
1. INTRODUCTION

Good lab facilities and updated lab experiments are critical for any engineering college. Physical distances and the lack of resources often make it difficult to perform experiments, especially when they involve sophisticated instruments. Also, good teachers are always a scarce resource.

The 'Virtual Labs' project addresses this issue of lack of good lab facilities, as well as trained teachers, by making remote experimentation possible. With the present day internet and computer technologies, these limitations no longer hamper students and researchers in enhancing their skills and knowledge. Also, in a country such as ours, costly instruments and equipment need to be shared with fellow researchers to the extent possible.

Yet another objective is to arouse the curiosity of the students and permit them to learn at their own pace. This facilitates the absorption of basic and advanced concepts through remote experimentation. Internet based experimentation further permits use of resources – knowledge, software, and data available on the web, apart from encouraging skilful experiments being simultaneously performed at points separated in space.

2. Objectives

The Virtual Labs project started in April 2009 under the National Mission on Education through ICT. Initially, approximately 20 labs were developed as proof of concept. The Main (First) Phase began in April 2010 with several web-enabled experiments being designed for the remote operation and viewing. The primary focus of the Current (Second) Phase of the Virtual Labs project is to maintain the labs already developed and reach out to all potential users of Virtual Labs. Additionally a new Remote Triggered Lab project is underway, in which approximately 30 remote-triggered labs are being developed.

There are twelve participating institutes: IIT Delhi (coordinating institute), IIT Kanpur, IIT Bombay, IIT Kharagpur, IIT Guwahati, IIT Roorkee, IIIT Hyderabad, Amrita University, Dayalbagh University, NIT Surathkal and COE Pune.

Specifically, the Virtual Labs project addresses the following:

(a) Access to quality labs to those engineering colleges that lack these lab facilities.

- (b) Access to quality labs as a complementary facility to those colleges that already have labs
- (c) A complete Learning management System around these labs
- (d) Teacher-training and skill-set augmentation through workshops and on-site training.

The intended beneficiaries of the projects are:

- All students and Faculty Members of Science and Engineering Colleges who do not have access to good lab-facilities and/or instruments.
- High-school students, whose inquisitiveness will be triggered, possibly motivating them to take up higher-studies.
- Researchers in different institutes who can collaborate / share equipment and resources.
- Different engineering colleges, who can benefit from the content and related teaching resources. The project has completely fulfilled the requirements of the targeted beneficiaries (and even gone beyond). An eco-system has evolved around Virtual Labs, where the community has become involved in evolving and benefitting from the project.

1. SALIENT FEATURES

(i) Common website for all Virtual labs

All Virtual Labs can be accessed through a common website: **www.vlab.co.in**

At the user end, a PC and broadband connectivity enables the users to access Virtual Labs.

(ii) Front-end

All users see a common web-based front-end which has been designed for ease of use. The Virtual Labs have standardized look and feel. All web pages are icon based. Phase II will ensure that all Virtual labs are Aakash compliant.

(iii) Back-end

The back-end is completely computer-driven. Virtual Labs will provide to the students the result of an experiment by one of the following methods (or possibly a combination): Modelling the physical phenomenon by a set of equations and carrying out simulations to yield the result of the particular experiment. Providing a corresponding measurement data for the Virtual Lab experiment based previously carried out measurements on an actual system. Remotely triggering an experiment in an actual lab and providing the student the result of the experiment through the computer interface.

(iv) Learning Management System (LMS)

Virtual Lab project provides a complete Learning Management System. For most users, Virtual Lab provides all the relevant material at one place including the Objectives of the Experiment, Procedure, Lab manual, Pre- and Post-experiment quizzes, additional Lab resources, in addition to the Virtual Lab experiment. Most labs also have an associated question bank.

(v) Standardization and best practices

The following standard process development and sharing of best practices have been carried out within the project

- Development of a standard process for Quality Control.
- Development of a standard process for Field Trials.
- Development of a standard process for obtaining user Feedback.
- Development of a standard process for obtaining Feedback of subject experts.
- Continuous Evaluations by Subject Experts, thereby permitting mid-term corrections.

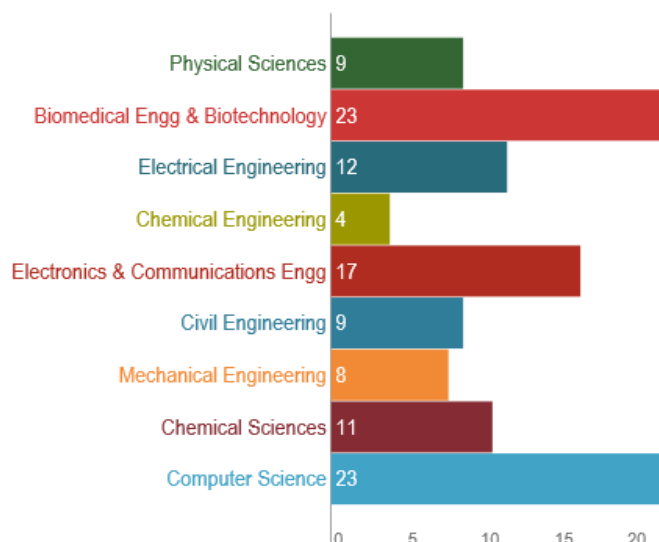
- Use of a standard collaborative platform
- Repository of all project related documents available on a common server

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1. Wiki and Developer forum
2. Standard Administrative Website for all labs

2. CURRENT STATUS

Virtual labs have provided both the students and teachers the access to quality labs in a wide range of topics, spanning different branches of science and engineering. Over 100 Virtual Labs have been developed. The importance and effectiveness of these Virtual Labs can be estimated from the user feedback. The labs are also being used outside the labs hours, and also on weekend, as depicted by



BROAD AREAS OF VIRTUAL LABS

 **50000**
Students trained

 **1000**
Faculty Trained

 **100**
Colleges in field trial

 **36**
Workshops conducted

Current Impact

The Field trials of Virtual labs were conducted in 42 Engineering Institutions around 16 universities comprising of Delhi & NCR, Haryana, Himachal Pradesh, Gujarat, Punjab, Rajasthan, Madhya Pradesh, Uttarakhand and Uttar Pradesh states in June-December 2012 session. Over 200 faculty feedback forms and 50,000 student feedback forms have been collected so far. Over 1000 faculty members have been trained on the Virtual Labs platform.

National Impact

Field trials were conducted in over 150 colleges and around 36 workshops were conducted in various colleges of several states. More than 1,000 faculty members and over 50,000 students were trained during these field trials. Students all over India are now taking advantage of Virtual Labs in order to get the feel of actual lab experimentation.

Current Status of Outreach of Virtual Labs Geographical Coverage



Virtual Labs was dedicated to the Nation on 23 February 2012. Virtual Labs are being used in engineering colleges in various parts of the country. The area wise details are given below:

National Capital Region (NCR)

Hyderabad, 2015.

Northern India: Panipat Meerut Karnal Jalandhar Baddi Dehradun Jaipur Gwalior Bhopal Lucknow Alwar Kurukshetra Gurgaon

Southern India: Amritapuri Bangalore Coimbatore Kottam Hyderabad Thiruvananthapuram Chennai Surathkal

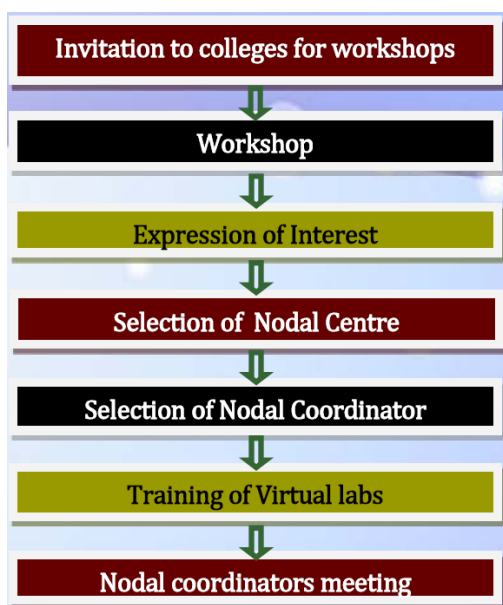
Eastern India: Guwahati Kharagpur Durgapur

Western India Ahmadabad Pune Mumbai Nagpur Nasik

NODAL CENTERS

Exhaustive field trials are presently being carried out on the labs already developed. The user community is made to feel a part of the development process, as their feedback is used to improve and augment the labs under development. Given the large number of engineering colleges across the country, private agencies will be roped in to make the process fast track. The process of field trials and limited deployment has been standardized. The process starts with a workshop, which explains the concept of the Virtual Labs project and provides an overview.

ESTABLISHING NODAL CENTRES



Demonstrations are invariably given to showcase the power of Virtual Labs. After the workshop, an expression of interest is sought. This is done to ensure a basic level of commitment. Those who qualify are declared Nodal Centres, and two Nodal Centre Coordinators are selected as liaison persons. This is followed by extensive on-site training and on-site workshops. The exchange of ideas and discussions take place during the Nodal Centre Coordinators' meetings, which are held regularly. Regular workshops and teacher-training would also form a part of this activity. A team of Field Engineers will conduct the workshop and provide hands on session for the experiments under all the labs. Field engineers per institute have been envisaged for this purpose. Incentives have been kept in project budget for nodal coordinators as well as users who provide feedback after the workshop.

FUTURE ROLL-OUT OBJECTIVES

To identify and work with government, private agencies and professional bodies for granting 'Certificate to users of Virtual Labs'.

Although significant attempts have been made in Phase I to reach to maximum possible number of colleges, it is also a fact that most potential users are still unaware of the existence of the virtual labs and their potentials. It is therefore envisaged in Phase II to engage special agencies to (i) create awareness of the labs among students and faculty members (ii) organize on-site workshops to provide a minimum level training to the local

faculty members/research scholars in the colleges. When publicized in this fashion, the faculty members in the colleges will seriously engage their students in using the virtual labs.

METHODOLOGY

Methodology of Field Trials (Current)

- The Virtual labs team conducted a workshop on Virtual labs for ECE, CSE and Applied Science disciplines in the designated nodal centres.
- The demonstration was given on Virtual labs in each session for one lecture in a classroom.
- The labs chosen for demonstration belonged to the syllabus of the on-going semester.
- The faculty members responsible for the labs/subjects were present during the demonstration.
- After the demo of virtual labs, hands on practice sessions were conducted.
- Upon completion of the demo and hands-on experimentation, the faculty members and students submitted the hard copy of the feedback forms to Virtual labs team members.
- These forms were compiled and analysed. The bugs/shortcomings were duly reported to the respective virtual labs developers for improvement.

To identify the gap areas between the typical syllabi of technical Universities and the existing labs and to develop additional labs/experiments to fill these gaps.

Development of Virtual Labs is continuous process. The feedback of the academic as well as the user community will be taken so as to fill-up the gap areas where Virtual Labs / Lab experiments are missing.

Different institutes will be encouraged to participate in the development activity. Expert committees will be formed to identify gap areas in selected domains and provide their recommendations to the lab developers, in consultation with DNCs.