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Overview of Virtual Lab

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Abstract: *Virtual laboratory is a platform at which certain practicals can be performed virtually. Virtual lab emerges as an excellent tool for education purpose for learners. Thus, by usage of this virtual lab platform students can perform practical as given by the teacher as well as they can give feedback. Having this concept of virtual lab into consideration we propose a unique virtual laboratory as a web application for mechanical engineering department at which students can perform practicals and also keep record of their performance activity. In this virtual we lab provide simulation, open source and videos for students. Simulations are of practicals which are provided by the university. Some subject's practical need specific software to perform their practical, so for such we provide open source at which students perform seamlessly. But there are some subjects which doesn't have open sources, so to eliminate such limitation videos are made and uploaded on virtual lab. By inculcating these all aspects in virtual lab, enthusiasm towards practical education for students will increase. Thus, improving understanding of process in practical will increase parallelly.*

Keywords: Virtual, Practical, Simulation

I. INTRODUCTION

Virtual labs are considered one of the most important techniques of e-learning, as they enable both teachers and students to achieve the educational goals. This is done by facilitating the application of the practical side of the curriculum at any time and place without any form of restrictions. From past few years technology application in field of education has varied widely. And development rates have accelerated in the field of e-learning in response to the digital transformation that we are witnessing in various areas of life now. Virtual labs have saved a lot of time and effort. Also, they removed many obstacles that were faced by both student and teacher to conduct experiments. As they facilitated the conducting of experiments outside the real labs. It helps solve the problem of limited resources and funding for experiments.

It helps the teacher to cover all aspects of the course curriculum with practical applications and help the student understand all the points of the course curriculum; which is difficult to provide in the case of limited equipment and funding. Virtual labs provide the synchronization between the process of explaining the theoretical ideas and practical application, just as real laboratory experiments are linked to theoretical lectures. Help students and teachers' study and prepare laboratory experiments at any time and place. The student is able to conduct the same experiment several times according his/her ability to grasp the information. This is generally difficult to provide in a real laboratory in the case of limited material and the lack of equipment in proportion to the numbers of students. It provides cooperation and interaction between the students and the teachers. The ability to record all the results virtually, which helps in analyzing them using the latest software programs and sharing the results and analysis with others. Help the teacher to evaluate students virtually and easily to guide them and follow their progress in conducting experiments. Save time and effort for researchers by eliminating the need to move between different laboratories.

Provide a comprehensive overview for the learner about the hazardous experiments which are not safe in the real world, thus providing him/her with a greater absorption of the course. Help educational institutions save money. Add entertainment while conducting the experiment, which helps attract the students' attention. Motivate students to conduct laboratory experiments. They satisfy the scientific passion of students, allowing them to access the various experiments easily regardless of time or place. Increase the understanding of scientific courses in physics, chemistry and biology; and

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Increase student achievement. Eliminate boredom, as it provides fun during the experiments. The virtual labs will increase the scientific research rates because it saves time and effort and enables researchers to use their time more effectively. The virtual labs will enable students to use modern technology and enable them to follow the tremendous progress of the information revolution. Students will be able to use the scientific method of problem-solving. Developing teaching and learning methods that will lead to the effectiveness of the educational process. Increased communication between students and each other on the internet, which helps with the exchange of ideas and experiences.

II. Literature Review

This paper outlines a demonstration of a few remote and virtual laboratories at Labicom platform. The interactive Labicom demo session during REV'16 conference will show client side browser applications. HTML5 plugin-less cross platform interfaces of remote and virtual labs will be demonstrated. An experimental WebGL 3D-interface of the laser laboratory will also be shown [1].

Inquiry-based learning allows students to learn about scientific phenomena in an exploratory way. Inquiry-based learning can take place in online environments in which students read informational texts and experiment in virtual labs. We conducted two studies using eye- tracking to examine the integration of these two sources of information for students from vocational education (78 and 71 participants, respectively, mean age of 13 years and 7 months). In Study 1, we examined whether the amount of time spent on reading text and on integrating the text content with information from a virtual lab (as measured via gaze switches between the text and the lab) affected the quality of the inquiry-based learning process in the lab (i.e., correctly designed experiments and testable hypotheses created) and the learning gain (increase in domain knowledge from pretest to posttest). Results showed, on average, a gain in domain knowledge. Pretest scores were related to posttest scores, and this relation was mediated by the score for correctly designed experiments in the lab. There was no relation between informational text reading time and inquiry process quality or learning gain, but more frequent integration was associated with a higher score for experimentation in the virtual lab, and more frequent integration attenuated the relation between pretest score and designing correct experiments. Integration could thus compensate for the negative effects of lower prior knowledge. In Study 2, we examined whether integration was stimulated by highlighting correspondences between the informational text and the virtual lab (i.e., signaling). Integration was higher than in Study 1, but this did not further improve the quality of the inquiry process or the learning gain. A general conclusion is that integration fosters inquiry-based learning, but that stimulating additional integration may not result in further improvement [2].

The requirements on the education of engineers change with an increasing demand from the industry to drive the transformation of the fourth industrial revolution. A series of education- related research projects was therefore launched by the German Federal Ministry of Education and Research in Germany (BMBF), of which the cooperative project ELLI - “Excellent Teaching and Learning in Engineering Science” is one among the most extensive. Of the three universities involved, namely RWTH Aachen University, Ruhr-University Bochum and TU Dortmund University, the last is at the center of the development of remote and virtual labs for mechanical engineering education with a focus on manufacturing technology. A tele-operative material characterization testing cell was conceptualized and implemented, along with a remote lab for incremental tube forming. To make further use of the remote labs, a Massive-Open- Online-Course (MOOC) was created which incorporates remote labs as part of the applied didactic methods. To overcome the limits of remote labs, virtual representations of these labs and a general virtual experimentation lab were Developed. They are designed for different devices enabling the students to explore and experiment complex processes visually. All these measures are currently being integrated into various lectures in different study programs. In the second funding phase, ELLI2, the spectrum of the developed labs is broadened by the inclusion of new processes and introduction of technologies, such as Augmented Reality and Additive Manufacturing [3].

The idea of the present analysis stems from the need to provide educational platform suitable for task solutions from the field of computer networking beyond capabilities of specialized hardware. The paper introduces possible approaches predominantly focusing on virtualization technologies and Linux operation system tools. Finally, the paper presents a design of virtual laboratory solution based in the concept developed in Java environment and Linux operation system tools [4].

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The paper introduces the concept of a virtual development lab that was born from cooperation between academia and industry. Shortage of young well-trained engineers and a wish to share the industrial experience that the authors have accumulated over a decade has led one of the authors to teach satellite navigation at a university whilst simultaneously leading an industrial R & D team. The paper presents the results of the use of a virtual lab (VL) that was developed to provide students with hands-on experience in the application of signal processing and automatic control. It is shown that VL has partly bridged the gap between the University training and the needs of industry. However, only an extension of the VL to the virtual development lab (VDL) has allowed the requirements of industry to be fully addressed. VDL is a web-based platform which assists learning by enabling the whole development cycle (design, development, verification) to be conducted in a controlled environment which is similar to industrial one. VDL combines ease of use with real life task setting, thus allowing a student to focus on the essentials of the engineering task. The ease of use is provided by incorporating routine engineering methodology (compilation, linking, testing, and result evaluation) into a graphical user interface (GUI), and a simple and intuitive application user interface (API). Realistic task setting is ensured by the nature of the tasks. The paper provides an explanation of all aspects of the VDL including the initial motivation, the technical and educational framework, its advantages and drawbacks, and the VDL design details. It also provides practical advice for VDL realization. The paper will help future developers of VDLs to deliver this approach [5].

Web-based educational resources have gained enormous popularity recently and are increasingly becoming a part of modern educational systems. Virtual Labs are E-learning platforms where learners can gain the experience of practical experimentation without any direct physical involvement on real bench work. They use computerized simulations, models, videos, animations and other instructional technologies to create interactive content. Proteomics being one of the most rapidly growing fields of the biological sciences is now an important part of college and university curriculums. Consequently, many E-learning programs have started incorporating the theoretical and practical aspects of different proteomic techniques as an element of their course work in the form of Video Lectures and Virtual Labs. To this end, recently we have developed a Virtual Proteomics Lab at the Indian Institute of Technology Bombay, which demonstrates different proteomics techniques, including basic and advanced gel and MS-based protein separation and identification techniques, bioinformatics tools and molecular docking methods, and their applications in different biological samples. This Tutorial will discuss the prominent Virtual Labs featuring proteomics content, including the Virtual Proteomics Lab of IIT-Bombay, and E-resources available for proteomics study that are striving to make proteomic techniques and concepts available and accessible to the student and research community [6].

In this article, we present the structure and publication of a virtual learning environment through the PACIE methodology, incorporating resources such as virtual laboratories to carry out information technology practices by students, accessing from computers and devices such as smartphones and tablets. PACIE comes from the Spanish acronyms that refer to the academic processes on which this methodology is based: Presence, Scope, Training, Interaction, and E-learning (E-learning). Because of the pandemic caused by the COVID-19 virus, students cannot enter the physical laboratories of the university. An analysis of the academic performance of students who received lessons in the previous semester is carried out in person with the academic performance of students who are receiving classes in this particular period online [7].

This paper describes a new way to perform automated experiments using virtual laboratories. Experiments are developed and executed using a new software tool: the Experiment Editor. This tool uses virtual laboratories applications designed with educational purposes. The main features/advantages of the Experiment Editor are: 1) the possibility of modifying the initial functionality of the laboratories (i. e. adding new controllers to the plant), 2) analyzing the obtained results during the experiment and performing complex or repetitive tasks in a simple way, 3) and any others explained in the paper. To illustrate the utility of the Experiment Editor a very well-known system is used [8].

Practical experience is an important component of the educational process. However, the time and economical resources often required for the setting up and construction of scientific laboratories is outside the scope of many institutions. A solution to this problem could be found in the adaptation of the Virtual Reality technology, which could allow the creation of Virtual Laboratories, which will simulate the processes and actions that could take place in real laboratories. In particular, this paper, based on the expertise and motivation gained by the VirRAD-IST project, proposes and describes such an educational virtual laboratory, which aims to meet the requirements of a real laboratory and

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furthermore to support communication and collaboration services. We propose a web-based system, which allows users to perform experiments on educational fields, such as Physics or Chemistry in 3D multi-user worlds where users are represented by avatars and they are offered a wide range of communication and collaboration services in order to simulate efficiently a real learning experimental process [9].

In this paper, we present and analyze a virtual-lab based activity oriented as an application of the stoichiometry concepts that appear in the first year of the Spanish Bachillerato (16-17 year old). The activity was brought to class and was used by more than hundred Catalan high school students. The task was worked in pairs and each action they did in the virtual lab was anonymously recorded to a log file. The analyses of these log file allow us to affirm that this type of activities provide a significant support for a focused and active learning experience [10].

Students can obtain lab content information equally well from two types of laboratories: a virtual and a physical lab. There is great potential in applying a 3D virtual lab based games to support teaching and learning in science. Moreover, it is significant to find practical ways to design and develop intelligent systems based on 3D games with limited complexity forms. 3D virtual environments provide an immersion into the learning contents, and interactions within the virtual world of the game, which are governed by established scientific principles. Therefore, people are looking for the forms of computer simulation - training that require fewer organizational and logistic efforts. Among them, three-dimension virtual environment is the important part of this system in enhancing the learning process. This paper aims to design and implement 3D virtual labs, which are considered as a low-cost alternative to educators and students, in science E-learning. This study focuses on the virtual assembly of instruments, the realization of dynamic 3D gauges, and the setup of emulation-based systems, which are key factors to provide students with the high-immersion 3D virtual lab. It also describes the setup of the network environment of this virtual lab; in this network, the server controls the options, user operations and the processes of experiments. Finally, this research involves designing and deploying a complex application that combines advanced visualization, interactive management through complex virtual devices and intelligent components [11].

Virtual Labs allow performance of experiments without real world instrumentation needs. Most of these virtual experiments are simulation based and developed using proprietary or Open Source simulation, Adobe Flash, and other client side software. The procedural steps involved in conducting these experiments are hardwired and require software modification for enhancements or alignment to the course structure. We propose a model based approach that eases development of virtual experiments without dependency on software programmers for any changes. We demonstrate our model driven based approach on Chemical Sciences labs of Virtual Labs, a Government of India initiative. With our model driven based approach, the effort for new experiment development or FOSS conversion of existing experiments that were using outdated technologies is less than a person day as compared to more than a person month [12].

The Virtual Labs project (vlabs) is a country wide effort to provide access to internet and browser based virtual laboratories to science and engineering college students in India. There are currently over 800 experiments packaged in 70 vlabs in more than ten science and engineering disciplines. More than five hundred workshops on these virtual labs have been conducted and the experiments have been used over 2 million times. Vlabs are an important Government initiative in higher learning in engineering in India. This paper examines virtual labs from a usability perspective, focusing on vlabs. Usability of user-interface elements (technical usability) as well as how they aid learning (pedagogical usability) has been considered. We adapt Nielsen's technical usability heuristics and Nokelainen's pedagogical usability criteria to virtual labs and evaluate the usability of the top three most used vlabs. We construct checklists for each of these criteria and evaluate the vlabs against this checklist. Our analysis reveals a lack of usability focus in lab design. Lab design and implementation guidelines seem to be deficient in covering key usability criteria. We make suggestions on how to quickly improve the usability of these labs [13].

A description of a database on the support of laboratory work on a unique experimental equipment, concept development and use of virtual labs in the learning process are present [14].

III. Design of Virtual Lab

We started web application design on CodeIgniter PHP framework, in that, we divide this web application in three panels:

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1. **Admin Panel:** This panel is for higher authorities in that they have all type of access to every decision to activate or deactivate accounts of staff or student in virtual lab as well to keep records.
2. **Staff Panel:** This panel is for staff member in which their access is limited to particular subject and student's activity, that is, activation or deactivation and managing records as well as reports.
3. **Student Panel:** This panel is for students where they have only access to perform practical on a particular subject.
4. **For video:** At first, we create demonstration video was made for finalization of the frame. After finalization, the video of practical was made. We decided to use YouTube platform in virtual lab web application to overcome the disadvantage of storage to some extent.

IV. CONCLUSION

A core implication of the study results is that interactive and flexible online learning environments have the potential to provide students with a deeper conceptual understanding in learning. Virtual experiments have the potential to save time and cost for both students and university as they reduce presence hours at the university in the real lab and offer a solution of COVID-19 movement restriction as students can learn practical from home. Virtual experiments provide flexible learning opportunities that can overcome time, pace, and place barriers for the learners.

Results shows that the virtual experiments (online environment) educational design has a critical role in getting the expected results. In addition, it is recommended that educational practitioners to design the virtual lab with more interactive activities and make sure to design videos with short periods. Virtual lab is an interactive product that assists students to perform their experiments with best visualization. Virtual lab encloses infotainment, edutainment and enrichment. Computers and the Internet have expanded the way in which information can be delivered to the students of today. Today's technology provides a valuable opportunity to practice new learning techniques. Teachers have record for every student while performing the practical or experiments. The Virtual Labs will be more than a "living" textbook. The "classroom of the future" will probably contain several kinds of simulators, virtual labs in addition to textual and visual learning tools. Non-traditional, technology-based exercises enrich the laboratory learning experience and increase student interest and satisfaction. Virtual Laboratory experiences reinforce critical thinking skills and understanding of the scientific method.

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