CORELA Collaborative Learning Environment Platform for Developing Skills in Electrical Engineering

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This paper presents the final results of the ongoing CORELA Erasmus+ project. The main focus of the CORELA project is to develop a common platform for distance and collaborative learning. The platform is intended to support and enhance the educational process of electrical engineering in high schools and can be used at any level of education. The platform offers different modules and supports collaborative and distance learning strategies. The implemented modules were created for the teacher as a tool for planning and designing the student tasks and exercises. Each exercise can be designed as theoretical, involve the simulation procedure, or be real-time executable with actual electronics components and devices. For a collaborative learning scheme, the platform is connected with a Massive Open Online Course (MOOC) platform, where all the data, results, and task progress can be shared withother students. A common MOOC and CORELA platform enable students to interact with each other to share their suggestions and experiences. The platform also supports the Virtual Remote Laboratories (VRL) in classic single-user mode, whereby the MOOC support enables multi-user mode with the possibility to follow the course of the experiment with interim and final real-time results.

INTRODUCTION

The fast-developing technology and modern communication networks, which can transfer an enormous amount of data, offer quick access to any information, and gain novel knowledge and experience. The new digital era offers immense possibilities and enables the teachers to identify the new teaching methods and how the changing technology influences the knowledge and skills needed in modern society. Distance Learning-DL and Collaborative Learning- (CL) are methods [1]-[8], which have great potential regarding the current state of technology. According to past experiences and the current world pandemic situation, such approaches were forced to completely replace classic Face ToFace (FTF) methods in many modern countries. The success of the DL and CL is dependent on the technical infrastructure, preparedcurriculum, and teacher competencies [7],[10]. Modern, sophisticated DL and CL platforms influence the acquired knowledge with novel approaches of teaching and excellent user experience, which simplify the teaching process, data handling[11].Many researches the efficiency of DL and CL process isclosely related to the user experience, which involves platform graphical user interface design, transparency, andmultiple operating system support and usage on different devices such as computers, tablets, and smartphones[9],[12].

Regarding the economic changes, unified market, and increasing globalization, the teacher role is drastically changed, which demands a re-examination of the teacher's professional skills and teaching methods. All the changes are interlaced with the pervasive rise of modern technology and have unintended consequences in the teaching methods**Error! Reference source not found.**,**Error! Reference source not found.**. The new wave of acquiring knowledge by students is clearly marked with the rise of the MOOC systems and their integration in DL/CL platform. The new way of acquiring knowledge is no longer restricted to formal classrooms and schools. DL/CL platformallows students to attend and follow the education process irrespective of time and location**Error! Reference source not found.**. For example, online courses allow the student to arrange their studying time regardless of the formal school schedule. The Remote Virtual Laboratories (RVL) offer a unique solution to practical education. RVLs already show some advantages over real laboratories and are emerging as laboratories of the future. One certain advantage is the opportunity RVLs offer for international student collaboration, which is simply impossible with conventional laboratories.RVTs allow the participant to execute experiments at a distance over the internet at any time, no matter the school working hours and employee engagement **Error! Reference source not found.-Error! Reference source not found.**. The experiment can be repeated as many times as is needed.All the facts above are possible with fast-growing Communication Technologies-CT. There are many conducted studies and analyses, which confirm the success of modern learning approaches and technologies.

Many studies and practice experiences confirm that the higher success is in combining both approaches, which involves FTF and modern DL/CL methods, where the ratio is 0.6 for FTF and 0.4 for modern DL/CL paradigms [3],[18]-[20]. FTF is mainly used for course introduction, instruction sharing, and the interim meeting to validate the course flow. The DL/CL plays a significant role in the students' knowledge acquisition and gaining new experience. It is necessary to mention that student satisfaction and higher motivation lead to thorough knowledge **Error! Reference source not found.**. All the fulfilled studied materials supported by modern technologies raise the efficiency of the obtained knowledge and speed up the education process. The developed CORELA platform contributes to the diversification and modernization of Vocational Education and Training (VET) education.The platform provides access to VET teaching staff and VET students to new sector-specific skills that enhance the competitiveness of professionals in vocational education and the innovative capacity of the VET providers and the Small and Medium Enterprises (SME).

According toindustry needs, which requires educated professionals at all education levels, especially in VET this platform addresses the following priorities.

- Development of the relevant and high-quality skills and competencies. This priority addresses the need for research and development focusing on teaching and learning issues in professional secondary education due to emerging information and CT over the next decade. These include the internationalization of the curriculum and flexible learning platforms.
- Open education and innovative practices in a digital era and introducing systematic approacbes to, and opportunities for, the initial and continuous professional development of VET teachers, trainers, and mentors in both school and work-based settings. The main idea of thisis to train VET teachers to implement laboratory exercises on a userfriendly and remote access platform which will integrate RVL and CL. This platform must be conceivedinordertomotiveteachers and students to workwith.

There are several benefits (results) regarding the implementation of this project. We can, however, organize them into given categories:

- Newteachingmethodologyfortheintegrationofcollaborative learningapplied
- Development of a flexible virtual laboratory platform that integrates international collaborativelearning
- Teachers training and realization of educational materials for the sustainability of the developedplatform
- Increased student satisfaction of incorporating new technologies and knowledgeimprovements

The developed platform is a product of the Erasmus+ CORELA project **Error! Reference source not found.**. The aim of the project is to develop a common platform for technical VET education. The CORELA platform has an extension with integrated RVL and is specially developed forhigher electrotechnical educational institutions. The presented platform can operate in three different modes. In the first mode, the platform allows analytical computation. The analytical computation is oriented to theoretical assignments without the involvement of the real parameters and elements. Theoretical assignments are a basis for general knowledge of a certain field and are important for further understanding and the complexity rise of the problem. The second mode introduces the simulation environment. The simulation environment is a reasonable further step from theoretical exercises. The simulation involves testing different kinds of real scenarios, like a parameter deviation, parameter and measurement uncertainty model mismatch, etc.. The simulation is still based on an analytical basis but can identify and approximate some real effects and results. The simulation is an intermediate step between ideal analytical computation and real experiments. The third operation mode of the platform is a real-time experiment with real-time measuring and components. The platform offers a variety of connections to different measurement tools. The platform also supports standard serial communication, which spread the functionality to the custom-designed experiments and measurement equipment, which can be stored for later analysis and examination. All three operation modes of the platform offer a connection to the MOOC system, where all data and parameters of calculation, simulation or real-time experiments can be presented. With regard to the discipline and the teaching methodology, the presented results are used for CL and interaction with different student groups or just automated data collection platforms for teacher supervision.

THE CORELA PROJECT ACTIVITIES

CORELA introduces innovative, integrated remote virtual laboratories designed to be used by the VET providers. VET providers lag behind higher education institutions in terms of introducing innovative learning practices. This project is a huge step forward by the VET providers in diversifying and modernizing the learning methodology. The project isenhancing the employability and career prospects of the VET students by providing them access to sector-specific skills and supports their creative potential, and increase the innovative capacity of the VET providers from the participating countries. The following activities contribute to a project to reach itsobjectives,

- New teaching methodology for optimal application of collaborative RVL in VET
- Development of a flexible virtual laboratory platform that integrates international collaborative learning
- Development of interactive multimedia training courses and VET teacher’s training to gain knowledge to design, implement and maintain virtual laboratory experiments in a collaborative environment
- Evaluation of teacher’s and pupil’s satisfaction of incorporating new technologies and knowledge improvements.

The previous experience of the transnational partners in different areas related to the project (remote laboratories, e- leaming, collaborative learning, VET education,virtual instrumentation) ensures successful project implementation.

CORELA introduces an innovative, integrated, tailor-made platform for VET education. The platform improves the remote laboratory concept that has been used in higher education institutions [21]-[24]. Usually, this concept is broadly accepted at technical universities, where remote experiments are implemented to support student’s curriculum. Most of the experiments are not widely disseminated and exist side by side with the known remote laboratories such as ATLAS (CERN) [24], iLAB (MIT, USA) [25], LabShare (UTS, Australia) [26], VISIR (BTH,Sweden) [27], Weblab-Deusto (Spain) [28], etc. In the last few years, simple versions of those laboratory experiments have been proposed to the STEM school teachers’ community. However, there is much less experience in implementing such technologies in secondary vocational education. It is clear that the benefits of the RVLs are significant, but their implementation cannot be blindly mirrored in secondary education. Comprehensive research and adaptation are necessary instead. The innovation in this project rises from the idea that globally distributed systems could be interconnected to function concurrently. Such systems are intended to be controlled by international teams of teachers and pupils, also distributed worldwide. The VET students will collaborate and communicate through the platform to achieve the required objectives. Remote virtual laboratories, which started then- development about two decades ago, are currently seen as the beginning for future advanced global educational systems. They offer a unique opportunity to develop a teaching and learning platform for the development of skills required for efficient collaboration and communication on a local and global scale. Currently,several RVs are reported worldwide (stated above), yet only a few are constructed to allow involved participants to be collaborative and operate in real-time. However, a number of other institutions have recognized the advantages of collaborative RVLs and are in the process of redeveloping their RVLs into a collaborative learning environment. On the other hand, very little research has been done on the evaluation of collaborative learning in RVLs, especially in secondary education. Among others, this is because a large majority of RVLs are designed as single-user laboratories where student collaboration is not possible. This contradicts vocational secondary education practice where students normally perform laboratory experiments collaboratively in larger groups. This project developsan internet-based software platform that supports international collaboration by forming groups from different countries and cultures while collaborating on remote experiments using RVLs.

Unlike in real laboratories, where pupils are often confined to a limited time, closely monitored by a supervisor, and without an option to repeat the experiment, the RVL platform offers unlimited access and freedom to explore. On the other hand, the platform forces students to act responsibly. Therefore this approach of collaborative learning provides a highly-valued concept of students centered learning. In our opinion, the most outstanding value of RVLs platform is the opportunity of pupils to repeat experiments whenever there is a discrepancy between their measurement data and the calculated results. This would be reflected in better performance and grades in laboratory components in different subjects. Fig. 1 shows the outline of the proposed idea.

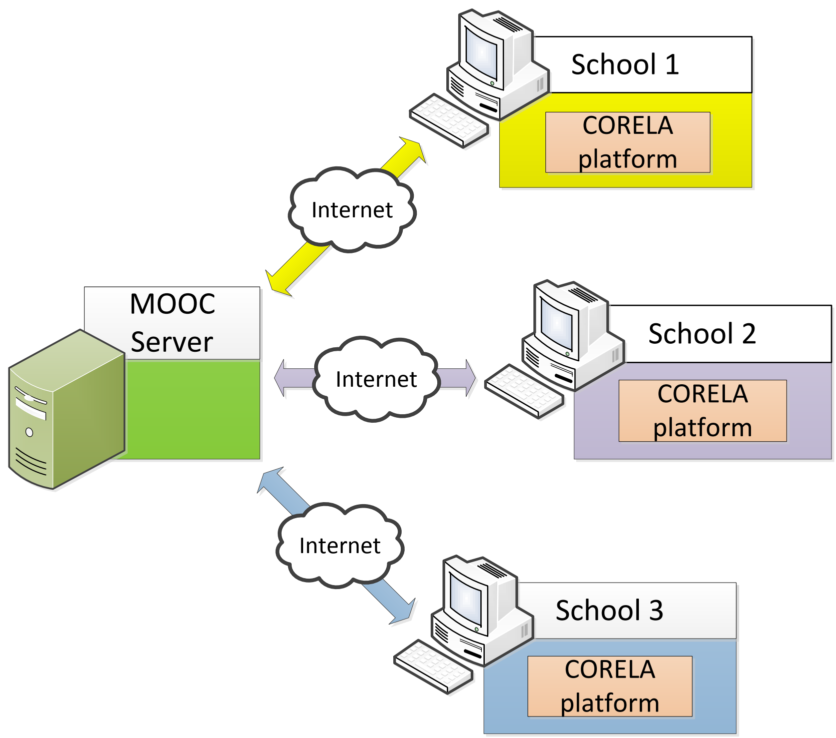

Fig. 1.CORELA network structure

The educational organization has access to the internet uses a common platform, which is developed within this project. This platform uses a unique graphical program language, which is based on a Labview idea and organization. The goal is that the school develop its own programs on a common platform, which supports several different exercises. The platform sends the data regarding developed exercises and comments to the server, which is located at SETU GS Mihajlo Pupin, Skopje, and enables sharing of developed exercises. Students can actively participate in the development of exercises by sharing comments among participating students and using social networks and applications for online communications.

At this stage of the project, the platform has been proposed, and the functionalities of the functions have been developed. By using a common platform, the project partners decided to develop the following exercises:

- Voltage and current measurements
- Statistical based methods
- Measurements of Resistance, Inductive and Capacitor (RLC) based circuits

- Measuring of transistors and diodes
- Data acquisition
- Bool algebra

The exercises can exchange through the servers, which will use a Moodle based platform, which serves as a communication tool between partners, developers, and students.

THE CORELA PLATFORM STRUCTURE AND FUNCTIONALITY

The CORELA platform has based on the Labview environment. The Labview language offers many Application Programming Interfaces (APIs) with the versatile possibility to develop own stand-alone applications, which can be used by the final users. The development of the platform has been executed in three main phases. The first development phase includes all the stakeholders sharing their experiences of teaching methodology with the support of modern technologies as a RVLs. The first phase also embraces how the platform will interact with the MOOC platform to support the collaborative learning methodology.

The second phase of the development is intended to design the functionality of the platform. In addition, to unifying and generalize the platform for the different education subjects, the three modes of operation have been implemented.The platform can be used for analytical and theoretical exercises. The second mode involves the simulation of electronic circuits with different electronic components such as resistors, capacitors, inductors, diodes, Operation Amplifiers (OA), et.. Regarding the simulation procedure's flexibility, the platform has integrated single electronic elements and allows the user to design its circuit. Nevertheless, the platform also contains standard electronic circuits such as Wheatstone and Maxwell bridges and inverted and non-inverted OA circuits. All the elements and courses can be combined in the simulation procedure. The third mode involves communication interfaces (CIs) to communicate with real measurement devices and micro-controllers systems. The ICs are used for the extension of the platform to the RVLs. The supported interfaces are USB 2.0 and standard serial communication protocols. The USB interface is common to different data acquisition devices, where the traditional serial communication is supported by many measurement tools and is standard peripheral components in most micro-controllers. Concerning the school usage and the teachers' previous experience, the NI-myDAQ is completely supported, with all the analog and digital inputs and outputs.

The third stage of development covers the data exchange between the CORELA and MOOC platforms. The CORELA platform can provide the data to the MOOC platform inside of the function block developed in the MOOC. The CORELA regard to the registered user in MOOC delivers data in the MOOC database. All the data in MOOC’s database can be provided in different elements of the MOOC. For example, the platform can provide the data in the forum and be presented inside the assignment or exam units. The CL environment is supported by the forum threads or assignment units, where the students can access the published results from different groups to collaborate with the teachers or other students within the same task. Figure 2. presents the developed user interface of the CORELA platform.

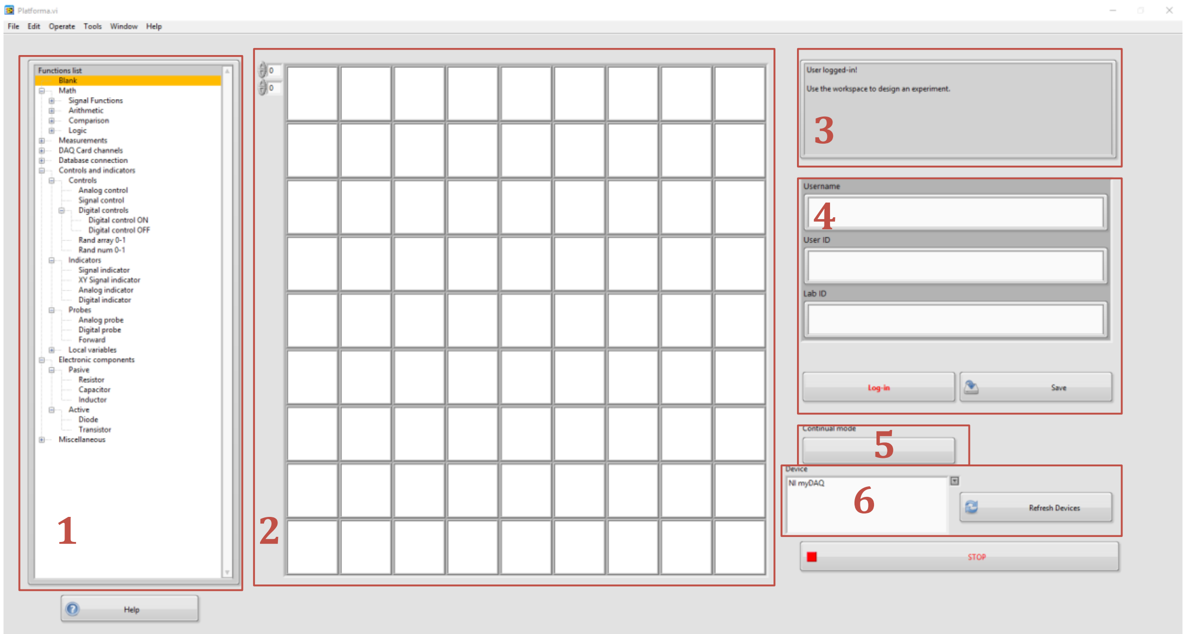

Fig. 2.CORELA platform user interface

The graphical interface is composed of six main elements. The main elements are,

- **Function list (1):**functions are collected in the group regarding the purpose and functionality properties.
- **Workspace (2):** selected function from the left pane (1) appears when clicking on the desired empty square in the workspace
- **Message box (3):** all results of the exercises appear in the message box, including calculated, simulated, or measured values.
- **Log Inbox (4):**The student can assign to the exercise with a given username and password. Lab ID stands for a number of activities for identification in MOOC-Moodle platform.
- **Continual mode (5):** with a click on this button platform re-calculatesthe created function workspace every 2 seconds.
- **Device box (6):** when the hardware is connected and installed to a computer, the device's name appears in the box. The button "Refresh Devices" checks for all the connected devices.

As mentioned before, users familiar with LabVIEW have advantages due to CORELA platform is based on LabVIEW programming language. However, the platform is a very initiative, and we expect that the other users will learn to use the platform very quickly. The platform enables to the creationof three kinds of exercises.

- Theoretical calculations and analysis
- Simulation of electric circuits
- Real-time measurement and experiments

All types of exercises can be interlaced with shared results over the MOOC platform or can be designed to stepwise pass from the theoretical part to the simulation and end with a real-time experiment. The data sharing over the MOOC is a key future of the CL and DL approach. For example, students from different schools can be divided into three groups, where each group performs one type of exercise. Then, the groups share their data over the MOOC platform with the other groups to analyze and compare them with results from their task. Finally, the student can interact and discuss the acquired results. Figure 3 presents the structure of DL method with COREL platform and MOOC system.

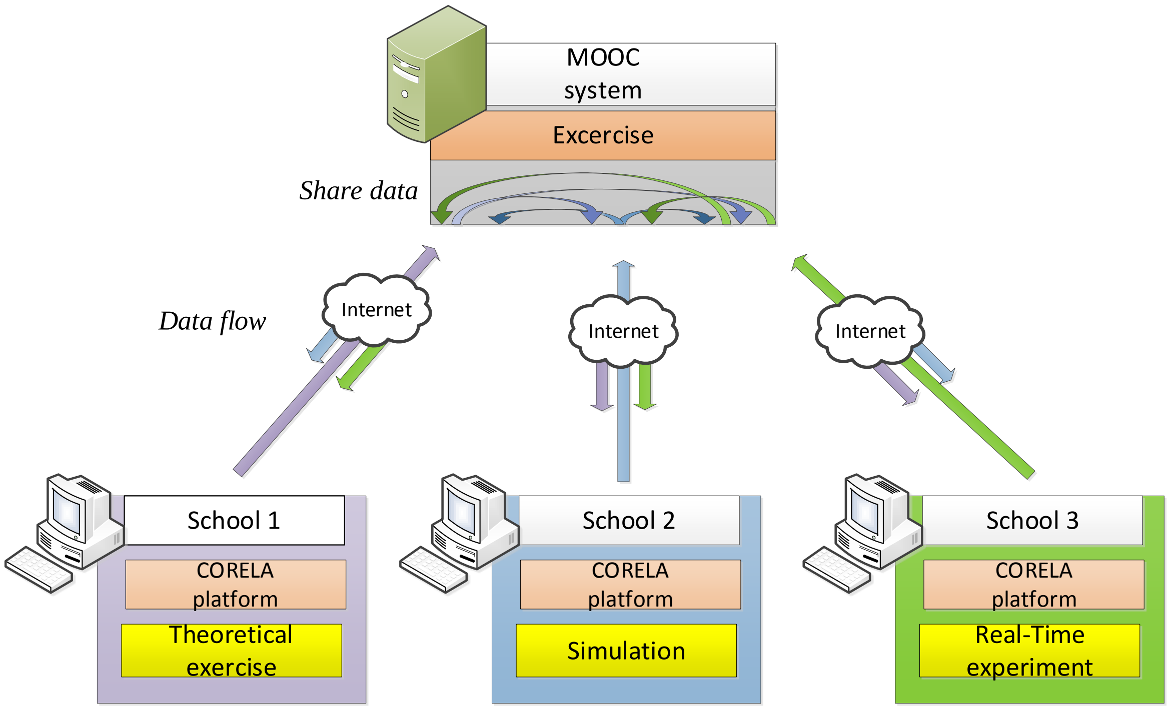

Fig. 3.Collaborative learning principle of the CORELA platform with MOOC system

Figure 4 presents the use of the CORELA platform without a MOOC system, where each group or single student performs all three types of exercise.

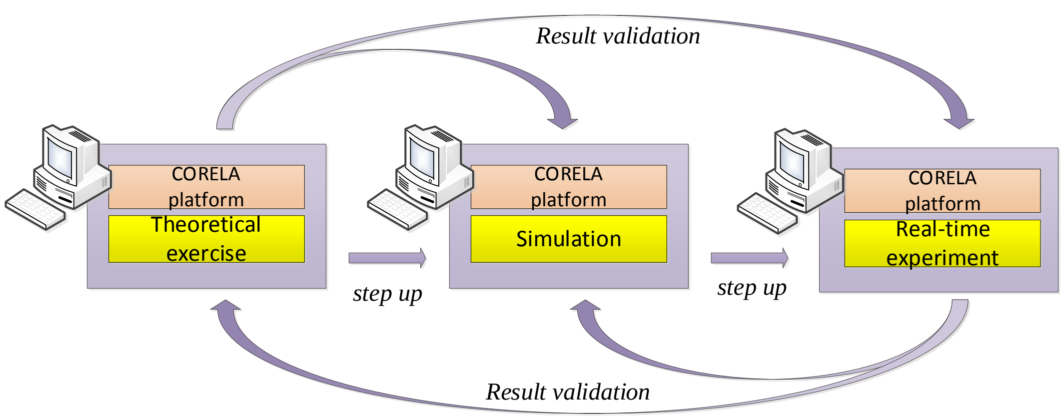

Fig. 4. Use of CORELA platform without the MOOC system

The main structures presented in Figure 3 in 4 can be created in mixed mode. For example, the data from the structure presented in Figure 4 can be provided to the MOOC system and can be shared with the other groups or students, where the DL methodology is supported.

For platform has seven different groups of implemented functions presented in Figure 5.

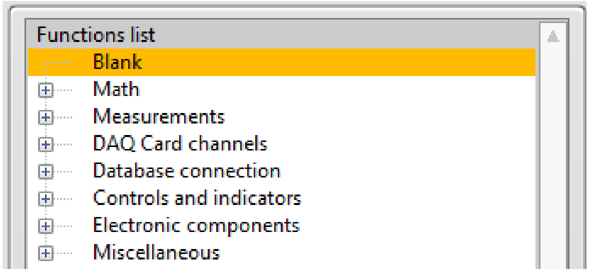

Fig. 5. Function groups of COREL platform

Seven thematic group covers different modules and functions. For example, the Math group covers arithmetic operation, bool algebra, and logical relations. The measurement group contains interfaces for various measurement tools such as sensors, bridges, etc. The DAQ enablesan interface for measurement modules. The Database connection group provides communication with the MOOC database. The control and indicators contain the functions for data analysis. The group electronic components contain the models of the electronics elements such as resistors, inductors, diodes, transistors, etc. And miscellaneous group contains the standard electronics circuits such as resistor-inductor-capacitor (RLC), OA circuits.To ensure CL, the CORELA platform is capable of sending calculated, simulated, or measured results to the MOOC platform, where another user can access those data over the internet. The connection to the MOOC system is possible only with a validated user account in MOOC. For that purpose, the platform offers a set of functions under the Database connection tag, where the data are tunneled to the MOOC. When the user wants to send data to the server or vice versa, the proper channel of a Database connection is selected.

EXERCISE DESIGN EXAMPLE

Theexample shows the principle of collaborative learning methodology on a simple example. For example, simple first Kifchoff law is used. The first Kirchoff law states ‘the sum of currents that enter or leave a given junction of the electrical circuit is equal to zero’. The idea is to analyze a simple electrical circuit formed by three branches, given in Figure 6. The first branch consists of a voltage generator E and resistor R1, while the remaining two branches contain the resistors R2 and R3 wired. The task is to determine the electrical currents I1, I2, and I3 and to check the first Kirchoff law for the junction J presented in Figure 6. To solve the electrical circuit, the following parameters of the circuit are given: E=12V, R1=220Ω, R2=470Ω, R3=100Ω.

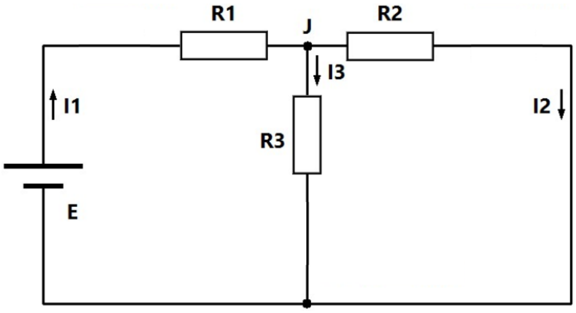

Fig. 6. First Kirchoff law exercise

The exercise is performed in three different groups, where one group performs analytical computations on a theoretical basis. The second group design a simulation of the circuit, and the third group executes an experiment with the myDAQ data acquisition device.

TASK OF GROUP 1

After the theoretical analysis of the circuit in Figure 6 the next step of the exercise is related to posting the results into the CORELA virtual platform and MOOC platform. The task is to record the calculated electrical currents I1, I2, and I3 into the CORELA database (Channel 0). Figure 7 shows an implementation of the following programming sequence into the platform.

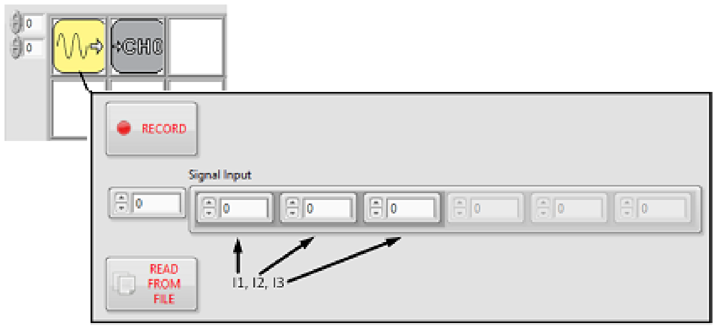

Fig. 7. Example of sharing the calculated values to the MOOC platform over channel 0.

TASK OF GROUP 2

The second group performs a simulation of the electrical circuit given in Figure 7, with actual parameters such as resistance uncertainty and amperemeter resistance. The simulation aims to check the difference of theoretical and simulation results of the electrical currents I1, I2, and I3. The simulation of the electrical circuit is realized with the CORELA virtual platform. Run the application and insert the virtual instrument for the first Kirchoff law is located in the list of functions under the menu *Miscellaneous* -> *First Kirchoff*. The application appears in the CORELA platform, as is presented in Figure 8.

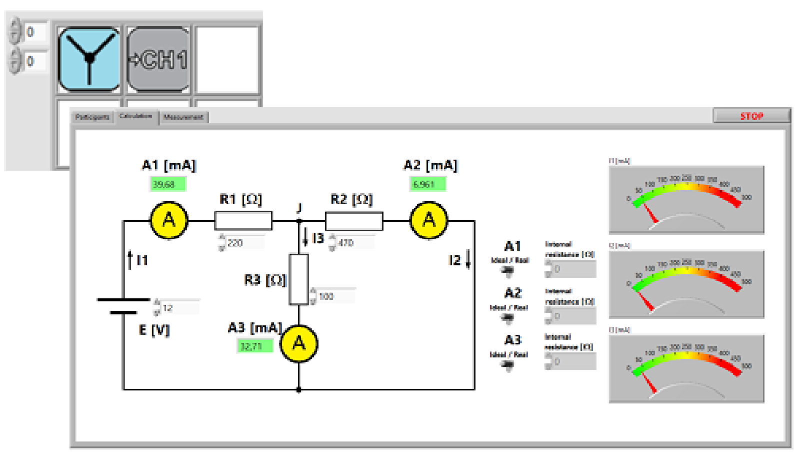

Fig. 8. Simulation of the electrical circuit with given actual parameters.

The simulated data are provided to the MOOC databases over channel 1.

TASK OF GROUP 3

The third group exercise is related to the practical realization of the electrical circuit and performing realistic measurements. The aim is to test the first Kirchoff law once again, but this time with real elements and conditions. To complete the experiment, the experimental board was used. Figure 9 presents an electric circuit with measurement devices.

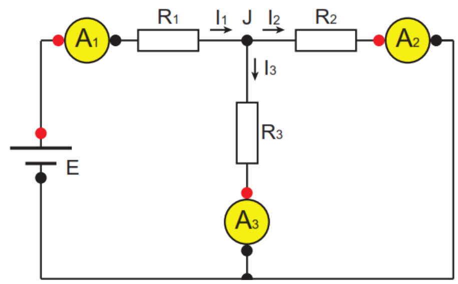

Fig. 9. The electric circuit with attahed measurement units.

For the real experiment, the following equipment was used, DC power supply (E), data acquisition card NI-MyDAQ and digital multimeter. All three current values from the real circuit are presented in the CORELA platform given in Figure 10.

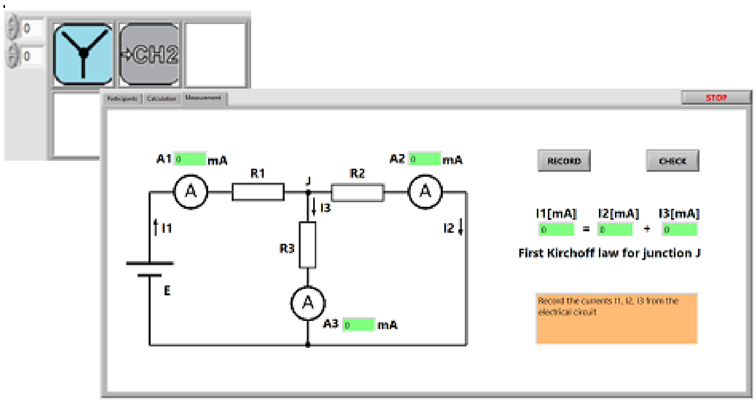

Fig. 10. CORLE interface for external measurements card

The button RECORD updates the values from the data acquisition card. All the values are provided to the MOOC platform over channel 2. The real experiment can be executed over the internet. Finally all the results are compared and further discussed in the MOOC platform over the forum thread or assignment comments. All the assigned users of the MOOC platform can participate in the discussion and analysis.

ANALYSIS AND USER EXPERIENCE

The purpose of this work was to study student and teachers' perceptions of group work in an effort to understand either the reticence or enthusiasm for this particular pedagogical instructional strategy. In general, teachers have anecdotal information about which aspects of small group learning elicit strong student attitudes. There is little research and data that thoroughly explore student attitudes, especially at the secondary school level and in the electrotechnical program. Therefore, this questionnaire intended to reliably tap into small-group distance learning areas that include student views and concerns, group dynamics theory, and how attitudes are related to behavioral and learning outcomes. Finally, this study was designed to highlight problematic areas of small group learning, which may lead to general recommendations being made. This study employed one methodology to determine student attitudes and perceptions of collaborative learning. The method involved a questionnaire (one for students and one for professors), which prompted the participants to respond with respect to collaborative group learning to questions concerning their self-image, their relationship to the group, their preexisting attitudes, and their perceptions of the learning process. The questionnaire for students consisted of 65 questions, and the questionnaire for professors consisted 44 questions, including attitude statements (e.g., When I work in a group, I am able to share my ideas), perception issues (e.g., I feel working in groups is a waste of time), and background questions (e.g., gender). Students indicated their responses on a five-point. Like scale ranging from strongly agree to strongly disagree. The results were analyzed as shown in Figs. 11(a) and 3(b).

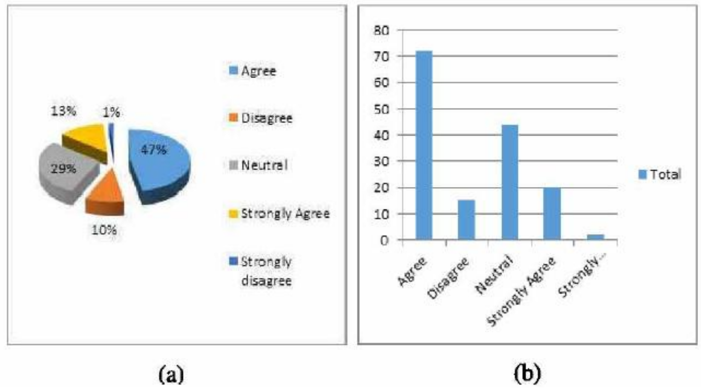

Fig. 11. Graphical representation of the answers regarding thestatement: *I will gain more knowledge when I work with other students*.

Most of the students are studying electro technical program, 66 of them are in the first year of study, 39 of them are in the second, 33 in the third year of study, and seven are in the fourth year of study. Fifty-seven of the students are with excellent grade success, 84 are with good grade success, and 11 are with satisfactory grade success. Most of the teachers teach electro technical programs and have long-term teaching experience.

Collaborative learning strategies, which focus the student in an active and participatory method of group interaction for learning, do not necessarily mean greater academic achievement, greater enthusiasm (or other attitudinal perceptions), or higher learning occurs. To understand how collaborative learning strategies can improve the learning process, we found out that there are no statistical differences between University and high school respondents, which means that both categories perceive that the learning experience is positive, enjoyable, and friendly as a result of collaborative

Very important to mention is that 80% of the student respondents will gladly participate in a mixed nationality working group, 40.8% of them are highly motivated to meet and collaborate with foreign students, 77% are taking distance-based learning as a challenge, but at the same time, majority would feel more comfortable to have teacher support and supervision, and 22.3% feel that are not competent to participate in an international educational project. Regarding the Professor's attitudes towards collaborative learning, we set a similar hypothesis that expresses teachers' opinions and support towards international mixed students group using collaborative learning at a distance. A significant fact for this project is that 86% of the respondents-teachers are comfortable supporting verbal/written English communication between international students. However, 65% of them does not hold any formal certificate on English course. Besides professional development in the electrotechnical field, it is worth mentioning that successful implementation of collaborative learning techniques requires structurally planned teaching and learning activities. Also, it is recommended that this approach is used for skills like cognitive development, socialization, teamwork, etc. This is because collaborative learning collects suggestions and ideas from different group members and contributes the concepts become quickly clear.

Moreover, this approach can also be used for the instruction in other skills such as listening, speaking, and writing. Teachers agree that there is a need for change in education by incorporating new innovative teaching methodologies, such as collaborative learning, which will introduce a higher quality education system. As mentioned before, in collaborative learning, students of various talents, abilities, and backgrounds need to work together to achieve a common goal with the constant support of their teachers. So, it can be said that the vast majority of the respondents believe that they are perfectly willing to participate in such learning activities. This is the student statement, and teachers agree with it the most. Therefore, it's safe to conclude that collaborative distance learning is the perfect way to connect learning.

After analyzing the teacher's and student's experience, the final questionnaire is intended to evaluate the steering committee experience with the project course, achieve results, and project management. The Steering Committee has five members from three different countries and five educational institutions;

- SETU GS Mihajlo Pupin, North Macedonia
- DTK Smart-Tech, North Macedonia
- TU Rugjer Boskovic, Croatia
- UM FERI, Slovenia
- Šolski Center Kranj, Slovenia

The participant project role is divided into three different groups; project coordinator, researcher, and contact person. The role distribution among partners is presented in Figure 12.

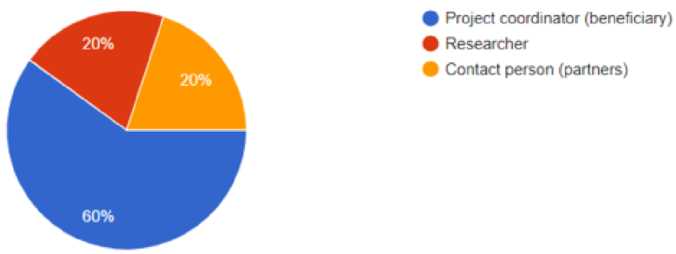

Fig. 12. Partners role distribution

Figure 13 represents satisfaction with the management and coordination of the project.

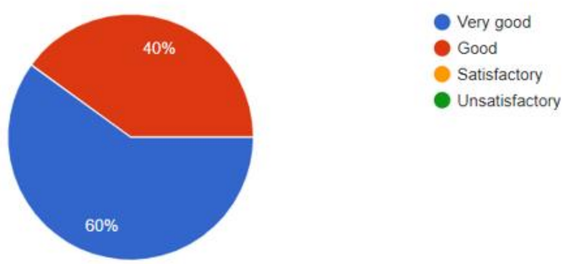

Fig. 13. Management and coordination satisfaction

The answers confirm that the management and coordination were successful, and partners are pleased with the project coordinator. In addition, the three partners estimate the coordination as very good and two of them as good, which confirms efficient project supervision, guidance, and coordination.

Figure 14 shows the achieved results regarding the project schedule.

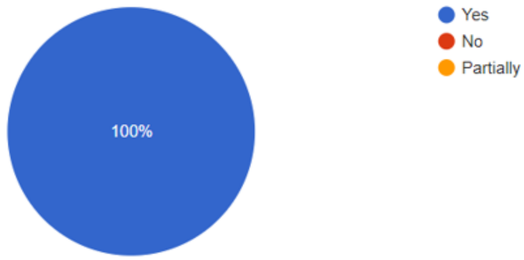

Fig. 14. Archived result regarding project schedule

The partners confirm that all work packages are successfully finished within the given project schedule.

The further presented results show achievements of the project implementation and goals realization. The highest score is 5 (Very good), and the lowest 1, which is an unsuccessful assessment. Figures 15 depicted the success of the RVL implementation, where all partners agreed that the implementation of RVL was aligned with the project plan.

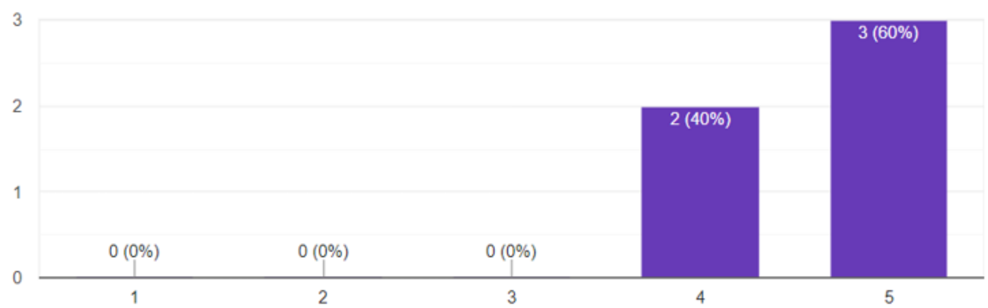

Fig. 15. RVL implementation success

Figure 16. presents the satisfaction with the implementation of the multimedia courses.

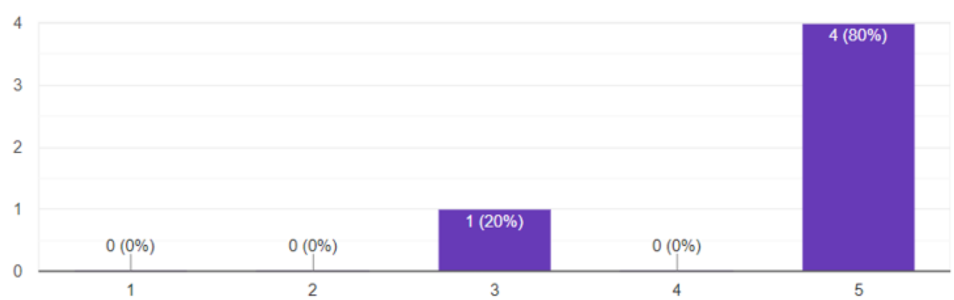

Fig. 16. Final assessment score of the multimedia courses implementation

Regarding Figure 16 the course implementation achieves a score of 4.6, which means that the implementation phase is successful.

Figure 17 shows the student's dissemination and collaboration activities.

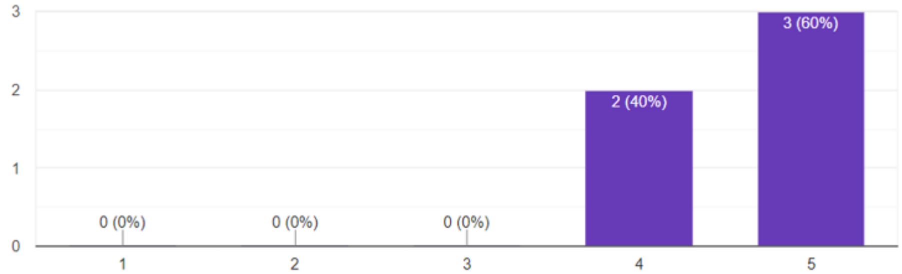

Fig. 17. Students dissemination and collaboration activities score.

The achieved score reflects good dissemination and collaboration activities among the students.

CONCLUSION

The concept of collaborative remote virtual laboratories has been well established and accepted into university education practice. Its implementation benefits are widely recognized, and they are yet to be exploited to their full potential. However, there is much less experience in implementing them into VET. The methodological aspects for implementing ICT technologies into Vocational Education are significantly different from those at the University. There are many factors that have to be considered for proper implementation: language barriers, ICT skills, students' age, social behavior, etc. It is clear that the existing methodologies are not to be blindly mirrored, and exhaustive research and methodology adaptation is needed instead. Practical laboratory tasks play a crucial role in secondary professional schools. On the other hand, laboratory management can be resource-intensive and expensive since it requires qualified staff and continuous equipment maintenance.

Moreover, a modem laboratory must be capable of following the actual technological advances. Therefore, alternative access modes (e.g. remote virtual laboratories) are considered a strong follow-up on the conventional laboratories. Remote virtual laboratories can extend the capability of traditional laboratories by increasing the interest of students to perform experiments. To increase the impact of using the designed RVL collaborative platform, the laboratory exercises are realized on a basic subject in technical VET schools, i.e. electrical circuits. To increase the implementation transferability potential, all laboratory exercises will be open to everyone.

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