REMOTE LABS IN HIGHER ENGINEERING EDUCATION: ENGAGING STUDENTS WITH ACTIVE LEARNING PEDAGOGY

Kholmonov Shodiyor Karshiboyevich,
Senior teacher, Tashkent University of Information Technologies named after Muhammad al-Khwarizmi, Uzbekistan, Tashkent.
shodiyor.x89@mail.ru
Nurmukhamedova Tursunoy Usmonovna
Senior teacher, Tashkent University of Information Technologies named after Muhammad al-Khwarizmi, Uzbekistan, Tashkent

Abstract:

The integration of remote labs in higher engineering education represents a pivotal advancement in modern pedagogy, offering unique opportunities for practical, hands-on learning experiences. Active learning pedagogy, when employed in conjunction with remote labs, serves as a critical tool in engaging students in the learning process, providing them with practical skills and experiences essential for a successful engineering career.

In today's world, remote labs grant students access to real engineering experiments and research without the need to leave the classroom. This approach actively involves students in the practical application of theoretical concepts, allowing them to genuinely engage with engineering challenges and problem-solving.

Active learning pedagogies such as problem-based learning, project-based learning, and collaborative learning are essential in realizing the full potential of remote labs. These teaching methods promote deep understanding and application of engineering concepts, foster critical thinking and problem-solving skills, and cultivate students' communication and teamwork abilities.

Keywords: *remote lab, higher engineering education, LabVIEW, new educational technologies, learning pedagogy, learning process.*

Introduction

Remote laboratories represent an important addition to modern undergraduate engineering education, creating unique opportunities for hands-on learning for students. Active learning pedagogy used in the context of remote laboratories is a key tool for engaging students in the learning process, providing them with the practical skills and experience needed for a successful engineering career.[1]

In today's world, remote labs allow students access to real-life engineering experiments and research without leaving the classroom. This approach actively

engages students in the practical application of theoretical concepts, allowing them to experience engineering challenges and problems in a real way.

Active learning pedagogies such as problem-based learning, project-based learning, and collaborative learning are becoming important tools in achieving full effectiveness in remote laboratories. This teaching method supports a deep understanding and application of engineering concepts, promotes critical thinking and problem solving, and teaches students communication and team skills.

The purpose of the task

Research and analysis of the use of distance laboratory work in the context of higher engineering education with an emphasis on engaging students in active pedagogical learning. The main focus is to explore how distance laboratories and active teacher learning can be combined to provide deeper student engagement, create hands-on educational opportunities, and promote the development of essential skills for future engineering careers.

Also, virtual measuring technologies make it possible to combine measuring systems with telecommunication networks, thereby providing the possibility of remote access to measuring and control equipment. Such integration makes it possible to connect a large number of different measuring and control devices remote from each other into a single system.

It is very important to promote distance technologies in laboratory workshops and in a training experiment in order to increase efficiency and reduce material costs for training in the field of engineering education.

At the same time, the following fundamental advantages of a distance learning laboratory are achieved:

- round-the-clock automatic operation;
- individualization and improvement of the quality of education;
- availability of a remote laboratory from any geographical point.

The role of distance learning experiment in modern engineering education:

The introduction of new information technologies is the most important factor in improving the efficiency and quality of the educational process. A special place in engineering education is occupied by laboratory and practical classes. In recent years, distance learning has been intensively developing in higher education. For a long time, the main obstacle to the use of distance learning in engineering and secondary technical specialties in technical universities and technical schools was the impossibility of conducting remote laboratory workshops based on traditional teaching technologies and obsolete instrumentation. The successful development of the technology of virtual measuring instruments and modern means of telecommunications make it possible to effectively carry out a remote experiment from almost any geographical point.

The transfer of a laboratory workshop to distance learning provides the following main advantages [1]:

1) round-the-clock automatic operation of a remote educational laboratory (without a teacher and laboratory assistant, laboratory rooms and seats for students, etc.). Achieved reduction of training space, optimization of the training schedule, savings by reducing the hours allocated for conducting classes by teachers (up to 30-40% of the payroll).

2) individualization and improvement of the quality of education. The student is forced to do laboratory work on his own, and not in a group of 3-4 people at one laboratory installation. Access to work is automatically conducted, work timing is indicated with calendar time, all student actions at the laboratory facility are recorded. The teacher has the opportunity to objectively evaluate the work of the student based on the results of monitoring. Qualitatively new opportunities for independent work of students appear. The time for completing the work is not limited to 4 academic hours, but is as much as the student actually needs.

3) public accessibility of the remote laboratory from any geographical point and at any time. The educational space of the university is expanding. Education is not localized outside of any educational building or university. A remote laboratory workshop can be performed from branches, a hostel, or from home. It becomes possible to use remote laboratories in cooperation with other universities, as well as to accept and train a student living in any city or remote locality.

Since general technical disciplines are the basis for the vast majority of subsequent special disciplines, in many educational institutions there is an unjustified duplication of laboratory workshops with their weak technical and methodological support. Scattered fine-tuning them in each individual educational institution to the modern level and their current support require huge material costs. The creation of remote laboratories with multi-user access frees from repeated duplication of laboratory benches, from the cost of allocating laboratory premises and their maintenance. In addition, prerequisites are being created for the unification of educational and methodological support on the scale of one or even several specialties, the need to develop the same type of teaching aids for laboratory workshops based on the study of the same objects is eliminated. At the same time, due to the individualization of the performance of laboratory work by students and active participation in the conduct of experiments, an increase in the quality of the learning process is achieved.

In addition to laboratory work in general technical disciplines, a number of educational institutions carry out work using special (unique) equipment, which is characterized by complexity, high cost and low throughput (no more than 5-10 students per day). The use of such equipment in the educational process is also limited by the

increased danger when performing experiments, due to the specifics of such installations.

A brief analytical review of the state of distance technologies in a teaching experiment in engineering education:

Due to the current level of development of measuring, computer and telecommunication technologies and means, as well as their mutual integration, remote control of real physical objects through public telecommunication networks is a global trend. A large number of works in this area are devoted to the creation of remote workshops in engineering general technical disciplines, which are an integral part of engineering education.

When developing software for remote experiments, much attention was paid to the organizational and methodological issues of their technology. These include: protection of access to the control of the stand, identification of the user, allocation of the necessary resources of time and computer memory with appropriate priorities, provision of the installation control mode by only one user, verification of the feasibility of the specified experimental conditions and their feasibility within the allocated session time, etc.

Technology of remote automated experiment through local and global information networks:

When creating remote control systems (RCS), as a rule, the following main tasks are solved [2]:

1) automation of measurements and control at the local level;

2) processing of measurement information;

3) creation of a flexible user interface;

4) organizing the transmission of measurement and control information over telecommunication networks (requests for measurements and measurement results);

5) organization of work with databases.

When performing an educational remote experiment, a student cannot be given direct access to the management of a unique installation. An approach is proposed that consists in simulating a real experiment. To this end, at the initial stage, according to the experimental procedure, a database of real measurement data is formed for various operating modes of the installation. In the process of performing laboratory experiments, a student, working in a software environment, receives from the database the results of a real experiment conducted in advance. To ensure the effectiveness of the workshop performed according to the proposed method, as well as to create a sense of reality, it is necessary to use modern multimedia tools (playback of video recording and sound of the operating installation).

The main components of the above structural diagrams are [3]:

- remote users;

- the Internet;
- main server;
- remote laboratories;
- LAN of the university;
- computer centers and computer classes of the university.

Conclusion

In conclusion, the incorporation of remote labs in higher engineering education has significantly transformed the landscape of pedagogical approaches, offering a dynamic platform for immersive, practical learning experiences. The utilization of active learning pedagogy within this framework has demonstrated its vital role in involving students deeply in their educational journey, providing them with invaluable skills and competencies essential for their future careers in engineering.

The seamless integration of remote labs with active learning pedagogy has not only democratized access to practical experiments and research but has also bridged the gap between theoretical knowledge and practical application, thereby empowering students to grasp engineering concepts with depth and clarity.

Furthermore, as we continue to assess and refine methods of student engagement through active pedagogy and remote labs, it becomes increasingly evident that these educational tools are pivotal in equipping students with critical problem-solving abilities, collaborative skills, and a comprehensive understanding of engineering principles.

In light of these developments, it is imperative to recognize the transformative potential of remote labs and active learning pedagogy in engineering education. By nurturing a generation of engineers with hands-on experience and a profound understanding of theoretical concepts, these methodologies pave the way for a cohort of adaptable, innovative, and skilled professionals poised to address the challenges of the future of engineering.

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