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A Study on Electrical Engineering Remote Training with Self-Assessment

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Abstract

The study focuses on the establishment of a remote laboratory for electrical engineering personnel and students to get training in the domains of electrical drive and power electronics. The authors have identified new issues in remote education based on an active learning method with self-assessment to assist online knowledge acquisition and professional growth. The idea and technical foundation of the laboratory layout are offered after the literature study and description of the enhanced evaluation technique. Improvements in the tracking of learners' progress and feedback composition have been implemented to bridge the gap between remote study of cutting-edge equipment and other educational activities in electrical engineering. An writing process is given that aids in personalising knowledge acquisition and expanding Web-based possibilities. Self-assessment-based educational management is explored.

Keywords: *self-assessment, active learning, distant learning, Advanced training, electrical engineering, remote laboratory*

INTRODUCTION

Electrical engineers are in charge of fostering innovation and competitiveness in the industry. Improvements in the industrial sector, business reactions to these novelties, and the advancement of information and communication technology all face a variety of challenges today including;

- continuous learning of new professional trends and streams
- project promotion in a timely manner under time constraints
- utilising Internet tools and resources to maintain electrical engineering systems
- a higher level of knowledge and skill is required Engineers are expected to work hard for their employers.

Collaboration, professional networking, idea development, and decision-making are all examples of professional skills that may be learned in an educational setting.

Over the last several decades, there has been a growing interest in efficient remote learning systems for engineering level continuous improvement. Employees often participate in online training courses, seminars, webinars, and conferences to further their professional growth. Universities and businesses are collaborating to bring various educational media to train students and improve staff skills and knowledge as a result of technological improvements. Furthermore, enhanced workplace training and situation-based learning are becoming increasingly prevalent in today's engineering culture. Many research and surveys [1–4] show, however, that a considerable portion of businesses are limited in their involvement in staff training and vocational education. It was also corroborated by the authors' recent findings that organisations are sluggish to adapt innovative training methodologies, and that standard courses do not assist employees much due to their job setting, productivity, and time constraints.

The unique method of professional profiles has been presented in [2] to identify the optimal paths to regular and advanced training. Using these profiles, corporate representatives may pick from a variety of courses and learning institutions to find the best fit for their needs and goals. In [3,] an overview of instructional approaches used by universities and businesses was provided, as well as a list of initiatives to improve their efficacy. With this goal in mind, industrial training may be separated into two types: formal and vocational. The former strategy covers a wide range of subjects with clearly defined themes and typically results in certification, while the later approach is focused on company-sponsored training with topics relating to specific occupations. Furthermore, it has been shown [4] that, in addition to the typical working setting, staff training takes occur at social gatherings and in a variety of daily activities. Work is often performed in a remote setting, where individuals cooperate and converse on specialised topics. As a result, businesses have the opportunity to combine economic, personal, and societal learning.

All electrical, control, and system engineers' activities have traditionally revolved around effective equipment use. However, today's industrial systems are becoming more complex, and as a consequence, there is a greater requirement for mastering specialised and costly equipment.

Only reputable training and research centres can now afford all of the necessary instructional equipment, and even these institutions can only get half of what they want. Remote labs equipped with cutting-edge technologies and gadgets, in this case, constitute a feasible alternative due to increased access to research resources [5].

Some important platforms for distant education have been created and implemented in recent years. The majority of these materials were designed to address difficulties connected to web-based instruction hardware and software development. Nonetheless, many other important issues, such as remote training technique, were treated as afterthoughts. The authors have identified new obstacles in distant practise based on an active learning method since this topic is still very essential for qualification growth.

The following are the goals of the research presented in this paper:

- to close the gap between remote mastery and other learning activities by improving the following: • to maintain a high level of engineering knowledge among students and staff by growing professional expertise in power electronics, electrical and electronic experiments

- increase the study of professional equipment and the feedback arrangement of learners' achievement by developing an authoring approach for personalising Web-based learning and professional development

- to improve online self-assessment capabilities in situations when a teacher is unable to follow the trainee as closely as in a typical workshop

The following is a breakdown of the paper's structure. The idea and foundation of the training arrangement are provided after the literature study and description of the self-assessment approach. Following that, it is shown how an active online learning technique enhances the ease with which teachers and trainees may share their expertise. The management of distant training with self-assessment is then presented. The acquired findings are summarised in the conclusions.

RELATED WORKS

The use of online training instruments with simulators and remote equipment is now prioritised in the qualification upgrading of electrical, control, and system engineers and engineering students, as illustrated in [6], [7].

The main requirements for remote electrical installations required for staff training were proposed in [8]–[10], where several ways to Internet-based control of electrically powered devices were shown. Nowadays, articles mostly focus on the discussion of remote hardware and software that aids employees and trainers in appreciating online methodologies.

The issues and downsides of distant resources are frequently split into technical and social sectors in literature. Because of the difficulties in replicating fast physical events online, most writers, for example [11], [12], focus on the study of fast physical phenomena. On the other hand, social considerations are critical since typical classroom interactions between tutors and trainees become problematic [13]. The peer-to-peer interaction between the learning actors is also affected. Learners and instructors may explain issues in the classroom, but such contact is limited in the remote setting. Reduced social interaction was cited as a major reason against distant learning and advanced training in [14]–[16].

The bulk of conventional remote equipment requires learners to use pre-prepared assessments and activities with pre-defined input settings [17]. They concentrate on interactive cookbook-style teaching aids and make use of them.

Maintaining equipment, taking measurements, entering data into tables, and drawing diagrams are all tasks that must be completed. Without any personal action, each student solves the same tasks and answers the same questions. Meanwhile, trainees may acquire their knowledge by effectively engaging with learning resources, objects, and actors inside the curriculum utilising a learning theory like constructivism [18].

ARRANGEMENT OF THE LABORATORY

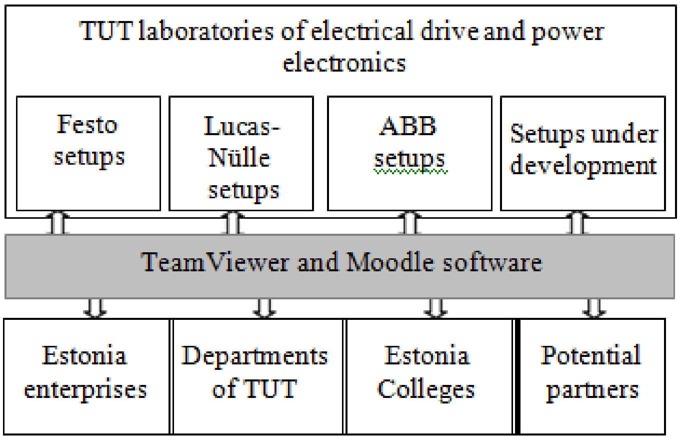

Figure 1 shows the functional circuit of a laboratory constructed by Tallinn University of Technology (TUT) for distance teaching in electrical drives and power electronics. The laboratory serves two purposes: on-site learning for TUT students and distant advanced training for overseas students and employees of industrial businesses. Educational equipment is housed in the distant facilities, which are made up of three sets of properly constructed stands. Festo's computer-aided equipment for step and servo drives completes the first group of configurations, while Lucas-induction Nülle's motor drives and power electronic converters complete the second.

The third set of setups is equipped with a series of TUT-developed original hardware-in-the-loop (HIL) simulators based on ABB industrial equipment. The pumping station [19], as well as the electric car and ship propulsion stations [20], are all part of this complex. Figure 2 shows the general functional circuit of one of the produced HIL simulators. This arrangement includes two ABB ACS800 series electrical drives, specifically a pump imitator and a pipeline imitator. Induction motors, power converters, and remote consoles with housing, measurement, and cabling equipment are all included in both machines.

The M2AA132S pump motor has a nominal power of 5.5 kW, a voltage of 400 V, a current of 11 A, a torque of 36 Nm, and a speed of 1450 rpm. The pipeline imitator's M2AA160L motor has 15 kW of power, 400 V of voltage, 29 A of current, 98 Nm of torque, and 1460 rpm of speed. The ACS800 converters have a voltage range of 0 to 415 V, a frequency range of 8 to 300 Hz, and a capacity of up to 75 kW. The scalar speed control at constant voltage-frequency ratio and direct torque control are the two basic control modes of the motor drive that are provided. The scalar mode is used to regulate the pump drive imitator, and the direct torque control is used to manage the pipeline imitator.

The ACS800 is integrated with ABB DriveWindow model-based control and measurement software, which allows for real-time parameter tracking and adjustment to facilitate online communication. DriveWindow allows you to operate the pump and pipeline imitators from a distance, as well as monitor them, tune them, and register parameters. During the testing, the DriveWindow software's output data linked to the measurement parameters is captured, presented, and exported in graphical and numerical versions for further study. The AC500 PLC, which includes the communication module CM572 DP, Profibus-DP Master module PM573, and Profibus DP adaptor RPBA-01, communicates with the pump and pipeline equipment.

Learners study equipment operation and maintenance processes throughout advanced training. They choose the pumping speeds and efficiency that they want. The pipeline imitator, on the other hand, is responsible for following the torque reference from the pump model to provide the needed torque on the shaft, allowing the drive to function in a variety of situations.

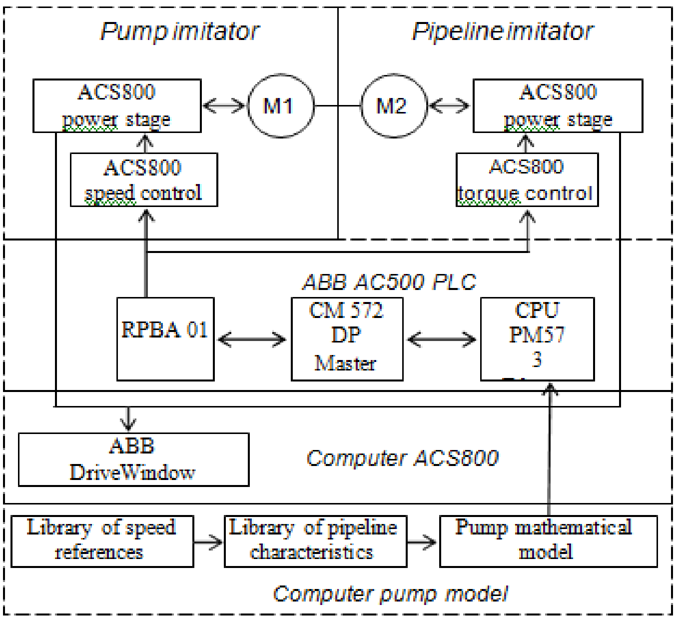

Fig. 2 HIL simulator of a pumping station

The torque is used as a reference in this system, which is based on the shaft speed set by trainees. Using the recorded voltage and current data as well as the built-in mathematical model, the ACS800 torque control system predicts the real torque. The power converter manipulates the motor supply voltage based on the torque reference and real values, allowing for a quick dynamic torque response. Furthermore, since the pipeline imitator is powered by the pump motor, similar to how a generator is driven by a prime mover, electric power may be sent back from the pipeline motor to its power stage, allowing electric energy to be consumed or returned to the grid. As a result, the pipeline's true torque value

The speed reference of the pump imitator may be changed by the imitator to modify the speed during load alternations. In the ACS500 PLC, the proper controller is installed.

When compared to the installation of the identical labs in different institutions, the laboratory represents a considerable reduction in cost and space for equipment, air conditioning, lighting, spent power, and so on. Because the training is done remotely, these expenses are lower in a distance plan. On the other hand, the number of students in the laboratory increases since access to the sets is available during non-working hours, such as evenings and weekends, which were previously restricted in the conventional method. This maximises resource use and encourages students to work in the laboratory during these times.

SKILL ACQUISITION MODE WITH ACTIVE LEARNING

Students from several universities have been participating in the programme since 2013. Distance learning was used by a number of universities. Virumaa College and Kuressaare College were the first to arrive. Both groups passed their laboratory sessions over the Internet using the new instructional technique. Following that, certain groups from Estonian industrial firms received advanced training.

Within the active learning context, an innovative learning environment has been created during the previous five years [21]. Our objective was to combine the advantages of online experimentation with online learning activities that allow students to connect in novel ways. Using multi-variant multi-choice individual work and increasing the amount of open issues where trainees may complete their own assignments, the key strategy for increasing student participation in skill learning and suppressing cheating was to apply this purpose. The questions and activities were then jumbled at random, resulting in a large number of versions for testing. In addition, the participants were given full access to the course materials in all of the practical assignments, which they may print out before the experiment. In addition, they might use a variety of stimulus materials in their response generation and data analysis (simulations, animations, virtual experiments in the form of Java applets or flash objects, and so on).

Individual off-site preparation, collaborative on-site pre-work conversation, per-variant experimentation, on-site summing-up discussion, and personal online reporting are now included in every distance training session. The first step is a virtual tour to ensure that learners are aware of the fundamental criteria and are familiar with the particular gear. A trainee must answer several questions on the system's performance in order to achieve this goal. This section is done in a collaborative cooperation setting.

The equipment study is the most crucial component. At this point, all participants are linked to the testing equipment through the internet and may operate the machines being researched remotely. This stage requires a significant amount of time in order for all participants to handle their tasks in turn. Each person is responsible for carrying out his or her own task, such as circuit assembly, computations, maintaining minutes, and plotting diagrams, among other things. Because these responsibilities vary on a regular basis, everyone learns to perform all of the roles.

After the laboratories have been implemented, the post-work discussion is used in a collaborative way to analyse the data and produce the future report.

SELF-EVALUATION IN LABORATORY PRACTICE AT A DISTANCE

Understanding learning outcomes requires progressive assessment [22]. It should show if the students can apply, analyse, synthesise, recall, summarise, or assess the abilities they have learned via practise. There are several challenges in distance assessment [17], [22]–[26], mostly owing to an issue with determining the person's independence throughout the evaluation process.

When the main assessment aim is to evaluate the students' capacity to reply to questions expressed in the form of credits and tests, it is difficult to determine if they can apply their knowledge and utilise it in a genuine engineering task [27]. It is the situation when the assessment is not a part of the instructional process, but rather a scheduled event that occurs at regular intervals during the academic year. Meanwhile, how instructors understand the significance of assessment, how strong it fosters learning, and how it impacts the topic students study and the consequences of their teaching have a substantial impact on the efficacy of education and overall study development. The students' evaluation must be an inherent element of daily education activities to encourage frequent assessment, without which the training process seems unachievable [28], [29]. This is why, as the learning process evolves, the assessment approach must be recast and redefined in order for a learner to obtain accurate and valuable feedback.

The assessment technique is seen as a strategy for bridging the gap between theoretical knowledge and actual work [30]. Rather than using standard grading to evaluate the learning process, an attempt is made to shift from learning estimates to assessment with the goal of improving learning, as advocated in [28], [31], [32].

The established assessment methodology was initially published in [33], [34], where the formative function of errors was selected as the primary motivator for student motivation. Next, we needed to figure out how to make the move from a one-step grading system to continuous evaluation. To do this, we undertake several iterations during the course duration by combining learning and assessment into a single cycle. Our evaluation techniques, which require a rapid reaction and a direct link to the student's interests, do not occur at set times during the semester, but rather flow in tandem with the teachings. The students' progress is continuously monitored through an assessment embedded into the lectures, laboratories, and exercises, which serves as a guideline for their success. Assessment became a form of feedback and reflection for instructors and staff in assessing problematic difficulties, identifying ambiguous areas, and knowing how students track their learning development as a result of this point of view. The described technique significantly alters students' perceptions of evaluation as an instructional tool that is used for more than simply exams. By integrating teaching and learning, an assessment may now be used as a relevant, genuine, and engaging educational tool, with the students as active participants in the evaluation of their own activity and the design of their reflective thinking [35].

The self-assessment techniques yielded significant advantages, including automatically rating replies to queries about lab preparation.

Students' competency self-assessment takes place at every step of the laboratory session, including pre-work and post-work conversations, experiment execution, and reporting. The necessary and optional components are included in each experiment. Only serious issues are assumed to be solved in the mandatory section, while the rest are optional. Optional points must be used by participants and teams in order to receive extra self-assessment scores.

All of the students' actions, as well as the laboratory report, are reviewed, and the learner's individual scores and final grade are shown as soon as the learner completes the laboratory work. Following reporting, the relevant review choices and comments from the instructor assist the student in determining if his findings are right and how to enhance his abilities further. The report engine that was created has an appropriate style for presenting the results. All laboratory participants may readily access information for future reference in the grade sheet that has been published.

The conventional conclusion portion of personal lab reports has been changed to better understand how students interpret the activity. There, the reporters are questioned on laboratory accessibility and the laboratories' capacity to communicate disciplinary topics. Students are also questioned about their suggestions for piquing their interest in experimenting, as well as errors in approach, circuits, instructional aides, and so on. Every useful suggestion receives a bonus point, which aids in the improvement of future work and teaching efficacy. The deadline and cut-off time scheduling is a helpful feature of the self-assessment technique. It is forbidden to begin the next lab before the previous work has been reported, to begin work if you arrive late, and to earn optional points after the deadlines have passed. This enhances the student's accountability for each step and activity while also supporting the learning discipline.

CONCLUSIONS

According to the initial course assessments, an active learning approach to advanced training over the Internet garnered high ratings from trainees, with an average score of four to five. The outcomes of the lab reports, quizzes, and written final examinations revealed that the students were quite engaged. The analysis of these replies reveals that the trainees' thoughts are properly balanced in terms of learning material.

Novel methodological resources for online studying of laboratory electromechanical and electronic setups aid in the development of learner habits such as the ability to effectively employ online software and hardware in real-world situations, interaction with peers in situations that require problem-solving skills, and development of close collaboration, initiative, and creativity. Furthermore, the suggested active learning strategy, which includes a unique self-assessment system based on interactivity and customization, boosts learners' interest in the task and incentive to learn.

In the context of active learning electrical engineering, a self-assessment technique fosters the development of theoretical appreciation, problem-solving abilities, effective circuit computation, experimental experience, practical training, and certification gain. The suggested technique effectively contributes to the experts' preparation, according to an analysis of students' involvement in self-assessment, class attendance, and final grades.

The distant laboratory practice's self-assessment approach encourages students to evaluate their procedural knowledge, which includes applying skills, addressing "why and how" inquiries, and explaining results, among other things. It enhances how you engage with your equipment and coworkers in a number of ways. This emphasis is customised to learners' participation in the creation of interdisciplinary context, discipline, pragmatic results, and professional preferences in order to get the most out of their education.

REFERENCES

1. V. Vodovozov, Z. Raud and L. Gevorkov, “Development of students’ activity through on-lecture assessment in electrical engineering,” 23rd IEEE International Symposium on Industrial Electronics ISIE 2014, Istanbul, Turkey, 2014, pp. 2209 – 2213.

2. D. Rover, N. Santiago and M. M. Tsai, “Active learning in an electronic design automation course,” IEEE International Conference on Microelectronic Systems Education, 1999, pp. 78 – 79.
3. Z. Raud and V. Vodovozov, “Teaching, learning, and assessment in electronics using concept mapping technology,” 1st WSEAS International Conference on Electronics and Electrical Engineering ELEL 2013, Valencia, Spain, 2013, pp. 102 – 107.
4. Y. E. Woyessa, S. P. Van Tonder and D. Van Jaarsveldt, “Alternative student assessment in engineering education: Lecturers’ perceptions and practices,” The 2nd International Multi-Conference on Engineering and Technological Innovation IMETI 2009, Orlando, Florida, 2009, pp. 224– 229.
5. A. Raviv, “Academic skills: The key to meaningful learning in the higher education system – An action research conducted at Tel-Hai Academic College,” The 7th International Conference on Education and Information Systems, Technologies and Applications EISTA 2009, Orlando, Florida, 2009, pp. 241 – 246.
6. A. Savander-Ranne, O. Lunden and S. Kolari, ”An alternative teaching method for electrical engineering courses,” IEEE Transactions on Education, 51 (4), 2008, pp. 423 – 431.
7. E. A. Mossin, L. C. Passarini and D. Brandão, “Networked control systems distance learning: state of art, tendencies and a new fieldbus remote laboratory proposal,” IEEE International Symposium on Industrial Electronics ISIE 2007, Vigo, Spain, 2007, pp. 1870 – 1875.
8. V. Giannikopoulou, I. Hatzakis and A. Zafeiropoulos, “A technology enhanced flexible learning approach for SMEs,” 18th IEEE International Symposium on Personal, Indoor and Mobile Radio Communications PIMRC 2007, Athens, Greece, 2007, pp. 1 − 5.
9. V. Chang and C. Guetl, “E-Learning ecosystem (ELES) − A holistic approach for the development of more effective learning environment for small and medium sized enterprises,” Digital EcoSystems and Technologies Conference DEST 2007, Cairns, Australia, 2007, pp. 420 − 425.

10. P. Piwek, “Supporting computing and technology distance learning students with developing argumentation skills,” 4th IEEE International Conference EDUCON 2013, Berlin, Germany, 2013, pp. 258 – 267.
11. E. A. Mossin, L. C. Passarini and D. Brandão, “Networked control systems distance learning: state of art, tendencies and a new fieldbus remote laboratory proposal,” IEEE International Symposium on Industrial Electronics ISIE 2007, Vigo, Spain, 2007, pp. 1870 – 1875.
12. A. Cristea, A. Wentzler, E. Heuvelman and P. De Bra, “Adapting SME learning environments for adaptivity,” 6th International Conference on Advanced Learning Technologies ICALT 2006, Kerkrade, The Netherlands, 2006, pp. 130 − 132.
13. L. Barreto, A. Vilaça and C. Viana, “NetStart – Achieving new abilities with ICT,” IEEE Technology and Engineering Education (ITEE), 4 (1), 2007, pp. 13 − 18.