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Digital India: Journey Of Virtual Labs For Enhancing Accessibility Of Scientific Experiments

Pulastya Joshi[1] and Drashti Joshi[2]

Indian Institute of Teacher Education, Gandhinagar

ABSTRACT

Labs are the important part of the curriculum for the enhancing the mastery on the subject knowledge and it also provide the environment for the developing the scientific reasoning ability, increasing the understanding of the complexibility of the subject, developing the practical skills, creating the scientific attitudes. In the digital area the process are changed and now we have internet facilities and technology so we developed the software that include the lab experiment online known as virtual labs. Virtual labs (VL) have become a valuable asset for educational organizations, especially in light of the COVID-19 pandemic. The purpose of this research is to examine the obstacles and difficulties related to accessibility in virtual laboratories and to suggest possible ways to get around them. These labs address the accessibility and inclusivity of scientific education by enabling students to conduct experiments with practical applications without requiring physical equipment. For students without access to traditional laboratories, the introduction of virtual labs—like smart science labs—has created new opportunities by offering hands-on training and practice. Virtual laboratories are still not completely accessible, especially for students with disabilities Additionally, it highlights the necessity of incorporating accessibility features and universal design principles into virtual lab platforms to make them inclusive and accessible to students with a range of learning needs and abilities. According to the research, user-to-user explicit interactions are a crucial component of virtual labs that support improved instruction. Moreover, the absence of high-quality, current lab experiments has been a significant barrier to engineering education; however, the use of virtual labs may be able to overcome this issue. In order to meet the varied requirements of students, including those with disabilities, the study also emphasizes the significance of adaptive technologies, individualized learning experiences, and collaborative learning opportunities in virtual labs. By implementing these suggestions, academic institutions and technology developers might endeavour to guarantee that all students have equitable access to virtual labs, giving them the chance to participate in scientific investigations and educational opportunities. Virtual laboratories are a crucial part of making Digital India's goal of a technologically advanced country a reality

in the educational system. This study captures the development of virtual labs, tracing their path from the beginning to their current critical position in the accessibility of scientific education. We need some more improvements but definitely we can say that we are on the right path to achieve the desired goals.

Key Words: - Digital India, Virtual Labs, Simulation, Problems and remedies

INTRODUCTION

Education is the continuous and comprehensive process of learning through the innovative teaching methods and technology. It is also the process of acquiring knowledge and improving your reasoning ability, critical thinking and preparing oneself or others intellectual for mature life. In the last 2 decades, the Internet and technology has grown very fast and it change the way of living of the people. It also changed the way people communicate, do shopping, being socialise and also the way of teaching learning happened. The changing face of teaching is now termed as ONLINE EDUCATION.

Online education is modern and flexible instructional delivery system that include all the kind of learning, very large number of topics, subject areas, discipline and degree programs that offered to the people of all the age group level that done through the Internet. Here the internet is used as the primary means of instruction and assessment. In the brorderd term, the online education means gaining the skill, Knowledge, reasoning ability, the critical thinking skill through the instruction provided through the internet and technology. Reading an article about the science is not included in the "online education" but enrolling in the online video course that provide the knowledge and understanding about the science would be considered as "online education".

Online education provides opportunities to the teacher to reach student who does not able to take admission in the school for their education. It helps the student to learn on their own schedule and at their own place with suitable environment. With the increased availability of the computer technology and the internet, students are able to access the information anytime and anywhere that would normally be available through the traditional classroom. (Encyclopedia, 2022)

There are several online educational portal run by GOI :-

- Swayam
- NPTEL
- NROER
- Virtual labs
- e-Pathshala
- DIKSHA
- SWAYAM PRABHA
- PM eVIDYA Programme
- Talk to Teacher
- Aakash Educational Portal

The main aim or the purpose of the all the free online educational portal run by the government is to make the education available and accessible to all the student of the country and keep the learning and the teaching process uninterrupted and ongoing. All the free e-learning portals developed by the GOI contain the difference courses that can be useful for the student, Teachers, learners and Professionals. It contain the various video lectures, pdfs, audio, test and that helps in the increasing the knowledge and understanding about the concepts. These portals provide access to quality education through digital media to the students of remote areas.

NMEICT

MHRD now termed as a Ministry of Education started one program named NMEICT. The full form of NMEICT is "National Mission on Education through Information and Communication Technology". The mission launched in 2009 with the goals of increasing the potential of Information and communication technology (ICT) to make the best quality content available to the all student free of coast. The goal of this mission is to address all the educational needs of the student, Teachers (Prasar, 2018).

The three principles of the Education policy vis., access, equity and equality are to be served through three major component :-

1. Content generation
2. Providing broad bend connectivity to higher education institute (Prasar, 2018)
3. Low coast access and computing devices for student and teacher

Programmes run under NMEICT :-

Sr. No	Programme	Level			Objective
		School	UG	PG	
1.	SWAYAM	➢	➢	➢	MOOC courses
2.	SAWAYAM Prabha	➢	➢	➢	TV channels (34)
3.	NDLI	➢	➢	➢	E –BOOKS
4.	NISHTHA	➢			Teacher training and Capacity Building
5.	FOSSEE		➢	➢	Learn open source software online
6.	e – Yantra		➢	➢	Learn robotics
7.	E- Shodh sindhu		➢	➢	e- Journals
8.	Virtual labs		➢	➢	Scientific Experiments
9.	Shodh shudhhi		➢	➢	Plagiarism
10.	Samarth		➢	➢	E – GOV suite
11.	Baadal		➢	➢	Free academic clouds
12.	Vidwan		➢	➢	Expert system

13.	e – PG Pthshala		➢	➢	e – Books upto PG

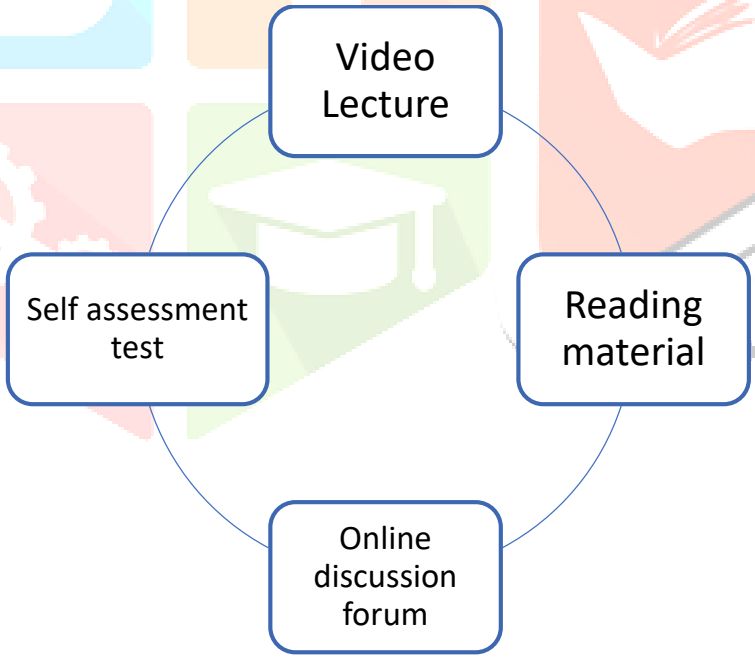
(Kumar, 2020)

SWAYAM

SWAYAM, the largest learning digital platform launched by the Indian government, was created to realise the three key tenets of education policy: access, equity, and quality. The goal of these efforts is to make the best educational resources available to everyone, including the most deprived. SWAYAM aims to close the digital gap for students who have so far been left out of the digital revolution and are unable to participate in the knowledge economy.

SWAYAM portal contain most of the courses that taught in the schools and colleges from class 9 till post-graduation and this courses is available and accessible to all the citizen of the country with free of coast and this courses made by the more than 1000 specially selected best faculties of the country teaching in the various premier institutes. (Ministry Of Education, 2022) These teachers provide their valuable knowledge, skill, ideas and the experience for making the courses innovative and interactive. UGC has already made the framework for the transfer of the credit of the course that done through the SWAYAM portal.

The Courses offered by SWAYAM are in 4 Quadrant:-



National Coordinator

Total nine National Coordinator have been appointed in order to ensure that the best quality content and courses are present and delivered to the students. This Coordinators have to keep eye on the content that presented on the SWAYAM portals and also ensure that this content is validate and proper.

1. CEC (Consortium for Educational Communication for UG education. (Ministry Of Education, 2022)
2. NITTTR (National Institute of Technical Teachers Training and Research). (Ministry Of Education, 2022)

3. NCERT (National Council of Educational Research and Training) for school. (Ministry Of Education, 2022)

4. AICTE (All India Council for Technical education) for International courses. (Ministry Of Education, 2022)

5. NIOS (National Institute of Open Schooling) for school education. (Ministry Of Education, 2022)

6. IGNOU (Indira Gandhi National Open University) for out-of-school students. (Ministry Of Education, 2022)

7. NPTEL (National Programme on Technology Enhanced Learning) for Engineering. (Ministry Of Education, 2022)

8. IIMB (Indian Institute if Management, Bangalore) for management studies. (Ministry Of Education, 2022)

9. UGC (University grant commission) for non technical post-graduation education. (Ministry Of Education, 2022)

Statics of SWAYAM

Partnering Institute	203
Completed Courses	8082
Student Enrolment	27956791
Exam Registration	2206713
Successful Certification	1177076

(education, 2022)

Advantages of the SWAYAM Courses

- SWAYAM courses are open access to all and learner does not have to pay for learning but he has to pay little money for the certificate after the completio0n of the courses.
- The availability of best and quality teacher was limited to the premier institute like IITs, IIMs and the top most university of the country but through the SWAYAM portal the students from the any part of the country can have access to these faculties of the country.
- The high quality education will reach to the mass at minimum coast.
- Learners can learn their topic of interest through the portals with the continuous of their regular studies and the certificate are also helpful for their professional carrier.
- Through the weekly assignment it’s ensure your progress in timely manner.
- It’s enable you to the your basic desire learning goals.
- Credit of the course can be transfer on to the academic of the students. (Hiremath)

What is a virtual lab?

Labs are the important part of the curriculum for the enhancing the mastery on the subject knowledge and it also provide the environment for the developing the scientific reasoning ability, increasing the understanding of the complexibility of the subject, developing the practical skills, creating the scientific attitudes. In the digital area the process are changed and now we have internet facilities and technology so we developed the software that include the lab experiment online and it is known as " VIRTUAL LABS".

It was defined as " Laboratory experiment without real laboratory with its walls and doors. It enables the learner to link between the theoretical aspect and the practical one, without papers and pens. It is electronically programmed in computer in order to simulate the real experiments inside the real laboratories (Harry and Edward,2005)."

In addition It was defined as "A virtual studying and learning environment aims at developing the lab skill of students. This environment is located on one of the internet pages. Usually, this page has main page and many links, which are related to laboratory activities and its achievement. (Zaitoon, 2005, 65)" Virtual lab use the computer to provide the virtual 3D image of the experiment.

Why we use the virtual labs

- Student and teachers cannot access the physical labs at all the time
- There is chance of accident in the physical labs when inexperienced student are working with hazardous chemical or substance and also with dangerous equipment.
- Modern and advanced machine and equipment are needed to do some experiment but some of the institute or laboratories cannot afford this equipment so the learners cannot do the experiment properly.
- As the number of student are more then the capacity of the labs then all the student cannot access the labs and they does not have chance to play around and do first hand experiments.
- Common problems of the physical labs are outdated equipment or machines and that are not useful for the learning so student have to only learn the theories part and the application based part are remaining.

There are some virtual labs that provide the open access and some of them is run by the MHRD under the NMEICT Project :-

- Virtual lab
- Amrita lab
- Labster
- Phet Interactive stimulation
- NOVA labs
- Crocodile labs

VLAB (virtual labs)

Vlab project is initiated by the Ministry of Human Resources Development (MHRD), under the vision and mission of the National Mission on Education through Information and communication technology (NMEICT). (Virtual labs) Any institute required the good lab facilities and updated experiments for learning. Through the VLAB project GOI tried to provide the lab facilities to the student of remote areas with the best quality experiments. VLAB is the simulation based labs in the various discipline of the science and engineering. Through this innovative project MHRD tried to remove the issue of lack of good lab facilities with the quality teacher.

Objectives of the VLAB

❖ To provide remote-access to simulation-based Labs in various disciplines of Engineering and Science (Delhi)

❖ To enthuse students to conduct experiments by arousing their curiosity. This would help them in learning basic and advanced concepts through remote experimentation (Delhi)

❖ To provide a complete Learning Management System around the Virtual Labs where the students/ teachers can avail the various tools for learning, including additional web-resources, video-lectures, animated demonstrations and self-evaluation (Delhi)

❖ Arousing curiosity in the student and provide the flexible environment so that they learn at their own peace (Delhi)

Through stimulation-based experiment, this student-centered method facilitates the integration of both fundamental and advanced concepts. The utilisation of extra web resources, video lectures, animated demonstrations, and self-evaluation are also made possible via internet-based experimentation. Specifically, the initiative of virtual labs address the following:

- Virtual labs provides access to online labs to those engineering colleges who suffers with lack of lab facilities (Delhi)
- It provides Access to online labs as a facilities to those colleges that already have labs (Delhi)
- Training and skill development through, on-site training, and online training, workshops (Delhi)

Participating Institute

1. IIT BOMBAY (Delhi)
2. AMRITA VISHWA VIDYAPEETHAM (Delhi)
3. IIT KHARAGPUR (Delhi)
4. IIT KANPUR (Delhi)
5. COE PUNE (Delhi)
6. DAYALBAGH EDUCATIONAL INSTITUTE (Delhi)
7. IIT DELHI (Delhi)
8. IIT ROORKEE (Delhi)

9. IIT HYDERABAD (Delhi)
10. IIT GUWAHAT (Delhi)
11. NITK SURTHKAL (Delhi)

Various virtual lab areas

- Mechanical Engineering.
- Chemical science.
- Biotechnology and Biomedical Engineering
- Electronics and Communication
- Computer science & Engineering.
- Chemical Engineering.
- Civil Engineering
- Electrical Engineering..
- Physical science.

Advantages of Virtual Labs

- Every student and teacher has unlimited access to the lab at all times and from Every locations.
- Assist in performing experiments that are difficult to perform in the physical labourites
- Make the newest technologies available to teachers and students.
- Provide the virtual experience of the instrument that can not accessible in the hands on labs.
- Save time and money of the institute, student and teacher
- It helps student to record the result of experiment electronically so they can share this result to other for verification and exchange experiences
- Here zero chance of accident so student can perform the experiment easily and also inexperienced student can also perform the experiment without fear.
- Remote areas student and teacher can easily access the labs and gain the understanding and application of that topic easily.
- Virtual labs allow student to stay touch with the internet so during the practical student can gather the Information about the experiment.
- Virtual labs make the process of the learning very simple and impactful through the visual experiences.

Drawbacks of Virtual labs

- The necessary device and technology are needed like computer, Internet etc.
- Full sensory exposure in a real lab can teach students vital lessons like weird smell and sound, random error, broken machinery, etc...
- Student cannot get the exposure to get interaction with the real equipment.
- Skills of using the instrument are not honed.
- Less interaction between the learner and teacher

➢ Plagiarism issues are evolved

Problems during providing the accessibility of scientific experiments

- **Absence of Customization Options**: People with particular visual needs may not be able to be accommodated in virtual labs if text size, contrast, and color schemes cannot be changed.
- **Ineffective Security Measures**: -Improperly executed security measures may jeopardize user data, posing a risk to users' privacy and safety when utilizing virtual labs.
- **Absence of Regular changes**: Virtual laboratories may lag behind in fulfilling new accessibility requirements and standards if they do not receive changes on a regular basis based on user feedback.
- **Inconsistent Observance of Accessibility Guidelines**: Users may unintentionally encounter obstacles in virtual labs that don't follow accessibility guidelines, which could prevent them from participating completely in scientific research.
- **Complicated User Interfaces**: Users with cognitive limitations or those who prefer simpler interactions may find virtual labs with too complex interfaces challenging.
- **Ineffective Alternative Input techniques**: People with motor skill issues may find it challenging to interact with the experiments if virtual labs do not offer effective alternative input techniques.
- **Inadequate Training Resources**: Teachers and students may find it difficult to use virtual laboratories successfully if there are not enough resources available. This could negatively affect the accessibility of the learning process as a whole.
- **Absence of Accessibility**: It's possible that accessibility was not considered when designing virtual labs, which makes it challenging for people with impairments to access and engage with the content. For students with impairments, virtual laboratories could not offer enough assistance, such as closed captioning, audio descriptions, or alternative language for photos.
- **Virtual labs are not readily available:** Virtual laboratories might not be available in every educational setting, which would limit students' ability to participate in virtual experiments.
- **Expensive virtual labs**: Because they can be costly to create and operate, virtual labs are not as accessible to students and institutions on a tight budget.
- **Inadequate Support for Screen Reader**s: Users who are visually challenged and rely on assistive technologies like screen readers may encounter difficulties with virtual laboratories since they are not optimized for screen readers.
- **Limited accessibility of virtual lab navigation**: It's possible that people with impairments won't be able to navigate virtual labs with ease, thanks to things like inconsistent and unambiguous labelling of buttons and links.

Remedies/Suggestions

- **User-centric research**: Make sure virtual laboratories are accessible to a broad spectrum of students by conducting in-depth studies to understand the various needs, preferences, and obstacles of learners.
- **Adaptive interfaces**: Create user interfaces that can change to accommodate different learning methods so that users with different needs can access virtual laboratories more easily.
- **Compatibility with assistive technologies**: To give visually impaired users a seamless experience, make sure virtual labs are compatible with screen readers and other assistive devices.
- **Other input techniques**: To support inclusivity and accommodate users with motor skill issues, incorporate a variety of input methods.
- Real-time feedback mechanisms: To improve the interactive learning environment and encourage ongoing development, including features that offer immediate feedback.
- **Working together with accessibility experts:** Make sure virtual labs follow best practices and universal design principles by collaborating with accessibility specialists.
- Content that appeals to several senses should be created in order to accommodate users with a range of sensory preferences and skills.
- **Customizable settings**: Give users the flexibility to change the text size, contrast, and color schemes to improve the readability for people with different needs.
- For the benefit of users with visual impairments, provide succinct and unambiguous audio descriptions for all visual aspects in the virtual lab.
- **Promote the sharing of best practices** and success stories related to the accessibility of virtual labs through conferences, publications, and online communities to inspire and inform educators and developers around the world
- **To guarantee that all students**, regardless of their financial situation, have access to high-quality, accessible lab experiences, promote the use of open-access virtual lab platforms and open educational resources (OER).
- **Encourage cooperation** between academic institutions, business associates, and governmental organizations to allocate funds toward the creation of cutting-edge and easily accessible virtual laboratory technologies.
- **Push for the incorporation** of universal design principles and accessibility in the creation of national and international standards for virtual lab hardware and software.

Conclusion

With the ever changing educational technologies, Educators are always exploring the new and innovative ways of online teaching learning process and this VLABS are the new step towards the opening the doors of the impactful learning. The GOVERNMENT OF INDIA is also trying to make the India digital and they started the step towards the making the education easily accessible to the every citizen of the country with the use of different technologies and techniques. SWAYAM and NMEICT are some of the initiative taken

by the GOVERNMENT OF INDIA and MHRD to increase the level of education in country. We need some more improvements but definitely we can say that we are on the right path to achieve the desired goals.

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