of virtual laboratories into the practical part of the curriculum. Prospective physics teachers should also be motivated and trained during their micro-teaching by their supervisors' or mentors' usage of virtual laboratories for experiments in physics for their teaching

practice. Aside from this, teacher education institutions should organize workshops and training programs on virtual labs for their teachers and prospective teachers.

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