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Educators' Approaches to virtual lab practical activities in Biology

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Abstract

Laboratory experiences have always been an integral part of learning biology, but recent developments in technology have placed virtual labs at the forefront. These digital platforms provide solutions to common challenges of traditional labs such as resource and safety concerns and ease of access. This study aims to explore the perception and response of biology teachers towards the implementation of virtual laboratories in their classes. The study used a qualitative approach and employed a survey method targeting younger biology teachers from rural Primary schools in Purba Bardhaman district. The results indicated that most teachers hold a positive stance towards virtual labs, acknowledging their pertinence and credibility in current education. Several participants expressed their eagerness to use virtual laboratories for teaching purposes and commented on their capacity to improve practical lessons. However, the research also reveals gaps, especially with regards to knowledge about the existing funding and digital resources. This sheds light on the need to have more effective mechanisms which will ensure that there are no gaps in the change process and the adoption of virtual laboratory tools is successful. As far as further research is concerned, the study acts as a point of departure for educational policy studies and provides frameworks of intervention to address the current changes in education.

Keywords: Biology education, teacher, attitudes, virtual laboratory

1. Introduction

Learning biology has always been integrated with the practical element of it being taught in the four walls of a classroom. These areas have served as the cornerstone for biology teaching for years. Students were offered the chance to deal with the subject matter by performing real-life experiments with different materials. Such environments have proved to be highly effective in deepening students' comprehension of biological concepts and their abilities to think scientifically (Triola & Holloway, 2011) [16].

However, today, we are witnessing a profound shift in education that has been, in large part, fueled by state-of-the-art technologies. In tandem with this shift, virtual laboratories are emerging as an effective substitute for the usual hands-on practical class, providing new ways to deal with most of the problems associated with traditional practical classes (Ray *et al*., 2012) [14].

In traditional methods of teaching biology, practical classes require students to actively participate with actual specimens and laboratory apparatus, which they use to conduct experiments that seek to integrate theoretical concepts with their practical counterparts. This approach has been quite helpful in providing students with a real experience of scientific research. However, it also comes with its fair share of challenges (Griffin, 2003) [5].

Exceeding Resources are almost always an issue, especially in the context of many schools or institutions that appear to have an inadequate supply of materials, equipment, and facilities necessary to support practical sessions. These constraints may affect not only the scope but also the effectiveness of learning through the laboratory. Furthermore, the safety issues related to biological specimens, chemicals, and other potentially dangerous equipment further complicate the traditional logistics of laboratories and require the use of strict safety procedures along with qualified staff members.

Addressing Other Challenges education needs to expand its sources of practical training and remain open for equal opportunities for all students in all institutions which makes accessibility a difficult challenge. A lot, if not most, educational institutions that are situated on the outskirts or are underfunded simply do not have the necessary infrastructure needed to ensure uniform practical class attendance and access. This greatly limits the ability of students to engage in meaningful practical work so as to acquire the necessary skills through real-life experiences.

In this regard, many of the obstacles raised could be addressed by the use of virtual laboratories. Such laboratories facilitate biology education in an interactive, versatile, and non-restrictive manner when it comes to physical space, limited resources, or safety issues. The continuous efforts being made in teaching are set to include the use of virtual laboratories in teaching biology which will not only change the concepts students have towards the biological sciences, but will revolutionize the perspective both students and teachers will have towards learning and teaching.

The rapid rise of virtual laboratories signifies a major shift in the pedagogical approach to biology. In recognition of the changing nature of education, these new platforms employ the application of information technology to imitate the practical components that have been the hallmark of teaching science for many years. Virtual laboratories hope to overcome the obstacles of resource limitations, safety issues, geographical barriers as well as widen the scope of biology education by replicating fundamental aspects of real-life laboratory work in a simulated environment.

The incorporation of these augmented spaces into the boundaries of biology subject area is in itself a step towards advancement in technology and a shift in teaching strategies. As we start adopting this new paradigm in science education, one critical aspect that must be addressed is the opinions of biology teachers because their sentiments toward virtual labs will determine how fully these resources will be utilized in the educational process. Teachers' comprehension of possibilities and limitations of virtual labs has a bearing on how such teachers are likely to change their instructional approaches, engage students, and eventually educational results.

This research intends to focus on the perspectives, problems, and advantages that biology educators have regarding the use of virtual laboratories. Their experienced insights, we posit, will provide a better understanding of the impacts of virtual laboratories on traditional methods of teaching biology and the changing faces of biology education in the future.

2. Objectives

- To find out prospect and relevance of virtual laboratory in 21st Century.
- To find out the teacher's attitude towards virtual laboratory for teaching biological science in school.
- To determine the reliability for conducting practical classes through virtual laboratory.
- To find out probable causes of different types of attitudes.

3. Literature Review

This review thoroughly analyzed the evolution of biology instruction and noted a change ranging from the traditional classroom setting to technology-based instruction. Educational technology has changed the way biological science teaching and learning takes place, especially with the use of digital technologies (Cronin, 2014) [4]. The literature praised the use of multimedia, simulations, and virtual laboratories which not only motivated the students, but also increased their access to learning materials outside the traditional classroom (Hoskins *et al*. 2011) [7]. This section analyzes virtual laboratories, focusing on their interactive and engaging quality. Overcoming other infrastructural and safety limitations is one of their most beneficial features. Research was done on how Virtual Laboratories affected students' learning engagement and achievement but also pointed out the necessity of adequate teacher training as a barrier. The review analyzed teacher disposition towards the use of technology for teaching biology based on the research done by Johnson and Smith and also Wang *et al*. that pointed out the disposition's complexity. Anderson and Maninger's work added important pieces of the puzzle related to the issues and prospects of using information technologies in teaching biology.

In retrospect, the review offered a sophisticated analysis of the impact of technology in biology education and its advantages and disadvantages for the field while emphasizing the importance of teacher disposition toward ensuring success.

4. Significance of the study

The Covid-19 pandemic affected all sectors including education. Most teaching and learning systems worldwide had to be modified. Practical and hands-on subjects suffered the most, like biology, where a lot of learning was done through laboratory-experiments. The most feasible option available was to set up online classes and create virtual laboratories. These developments were necessary to adapt to the change in the instructional model.

This study focuses on assessing the perspective of Biology teachers from the Higher Secondary Schools of Purba Bardhaman district on the shift towards virtual practical classes. Although digital tools are becoming increasingly integrated in education, very little attention has been devoted to the perceptions of biology teachers regarding the efficacy of e-practicums conducted in virtual laboratories.

This study seeks to understand how teachers perceive the implementation of Online Practical Sessions (OPS), the logistical steps needed to be taken to make this shift, and what teacher training is necessary to ensure OPS is successful in the implementation stages. Focusing on biology teachers shows their importance in the educational balance. It is well-known that teachers have a very good idea of what the students need, aside from their parents; meaning, teachers' readiness and attitudes count a lot. Thus, their willingness and preparedness to seamlessly integrate virtual labs into the curriculum is crucial, even if the learning environment is virtual.

As such, this study hopes to provide some insight into the

debate of how technology can be used in education, especially within the biological sciences, and what support teachers need in adapting to this new educational paradigm.

5. Materials and Methods

5.1 Design: The primary objective of the study was to examine Biology Teachers' attitudes towards teaching via virtual laboratory aids. The researcher employed a qualitative strategy using the survey method. A qualitative approach generally focuses on the discovering and understanding the intricacies or complexities of human experience, perception, and behaviour.

5.2 Participants: Biology teachers from Purba Bardhaman district who participated in this study represent mostly younger teachers from rural areas. The researchers utilized the Stratified Random sampling strategy. In stratified sampling, a homogenous population is broken down into basic variables' sample strata. The researcher collected data from 103 participants for this study through the stratified random sampling method, with 47 from urban areas and 56 from rural areas.

5.3 Tool: To achieve all the set goals, the researcher crafted a questionnaire to assess Biology teachers' attitudes toward the virtual laboratory. The questionnaire had two sections: one dealing with demographics of the teachers, and the other was divided by objectives. It was constructed with four components. The first dealt with the importance and relevance of a virtual laboratory in the 21st Century. The second aimed to assess Biology teachers' attitudes toward virtual laboratories. The third component focused on the acceptance level for practical classes conducted via the virtual laboratory. The last component sought to determine possible reasons for various attitudes.

This questionnaire began with 29 items, but after computing the p-value and DI value, it was shortened to 20 items, 13 of which were favourable and 7 unfavourable. A five-point summative Likert scale was utilized to measure each item on a continuum ranging from strongly agree to strongly disagree. For reliability testing, the test-retest method was used. The correlation between the two tests was computed using Pearson's product movement method, yielding a reliability score of 0.86. This result indicates a high level of reliability for the questionnaire.

Table 1: Test-Retest Reliability

Item Number	Statement	Favorable/Unfavorable	Test 1 Score	Test 2 Score	Pearson Correlation (r)
1	Statement 1	Favorable	4	5	0.86
2	Statement 2	Unfavorable	2	2	0.86
3	Statement 3	Favorable	3	4	0.86
4	Statement 4	Favorable	5	4	0.86
5	Statement 5	Unfavorable	2	3	0.86
6	Statement 6	Favorable	4	4	0.86
7	Statement 7	Unfavorable	1	2	0.86
8	Statement 8	Favorable	5	5	0.86
9	Statement 9	Unfavorable	3	3	0.86
10	Statement 10	Favorable	4	5	0.86
11	Statement 11	Unfavorable	2	2	0.86
12	Statement 12	Favorable	5	4	0.86
13	Statement 13	Unfavorable	1	1	0.86
14	Statement 14	Favorable	4	5	0.86
15	Statement 15	Unfavorable	3	3	0.86
16	Statement 16	Favorable	5	5	0.86
17	Statement 17	Unfavorable	2	1	0.86
18	Statement 18	Favorable	4	4	0.86
19	Statement 19	Unfavorable	1	2	0.86
20	Statement 20	Favorable	5	5	0.86

5.4 Data Collection: The information was collected using an online form on Google Forms. The link was shared via WhatsApp. Respondents were required to participate in the survey to obtain relevant information. In the survey, there are open questions which seek to elicit detailed answers from instructors regarding their understanding of virtual laboratories, challenges faced during practical classes, and their opinions on the effectiveness of virtual laboratories.

5.5 Data Analysis: Thematic analysis serves to identify recurring patterns of categories and themes within qualitative data. This approach enables an in-depth examination of teachers' attitudes.

6. Results

The participants of this research work were Biology teachers of secondary schools in the Purba Bardhaman district of West Bengal. 50 respondents were selected. The researcher obtained information from the urban and rural areas of the Purba Bardhaman district.

Table 2: Locality where the study was conducted

Rural	Urban	Total
30	20	50

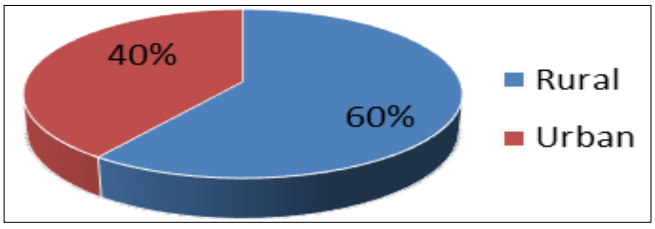

Fig 1: Locality where the study was conducted

Table 2 shows that locality where the school was situated. The researcher has collected data mostly from rural areas. 60% of data were collected from teachers of rural areas of Purba Bardhaman districts.

Table 3: Experience of Teachers in Years

Experience (In Years)	Frequency	% of frequency
1 -3	13	26
4-6	21	42
7-9	5	10
10-12	6	12
13-15	2	4
16-18	1	2
19-21	2	4
Total Number- 50		

Here Table 3 showed the experience (in years) of teachers and their frequencies. Here 42% respondents are having 4 to 6 years of experiences in their teaching life. Most of the respondents are of new generation.

Table 4: Prospect and Relevance of Virtual Labs.

Responses	No. of Responses	Total Response	% of Responses
Strongly Agree	36	50	72
Agree	12		24
Indifferent	2		4
Disagree	0		0
Strongly Disagree	0		0

Table 4 contains the different responses of teachers and it focuses on the 1st dimension of the research. The first dimension of the questionnaire indicated to relevance and prospect of virtual laboratory in 21st Century. About 72% of respondents were strongly agreed with this regard.

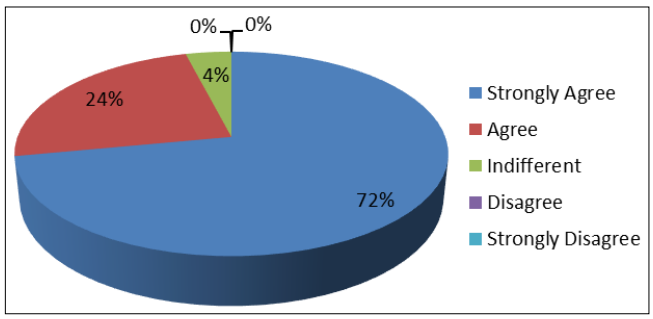

Fig 2: Different Opinions Towards the Prospect and Relevance of Virtual Labs

For Objective 1 the researcher had set four questions. The last question was about the effect of virtual laboratory on the entire teaching – learning programme. 64% teachers gave their opinion that Virtual laboratory can bring ease in the entire teaching-learning programme.
The researcher had set her 2nd objectives to find out different types of attitudes of teachers towards virtual laboratory for teaching in practical situations in their own environment. 48% respondents agreed with that teachers would be benefitted if they conduct practical classes through virtual laboratory. While 40% of teachers showed their high expectation of getting benefitted.

Table 5: Conducting Practical Classes through Virtual Laboratories in Their Own Environment

Responses	No. of Responses	Total no. of Responses	% of Responses
Strongly Agree	20	50	40
Agree	24		48
Indifferent	2		4
Disagree	4		8
Strongly Disagree	0		0

The researcher found that about 50% of the respondents were very much enthusiastic to take training for establishing for their own laboratory. 40% of the respondents thought that learners will be highly benefitted if teaching conducted through virtual laboratory.
The researcher had set her 3rd objectives to determine the reliability for conducting practical classes through virtual labs. For that reason, the researcher set three questions. The first question answers for the how it is reliable as a time saving programme. 52% of the teachers strongly agreed that it is a time saving programme.

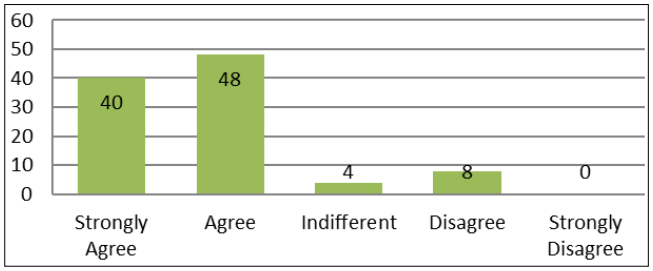

Fig 3: Conducting Practical Classes through Virtual Laboratories in Their Own Environment

Table 6: Reliable as Time Saving Programme

Types of Response	Strongly Agree	Agree	Indifferent	Disagree	Strongly Disagree	Total Response
No. of Response	26	17	5	2	0	50
% of Response	52	34	10	4	0	

The researcher set her 4th objectives to find out different reasons behind different attitudes. This last objective contains five questions about the cost for implementation, liability of school authority, role of guardians and students, and about the learners of marginalized section of that locality.

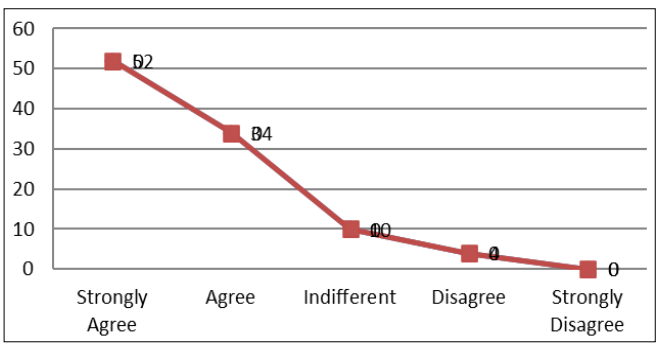

Fig 4: Reliable as Time Saving Programme

The researcher found that about 38% of respondents were ignorant about attitude of school authority towards virtual laboratory. On that question rest of the teachers gave mixed reaction. Table 7 showed about financial support by school authority. 44% respondents didn't know whether school authority is going for sanctioning any grant or financial support. Rest of feedbacks were mixed.

Table 7: Financial Support by School Authority

Responses	No. of Responses	Total no. of Responses	% of Responses
Strongly Agree	09	50	18
Agree	08		16
Indifferent	22		44
Disagree	7		14
Strongly Disagree	06		12

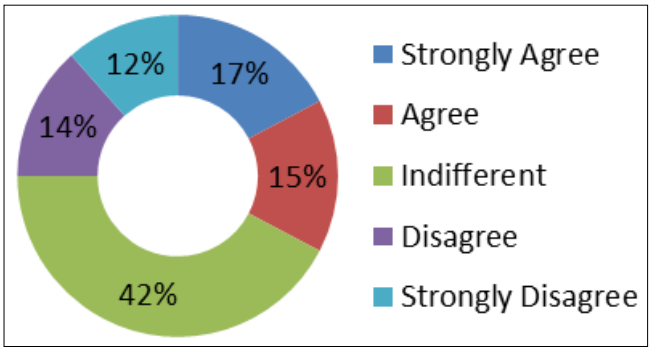

Fig 5: Financial Support by School Authority

Total 44% respondents admitted that the cost for establishing is effective though it was initially expensive by means of it required gadgets and other essential equipment's. Maximum respondents gave their strong opinions and they strongly agreed that every learner should have personalized gadgets. Though virtual laboratory is technology based, but it avoids accidents often occur due to inattentiveness in traditional laboratory. 54% of the respondent's strongly agreed with that statement which stated virtual laboratory avoids accidents and losses due to accident. 50% of the respondents agreed to help the learners from deprived society. Rest of the teachers showed mixed opinions.

Table 8: Gurdian's Interest about Virtual Laboratory

Types of Response	Strongly Agree	Agree	Indifferent	Disagree	Strongly Disagree	Total Response
No. of Response	6	9	25	2	8	50
% of Response	12	18	50	4	16	

Table 8 showed that interest of guardians of students towards virtual laboratory. The table stated that 50% of the respondents don't know whether the guardians of student's interest.

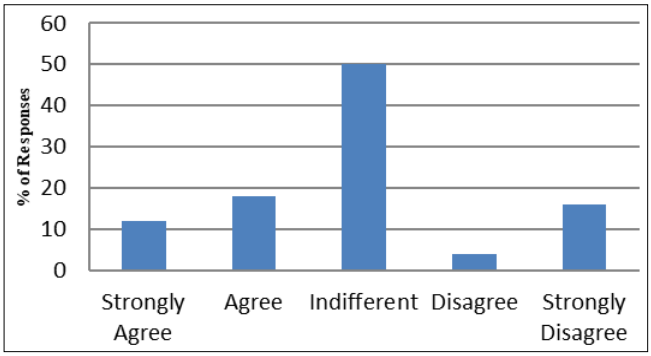

Fig 6: Guardian's Interest about Virtual Laboratory

The final objective was to address the different problems to establish a virtual laboratory for their own. Most of the respondents were unaware about the financial support. Most of the respondents didn't know whether the learners have or haven't digital back up.

7. Discussion

The findings related to Objective 1 highlight a positive inclination among respondents toward the prospect and relevance of virtual laboratories in the 21st century. The majority, comprising 68% (50% strongly agreeing and 18% agreeing), express a favourable attitude, underscoring an acknowledgment of the significance of virtual laboratories in contemporary educational landscapes. Moreover, the results pertaining to the second objective reveal a prevalent positive attitude towards teaching through virtual laboratories, emphasizing the receptiveness of educators to leverage this technological tool for instructional purposes. Moving on to the third objective, the researcher notes a strong consensus among respondents regarding the reliability of conducting practical classes on virtual platforms. This alignment with the reliability of virtual laboratories substantiates the viability of virtual platforms in delivering effective practical instruction. Lastly, concerning the final objective addressing the challenges in establishing virtual laboratories, the research identifies a lack of awareness among respondents about financial support and the digital backup availability for learners. This point to a critical need for disseminating information and providing support to educators navigating the financial and technological aspects of implementing virtual laboratories in their teaching practices. These insights collectively contribute to a nuanced understanding of teacher attitudes and provide valuable guidance for further research and practical interventions in the integration of virtual laboratories in biology education. The research provides valuable insights into the current landscape of teacher attitudes towards virtual laboratories in biology education. The positive attitudes identified suggest a fertile ground for further exploration and implementation. However, the awareness gaps regarding financial and technological aspects emphasize the importance of comprehensive support structures to facilitate a smooth transition towards the

effective use of virtual laboratories in the educational setting.

8. Conclusion

The introduction of E-learning systems emerged as a solution for the disruptions caused by the Covid-19 pandemic on education. Learners, both at the school and college levels, have, alongside their teachers, recognised E-learning as an essential part of education today. It has the potential to drive the future of education. Theoretically oriented lectures have adapted more readily to online learning environments than practical oriented ones. Therefore, the researcher carried out a study on the perception of Biology teachers towards virtual laboratories in Purba Bardhaman district. The subjects of the study were Biology teachers from the newer generation who normally come from rural areas of Purba Bardhaman district. The research showed that an overwhelming number of teachers demonstrated a high level of interest and a very positive perspective toward virtual laboratories. Teachers overwhelmingly agreed that virtual laboratories were extremely relevant to the 21st Century and very dependable, especially in terms of efficiency and economy. There is a high capital outlay required to set up the system, however, because it prevents accidents and damages, it is more economical in the long run.

It was noted that a significant number of teachers demonstrated a lack of knowledge concerning the grants provided by the school administration or their parent's assistance towards their children's educational shift. Teachers, on the other hand, showed great willingness to accept training on virtual laboratories and wanted to build their own virtual laboratories. While recognising the existence of risks and barriers to the integration of virtual laboratories in schools, teachers' positive attitudes towards overcoming these barriers indicates the need for change in order to achieve full participation. The researcher recommends that decisive steps be taken to remove these barriers to access for the use of virtual laboratories in school settings.

8. Recommendations

In light of the identified challenges and benefits associated with implementing virtual laboratories in biology education, several recommendations can enhance the effectiveness of their integration. Firstly, educational institutions should invest in comprehensive training programs for biology teachers, equipping them with the necessary skills to navigate and utilize virtual laboratory platforms. Additionally, fostering collaboration between educators, technology experts, and curriculum developers is crucial for designing virtual experiments that align with curriculum objectives and enhance student learning. Institutions should also consider allocating resources for continuous technological updates and maintenance to ensure the sustained functionality of virtual laboratories. Furthermore, policymakers and school administrators must develop clear guidelines and allocate funding to address infrastructure disparities, ensuring that all students have equitable access to virtual laboratory experiences. Lastly, encouraging research and on-going assessment of virtual laboratory effectiveness will contribute to the refinement of these tools, fostering a dynamic and continually improving learning environment in biology education.

8. Future Directions

Future research could employ a mixed-methods approach, combining surveys with interviews or classroom observations, to offer a more comprehensive understanding. Future investigations could explore the intersectionality of teacher and student attitudes, providing a holistic view of virtual laboratory integration in biology education. Finally, as technology continues to evolve, future research should continuously assess the effectiveness of virtual laboratories in keeping pace with educational advancements and adapt to emerging challenges.

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