VIRTUAL LABORATORIES: A POSITIVE INTERVENTION IN SCHOOL EDUCATION

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The Indian Education System, though considered to be very robust at the secondary and higher secondary levels, has some innate flaws that educationists, policymakers, teachers and other stakeholders, including parents, have been pointing out time and again. The overwhelming content and emphasis on rote learning have been the main issues that have created a disconnect between students and their learning and, as a result, they are often not able to apply the knowledge acquired in the classroom to solve contemporary challenges. To mitigate the issues, educationists worldwide have emphasised imparting practical knowledge. Practicals have, therefore, been integrated with the general coursework. For science students, it has been mandatory to have laboratory exposure. Students have also been evaluated for their capabilities to conduct lab experiments and analyse the results. However, we understand that only a fraction of school engage students correctly in laboratories. Many secondary and higher secondary schools struggle to have basic laboratory facilities in place. Besides, the lack of quality equipment and trained manpower to maintain these labs is prevalent in many parts of the country. The right to quality education is now enshrined in our constitution. Therefore, a person in any part of the country is entitled to receive that. To achieve the mission that each student gets the exposure, if not in real-time but through remote access, the concept of Virtual Labs gained popularity. In 2009, the pilot project to start these labs started in India in an organised and nationally coordinated manner. The top-down approach was used to introduce Virtual Labs in teaching-learning. It has penetrated secondary school education lately and these Virtual Labs are now seen as a positive intervention in school education where secondary school students can access practical knowledge through engaging learning management platforms. It is essential for schools to invest in building infrastructure to support these for the government to train people who can help develop the content that is more pertinent at regional levels, and for the stakeholders to accept the new technology and reap the harvest. There is also a strong need to have the content available in regional languages.

Introduction

Laboratory is a place where students can learn theoretical concepts by designing new experiments or following standardised procedures to decipher some concepts. In many countries, laboratory sessions are a strategic imperative in all good schools. Laboratories have, therefore, been an integral part of various streams, especially sciences, Hofstein and Kind (2012). Earlier, people had this notion that a laboratory can only complement the understanding of STEM subjects in schools. However, it was realised that these are important to make students understand the social sciences as well, (Pace 2008). Recently, educationists have been advocating their role in improving the concept building in Mathematics and the languages, (Alexander 2007 and Rane-Sharma *et al.* 2017).

In India, the higher and senior secondary schools need to have well equipped science laboratories, and schools get mandatory recognition only after they meet those critical minimum requirements. However, the school systems in rural areas have been fluid. Some

rural schools have a manpower crunch, and there is apathy towards maintenance of infrastructure in many, and many schools in far-flung areas do not have round-the-clock electricity to run the lab equipment. Schools in various parts of the country have also faced problems from natural disaster such as floods, tsunamis and fires. Recently, a number of government schools in Tamil Nadu and Srinagar had a lot of material loss on account of floods (TOI, The Times of India, News Reuters). School closures due to insurgency, pollution and other civic problems have also taken place many times in the recent past in different parts of the world as well, Call and Coleman (2014). In the national capital, air pollution warranted the closure of schools on account of high particulate matter in air that was posing severe health threats to school going children Sarkar *et al*. 2018.

Considering these problems, the Virtual Labs that MHRD's National Mission on Education through ICT started with a few pilot projects entering the schools (Digital Learning, 2012). Many international schools that run in many places in the country have enormous funds and these were the first to adopt these labs. The importance of these on teaching-learning was soon realised and it was seen that the schools that integrated Virtual Labs with the normal curriculum produced students who might not have been top scorers in Board Examinations but landed in the best of the universities abroad. The ATAL Innovation Mission adopted in India also focused on building analytical skills to cater to the inquisitiveness of the young students.

The intent of the National Mission on Education through ICT was launched by the Ministry of Education, Government of India in 2009, was to make available quality educational content to learners in a seamless manner. Under this mission, many interesting products, tools and applications have been developed by various stakeholders, and have been adopted by educational institutes offering education at middle, secondary and higher secondary levels.

So, Virtual Labs are now a part of our education landscape in several places and need to penetrate across the length and breadth of the country. Further, these need to be given enough impetus so that the advantages can soon be realised and the knowledge and concept building can be harnessed for the youth.

What are Virtual Labs?

The laboratories are not static but have evolved over the years and are still evolving. Labs that use audio-visual simulations, models, videos, supplementary material and create experiments that give a real-world feeling in a meaningful manner are called Virtual Labs. These labs have inbuilt platforms with a lot of related content; students get access to a variety of resources, tools, kits, etc., to create stuff using information and communication technology. These labs are created by a group of people who are from different disciplines and expertise, and work as a team to create the content, Keller and Keller 2005. These labs are designed to grab the attention of the students and engage them in various activities in a variety of ways.

Virtual Lab Platforms

During the last few years, many interesting platforms have come up to meet the requirements of students who have different

attitudes and aptitudes towards learning. Some of the labs are more focused and cater to higher order learning, and many cater to the needs of the average learner.

A Few Selected Virtual Lab Platforms

VLabs: These labs provide a complete learning environment, whereby they are given access to a variety of tools for learning, including additional web resources, video lectures, animated demonstrations and self-evaluation. These labs can be accessed at https://www.vlab.co.in/. These labs are mainly aimed at the students of the undergraduate level. However, there are many experiments that are equally relevant to secondary classes as well.

OLABS: These labs have been developed by Amrita Vishwa Vidyapeetham and CDAC Mumbai and the initiative is funded by MeitY (Ministry of Electronics and Information Technology) and can be accessed at https://www.olabs.edu.in/. The project offers the experimentation of laboratory work for students and teachers in Physics, Chemistry, Biology, Mathematics and English.
These labs are based on the notion that experiments can be taught and performed over the internet remotely, more efficiently and less expensively. These labs can also be used in scenarios where no access is available to physical labs. These labs too are accessible anytime and anywhere in the user-friendly and self-paced scenario. Several schools from different parts of the country have registered for these labs. More than 8,000 schools, over 27,000 teachers, and four lakh users have been registered on this OLABS platform so far. The content available on OLABS is based on NCERT/CBSE and State Board Syllabus for Classes IX–XII. English and Maths lessons are available in Classes IX and X only. The platform is full of interactive simulations, animations and videos of the labs. The OLABS platform enables the learner to perform, record and learn experiments anytime, anywhere and individualised practice in all areas of experimentation.

MIT Open Course Ware: It was one of the pioneering steps initiated in 1999 to boost open education through MIT, which opened its wealth of knowledge to the world free-of-cost. The main aim was to position MIT as a leader in distance and online education. By the later part of 2004, over 900 MIT courses were made available online for anyone and everyone interested to benefit from them.
In the year 2007, MIT OCW introduced a dedicated section focused on the high school segment and named it as 'Highlights for High School' thereby, indexing the resources useful for advanced high school study in the subject areas of STEM to support the US education at the secondary level. The content has been made freely available for the world community. The year 2012 saw the launch of an important platform jointly by MIT and Harvard University called MooC (Massive Open Online Courses) aimed at offering online learning opportunities to the public at large from the comfort of their offices, homes, schools, colleges or wherever they are. This led to a massive revolution of sorts in distance learning as the courses were presented in a well-organised and sequential manner to improve learning outcomes of the learners. This led to a revolution of sorts with many organisations and institutions launching similar or collaborative initiatives in MooCs the world over. The MooC platform, setup by MIT faculty and named edX, saw a growth of

about 81 million total global enrolments in 2019.

PhET Simulations: This initiative was founded and initiated by Nobel Laureate Carl Wieman, in 2002. It was named the PhET Interactive Simulations Project initiated at the University of Colorado Boulder. As a part of this programme, free interactive Maths and Science simulations have been created and delivered free-of-cost to any learner throughout the world. PhET sims for short have established themselves to be very effective in encouraging and engaging students through an intuitive game—like environment. It is an excellent platform where users learn through the process of exploration and discovery as per their website (https://phet.colorado.edu/). The portal provides access to Sims in Physics, Chemistry, Mathematics, Earth Sciences and Biology, which are organised on a nicely designed learning management system with multiple filter options to zero in on one's favourite Sims in each subject area. The Sims have been organised at different levels—right from the elementary school level to university level.

The authors do not claim that these are only such resources, as in today's connected world, such initiatives are being taken by academicians and organisations from all across the globe. There are several such platforms available to suit the needs of learners of all ages.

Challenges and Recommendations

In the Indian context, there are several challenges that need to be addressed to make these resources more impactful. Limitations posed by factors, such as students coming from vernacular medium backgrounds, less or no connectivity, availability of smart access devices, inhibition of teachers to either use such resources or encourage their students to use them, GER and other such things are challenges which need to be considered while discussing such resources. To overcome some of these issues, there is a need to blend such and similar resources into the curriculum and make them compulsory with a blending level of say 20 per cent to start with. These resources need to be made part of the teacher training curriculum so that teachers understand their importance in the overall learning cycle. The institutional mechanism that can be steered by national agencies needs to be developed to make these more accessible and user-friendly. Further connectivity in schools needs to be further augmented, which is a continuous process and has been met, to some extent, through various initiatives taken in the recent past by the Ministry of Education, Government of India.

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