Literature Survey on virtual laboratory for secondary students

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Abstract: Today's students lack the ability to visualize some concepts due to the increased usage of technologies in day-to-day living, which leads to a lesser understanding of theory. Even though these concepts can be better understood in laboratories found in schools and institutions, there is currently a need for an hour to find better solutions to these issues due to time restraints and a lack of enough resources. This paper provides study on a variety of virtual laboratory implementations, including tools, approaches, and strategies. This paper aims to examine and present various existing systems and methodologies. This study primarily examines numerous remote laboratories and virtual laboratories that already exist, along with their approaches, strategies, and instruments.

Keywords: Virtual laboratory, experiments, Practical knowledge, Online Learning, VISIR

1. INTRODUCTION

Through the Internet, online laboratories provide access to experimentation equipment. Users can access this equipment at any time and from any location. Many researchers have confirmed that, under certain conditions, online laboratories can provide pedagogical benefits.

Engineering education is linked to theoretical and practical knowledge, with engineering students expected to go beyond conceptual understanding of theoretical knowledge and acquire practical skills. The theoretical portion can be obtained through classroom learning activities, whereas the practical portion involves skills that can be achieved through experimentation in physical laboratories (PLs). Students can improve their practical skills by experimenting with real-world equipment in PLs. [1]

Resolving the problem of development of virtual laboratories requires an interdisciplinary approach and coordinated work teams of specialists from various fields such as programmers, designers, educators, mathematicians, and so on. This issue is not limited to the creation of virtual laboratories for educational purposes. Any software product requires a varying approach, from games to software systems simulating complex physical, chemical, biological, and technological processes, among other things. One of the most important aspects of approach is the availability of skilled IT professionals who can solve problems. When IT specialists are knowledgeable with the subject and substance of the project components in addition to programming languages, systems, and procedures, high-quality development results. For contemporary colleges, the proper teaching of such IT specialists is a critical concern. [9]

The remainder of the paper is structured as follows. In section III, we go over several papers on virtual laboratories and their various methodologies, techniques, and so on.

Section IV will go over the various findings and results from the literature review. Section V concludes the literature review and presents potential future work.

2. Literature Review

The enhancements to the virtual laboratory for secondary education, known as iLabRS, were proposed by the author, F. Garófano in his paper [2]. iLabRS is developed on Telecom BCN modular platform using resources from the university, the lab offers high school students experimental activities. Promoting communication between the two educational levels is its secondary objective. The software control that dynamically controls LabView virtual instruments and reallocates resources up to 20 concurrent users of the same experiment was proposed as a new feature by the author. 35 high school and professional training teachers have also completed a training programme. The evaluation process was helpful in understanding the thoughts of the students and teachers.

The authors A. pernjak and A. orgo in his paper [3] conducted study into the adoption of computers by Slovenian biology teachers as a communication and informational tool for use in teaching preparation. It was suggested that students in lower secondary schools, ranging in age from 11 to 15, performed three laboratory exercises in traditional, computer-supported, and virtual lab environments. After participating in each approach, a brief survey was administered to the students to determine which way they preferred. Computer-supported laboratory came in first, followed by traditional laboratory, and virtual laboratory came in last.

A software system for managing resources for online virtual laboratories experiments was suggested by the author H. H. Saliah in his paper [4]. In order to incorporate modern technology into teaching methods, a number of institutes, universities, and academics collaborated to create the system. The four main designs that comprise the Learning Systems Engineering Method are learning objects, a pedagogical model, a multimedia model, and a delivery model (MISA), which was created. Later, the author suggested a distributed resource management to make it easier to prepare for and carry out remote laboratory experiments.

In his paper [5], author O. Dziabenko demonstrated the Ohm's Law in secondary school physics curriculum. Using Virtual Instrument Systems in Reality (VISIR), designing, constructing, and measuring electrical circuits, the author constructed a remote laboratory assignment. The key function of VISIR is the scenario of a fundamental AC-DC circuit experiment related to Ohm's law. Paper uses WebLab-Deusto to incorporate the virtual laboratory into the syllabus for secondary schools. In addition, the author suggested a web-The authors also discuss about the key issue in virtual laboratories. Students losing sight of the underlying hardware as a result of their focus on the reality of the learning experience, and instead began playing video games. The work-in-progress paper examines how much kids participate in cognitive processes as well as how their knowledge is created. A multi-site study examination into four unique virtual laboratories at four separate colleges is presented in this report. Discussed differences between how rookie and experienced users of the lab engage with the students. Additionally, the students' motivation was changed by their dependence on the virtual laboratory as a replacement or supplement to the curriculum.based interface for experimentation and a remote laboratory. 72% of the students completed their lab work and activities effectively.

In order to educate an electrical circuit, author J. B. da Silva proposed in his paper [6] utilised a virtual laboratory using the Falstad circuit simulator. VISIR was chosen as the virtual laboratory (Virtual Instrument Systems in Reality). 71 high school students participated in the system's demonstration. The Go-Lab Project's proposed structure served as an inspiration for the system's development by RExLab.

A. Mujkanovic, the author of paper [7], created three lab setups with the intention of connecting them to the cloud and making them accessible to other students. In the beginning, the author created virtual lab interfaces that let lab resources connect to a Cloud. In order to understand the needs of young learners and boost the use of virtual laboratories in the class, they look at age-appropriate requirements. Finally, the author hopes to learn crucial information from evaluation procedures, particularly from foreign research collaborators and their users (Teacher, students).

No matter if they arise in a lecture, a lab, or a dorm room, the author M. Walters seeks to find solutions for them in his paper [8]. The author suggested a portable lab as an addition to the conventional lecture and lab-based curriculum, allowing students to learn ideas in their preferred setting. The author talks about NImyDAQ, a low-cost portable data acquisition system that enables eight LabVIEW software-based instruments to measure and analyse live signals.

In his paper [9], the author A. V. Baranov developed a project using computer modeling to teach physics to IT students at Novosibirsk State Technical University. Student teams create software that functions as a virtual substitute for experimental setups. His approach distinguished between two forms of project development. The first category is distinguished by digital replicas of actual systems in university laboratories. Another area of student research is the production of digital replicas of experiments that are not included in university's laboratory syllabus.

In assessing effects of usability and learning objective elements, author A. A. Altalbe in his paper [10] seeks to examine how using a virtual lab affects students' performance. To capture all of the similarity of students' perceptions and use results from using the virtual laboratory, the author presents a model based on characteristics of model and laboratory learning objectives. 116 first-year engineering students provided survey data for the study that reflected their individual experiences with using virtual laboratory technologies. For statistical analysis and testing, the partial least square approach employing structural equation modelling technique (PLS-SEM) was applied. The findings demonstrate that the suggested model offers a thorough grasp of students' views, and that the understudy components were genuinely relevant in representing the effects of using such laboratory instruments on students' performance.

The authors Euan Lindsay in the paper [11] discuss about the key issue in virtual laboratories. Students losing sight of the underlying hardware as a result of their focus on the reality of the learning experience, and instead began playing video games. The work-in-progress paper examines how much kids participate in cognitive processes as well as how their knowledge is created. A multi-site study examination into four unique virtual laboratories at four separate colleges is presented in this report. Discussed differences between how rookie and experienced users of the lab engage with the students. Additionally, the students' motivation was changed by their dependence on the virtual laboratory as a replacement or supplement to the curriculum.

The authors William T. Neumann and Marvin C. Woodfill in their paper [12] recognised the need for a large time commitment from both the instructor and the student in order to acquire the laboratory skills required for understanding. Embedded debugging tools, software development tools, and architectural structure of creating stations were the key areas of focus for the approach. The three approaches were explored in more detail, and the major paradigm components were examined. They discovered that their software had four major advantages. First, by allowing students to carry over information from one semester to the next, they greatly reduced the instructional load. Second, they used shared peripherals like a keypad and a led display to help students transfer their expertise to various kits in the lab. Thirdly, the overwhelming favourable response to their approach from the students gave them more confidence. The forth used their knowledge to tackle brand-new issues.

The authors Ifeyinwa E. Achumba in the paper [13] theorised that the traditional laboratories' characteristic high prices are to blame for the growing acceptance of online laboratories. Therefore, they included a thorough description of the assessment tools, as well as their verification, evaluation, and application methods, in their paper. The outcomes of the author's LAP model for evaluating student performance were positive, and they anticipate that future studies would use their model in actual laboratory settings. The feasibility and behaviour of the LAP model may have been evaluated, and the outcomes were positive.

4. Discussion

Based on a review of various approaches, methodologies, and techniques for developing virtual labs for students in schools and universities, it was discovered that there is no general methodology for developing a virtual lab. Another finding is that creating a single virtual laboratory takes a significant amount of time and resources. Furthermore, due to the diversity of various experiments and curriculum, it was not possible to develop a common component required for the development of virtual.

5. Conclusion

We reviewed various technologies used in the development of virtual laboratories in this paper, such as Virtual Instrument Systems in Reality (VISIR), could-based environment, NImyDAQ, a low-cost portable virtual lab, and computer modelling to teach physics. We also discussed the results of several experiments conducted by the student, as well as their benefits and drawbacks. We can conclude that there is no common platform or resource for developing virtual laboratories. As a result, there is a need for an environment or platform where teachers can easily create and assign interactive and personalised experiments to students.

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