Sharing educational experiences from in-person classroom to collaborative lab environments

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***Abstract*—This paper describes how the Spanish University for Distance Education (UNED) is currently sharing its educational experience on collaborative labs environments with an Argentinean University: the Santiago del Estero National University. This experience takes place within a wider framework provided by the VISIR+ project, which aims to define, implement and evaluate a set of educational modules following an Enquiry-based Teaching and Learning Methodology supported by the VISIR remote lab.**

Keywords: remote laboratories; VISIR; educational experiences; practical competences; collaborative laboratories

I. GENERAL INTRODUCTION

In-person laboratories are the first approach in order to achieve curricular capabilities. However, due to the policy followed in the educational methodology at the Electrical and Computer Engineering Department (DIEEC) of the Spanish University for Distance Education (UNED), and although there are in-person lab sessions, they cannot meet the requirements to provide a solid formation at UNED. Simulators and virtual labs have been integrated in the learning process; however, they are still far from delivering to student the performance of the real equipment under real-life operation conditions. Remote laboratories have alleviated these disadvantages intrinsic in distance education. In any case, remote laboratories are not meant to replace in-person laboratories. Neither option is better than the other one (in-person laboratories, remote laboratories or simulators); each environment provides different capabilities due to their complementary nature [1], [2].

VISIR (Virtual Instruments System In Reality) is a remote lab for wiring electric and electronic circuits experiments. The DIEEC-UNED has been, and still is, using VISIR in different degree and master subjects, expertise courses, SPOCs (Small Private Online Courses) and MOOCs (Massive Open Online Courses) since 2010 [3].

The VISIR+ project "Educational Modules for Electric and Electronic Circuits Theory and Practice following an Enquiry-based Teaching and Learning Methodology supported by VISIR" is carried out with the support of the European Union ERASMUS+ program, under the coordination of the Polytechnic of Porto (IPP, Portugal) [4], [5]. It aims to define, develop and evaluate a set of educational modules, for electrical and electronic circuit theory and practice, promoting new teaching and learning methodologies, especially student-centered ones. VISIR+ project includes five one-on-one partnerships between European and Latin American Partners in order to facilitate the cooperation and content development tasks. As such, UNED's partner, Santiago del Estero National University (UNSE), has been using the VISIR remote laboratory installed at DIEEC-UNED during the first phase of the project. UNSE teaching staff have received both distance training, by means of video-conferencing or web conferencing through AVIP classrooms (Audiovisual tool over IP technology) developed by UNED-INTECCA (Technological Innovation and Development in the Study Centers), as in-person training. The educational scenario at UNSE, where VISIR is going to be an active actor during lectures, allow to integrate in the same collaborative scenario the Teacher (or Tutor), the Students (or the Trainees) and the Remote Laboratory (in this case VISIR), where the teacher and the students could interact using the laboratory as one active shared service where they can see the effects of the interaction within the videoconference environment.

Distance education has become widespread in the last decade and has fostered lifelong learning and continuing education patterns, allowing access to learning resources at anytime and from anywhere. It has been possible thanks to the internet development and technologies associated with learning tools for a new teaching pedagogy. To support life-long learning and students' autonomous learning activities, remote experimentation has become a challenge in electronics courses. The way the universities and educational organizations or institutions deliver remote experimentation to students in distance learning environments has become a challenge.

Nowadays, there is an extensive variety for providing theoretical contents in distance learning (videos, documents, tutorials, scaffolding activities, peer-to-peer reviews, forums,

etc.) to students. These tools, by an efficiently and appropriate selection from professors and use from students, can complement or replace successfully in-person education, even they can reach some aspects that in-person education cannot achieve. Unfortunately, practical issues are not as developed as theoretical ones are. A first approach to this problem is clearly the use of simulators and virtual labs, although, they are still far from providing to students the real performance and features of equipment under real-life operation conditions. The major challenge is the provision of laboratory working online along with the theoretical contents in a massive context.

II. THE FIRST APPROACH: A GENERAL OVERVIEW

The project had its kick-off meeting on February 1st, 2nd and 3rd, 2016, in the city of Karlskrona, Sweden. During these days, different kinds of academic activities were carried out tending to gain a greater comprehension about the project by the team members, to foster liaison and mutual exchange, clarify doubts and instruct about the VISIR system. Among the various strategies to achieve these objectives, there was a Training Action structured around two sessions. The first one consisted of a more technical training by two local programmers. The second was organized with several speakers: teachers-researchers from European universities where VISIR is already used and some Latin American teachers-researchers, who made institutional presentations on the possibility of future use of VISIR. While the first one covered a single module of two hours, the second was longer (2 modules).

With the delivery of those first modules we achieved several results:

1. Get a common background of all the new partners that need to have an in-depth literacy of the VISIR system as well as a general introduction of the technical aspects of VISIR and its implementation inside a new institution.
2. Achieve a best understanding of technical and educational application of the competence base-learning that could be achieved using VISIR inside the classroom and in an online learning environment.

VISIR is a remote lab for electric and electronic circuits experiments, developed at Blekinge Institute of Technology (BTH) in Sweden and in use in several universities all around the world. In VISIR, the traditional equipment (DC-power source, function generator, multimeter and oscilloscope) are replaced with an equipment platform, which is suited for remote control such as PXI (PCI eXtensions for Instrumentation), LXI (LAN eXtensions for Instrumentation) and GPIB (General Purpose Interface Bus) [6].

VISIR is an open remote lab dedicated to experiments with electrical and electronic circuits. It allows teachers and students to perform experiments with real laboratorial equipment, remotely and in real-time. The user interface replicates a physical breadboard, all available components and the instruments front panels, being possible to wire the desired circuit and analyze its behavior with several instruments. The interface main windows are represented in Fig. 1.

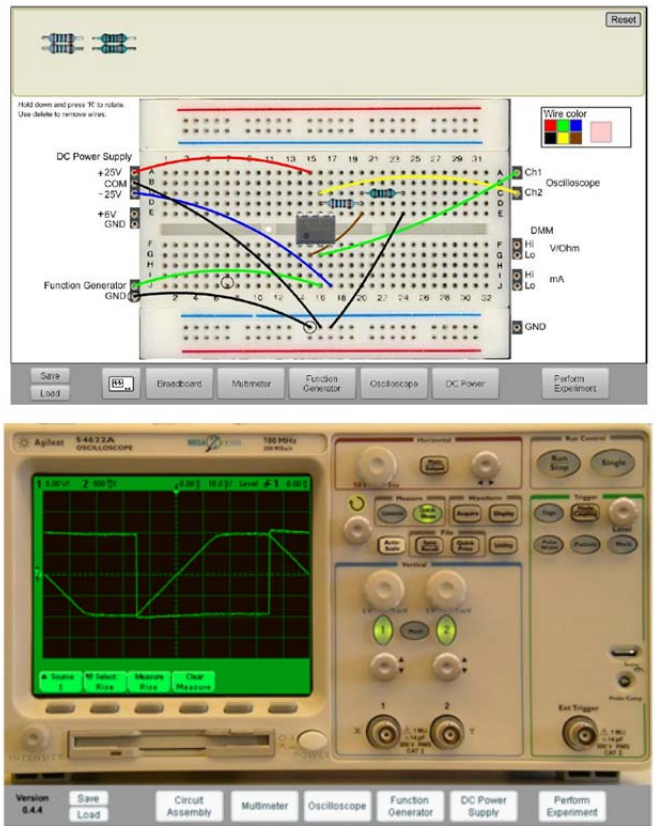

Fig. 1 - VISIR Interface Examples

Any remote accessible instrument can be installed (most VISIR based labs use PXI instruments), being possible to use customized front panel graphical representations. Each user institution can replicate the equipment installed on its real laboratories and most of the device dials should be directly controllable by the user. On normal teaching environments, where the instruments are not pushed to their limits, the overall feel and results should replicate those obtained using the real lab equipment. In some cases, students are even encouraged to use the manuals from the emulated instrument.

The experimental hardware apparatus is built around a switching matrix, which is used to create the intended experiences sequentially. Each time an user requests an experiment, via the interface, the matrix reconfigures itself physically implementing the required connections and instrument settings.

Therefore, VISIR is a real laboratory as in-person laboratories are, but designed for remote access. Its integration in LMS (Learning Management System) evolves into a Remote-LMS (RLMS); a responsive design of the whole system evolves into a responsive-RLMS (r-RLMS).

The essential difference between remote laboratories and in-person laboratories results from how the interaction between student and workbench is performed. Therefore, remote laboratories have very limited ability to provide manual skills; "Physical presence however is only one element in the perception of reality, a student's subjective mental

reality" [7], [9], [10]. This difficulty can be overcome by immersing users in the laboratory by means of its interface.

The possibility of a direct comparison between the different alternatives is constrained by a lack of uniform criteria with which to evaluate the effectiveness of laboratory [11], [12], [13]. It is impossible to conclude that any type of laboratory is superior to another objectively, but also each one provides different learning outcomes [11], [13]. Regardless, the most effective solution with regard to meeting the expected learning outcomes is still a combination of the methods [11]

III. DISTANCE TRAINING

We use as a collaborative environment for the collaborations of the users and the training a system based in Moodle as well as we use this system as part of the developments to support as a new framework for the MOOCs support.

Moodle (the Modular Object Oriented Dynamic Learning Environment) development is increasingly influenced by Moodle community of developers and users [14]. The platform offers more than MOOC-platform edX in terms of educational tools, analytics and SCORM compliance [15]. Moodle offers a full-featured flexibility for the provision of instructional materials and assessment tools; it is completely customizable LMS (Learning Management System). Another advantage of Moodle with respect other platforms is that it is provided freely as Open Source software under the GNU General Public License (GNU GPL or GPL).

The trade-off in Moodle is that the number of configuration options can be daunting, and system performance suffers with larger numbers of students [15].

The use of Moodle as learning environment allows having a speed-up process of the learning curve by the new users and teachers as they could observe the use of VISIR in the synchronous or asynchronous activities (using the previously recorded ones). And of course Moodle acts as a learning repository of the materials and the practical works and documents shared with the in-training teachers that will use those to increase their capabilities and knowledge of VISIR and this implementation in real life courses.

IV. IN-PERSON TRAINING

The VISIR+ project is developed around a consortium of 5 European and 5 Latin America Higher Education Institutions (HEIs), plus two support institutions also in Latin America. It is organized around a set of three Training Actions where all actors (researchers, teachers, technicians) become involved.

Training Action 1, covering technical, pedagogical and research aspects of VISIR, was held at BTH in February 2016, with presentations done by all European partners. At least two representatives from each Latin America countries institutions participated locally, while a number of teachers from the Argentinean and Brazilian HEIs participated remotely. At the end of this activity, participants became familar with VISIR, what experiments does it support, how it can be incorporated into a course curricula, what learning outcomes does it enable, etc.

Training Action 2 took place between August and September 2016 in all five Latin America HEIs and targeted all teachers with lecture duties in the institution's courses related to electric and electronic circuits, plus representatives from nearby associated institutions. Other teachers from the associated partners participated remotely. At the end of this activity a set of educational modules were made available, comprising all the required information on the use of hands-on, simulated and remote labs.

Training Action 3 will be jointly delivered by each Latin America country HEI and one European partner HEI and will test the capacity to aggregate other institutions around the use of VISIR, similarly to what happened in Europe (e.g. UNED and UDeusto participation in Go-Lab). This training action will include application examples from the partner countries HEI, to prove the adaptability of VISIR to different institutional cultures and its universality in terms of experiments with electric and electronic circuits.

In particular, TA2 is especially interesting for the scope of this paper, as it refers to a closer academic relation and personalized strategy to share educational experiences. As it was anticipated, the VISIR+ Project sets a Training Actions 2 with the following characteristics:

> *A 2nd training action in each partner country HEI, led by the two representatives of each host institution, who attended the 1st training action, plus two representatives of one European partner . This 2nd action targets all teachers with lecture duties in the institution's courses related to electric and electronic circuits, plus two representatives from the nearby associated partners. Other teachers from the associated partners may participate remotely.*
>
> *The instructional design of all target courses: At the end of this activity the expected result is a set of educational modules comprising the use of hands-on, simulated and remote labs, following an enquiry-based methodology, this accomplishing Objective 1. The course curricula, lessons plans, and the contents of the target courses LMS pages will provide the measurable indicators*

TA2 at UNSE took place from September 12th to the 16th, 2016. It was carried out by two professors from UNED, who are co-authors of this paper, with the support of the Research Institute of Education Sciences of Rosario (IRICE) which belongs to the National Scientific and Technical Research Council (CONICET) of Argentina, in charge of data collection and quality monitoring workpackage at the VISIR+ project. The remarks expressed by the members of this workpackage, who are also authors of this paper, were made from a twofold perspective: emic and etic [16], which intends to be part of the experience and to be objective at the same time, considering human perspective limitations. During TA2, the challenge of the role as observers of Project development was both acknowledging the TA2 hosts' warm welcome and their effort to carry out the sessions successfully, and keeping aloof from the local experience to observe the actual outcomes of sessions (for detailed information see Table I).

TABLE I: SYNTHESIS OF TRAINING ACTION 2 AT UNSE

Participant Institutions	**UNED & UNSE**
Local coordinator	Rubén Fernández
Members from EU HEI	Manuel Castro & Félix García Loro
Members from LA Institution/s	Rubén Fernández, Héctor Paz, Mario Gómez, Fernando Soria
City	Santiago del Estero
Dates (2016)	September12th, 13th, 14th, 15th and 16th
Total number of turns[a]	8
Number of de attendants	31
Attendees' institutions	Universidad Nacional de Santiago del Estero, Universidad Católica de Santiago del Estero, Universidad Nacional de Salta, Universidad Nacional de Tucumán, Universidad Tecnológica Nacional, Facultad Regional de: Buenos Aires, Delta, Paraná, Escuela de Educación Técnica Nº 8
IRICE member in person	María Isabel Pozzo
News on the web	Link Faculty in UNSE: http://www.unse.edu.ar/index.php/editar/2963-se-dictara-taller-internacional Link home UNSE: Taller de capacitación
Own VISIR?	No
Technical Training Action	No

[a] It refers to periods pre- and post-lunch (morning and afternoon). It does not take into account coffee breaks within each turn.

A. *Session arrangements*

The schedule for each session was agreed through emailing between the Latin American host (UNSE) and the European guests in charge of TA2 (UNED). The process for the agenda scheduling started the discussion a month in advance exchanging a vast number of emails about the TA2 programme. In spite of the period of the year when TA2 had to be scheduled, i.e. summer recess in Northern hemisphere, no delayed in communication pre-TA2 occurred between them. The guest lecturers carried out exploratory enquiries about the TA2 participants (number of attendees, their work, interests, etc.), time load distribution for the sessions and connectivity. It is important to remark there were no previous work experiences between these two partners, neither on remote labs nor on any other topic. All participants had the event programmes at least a week in advance when enrollment was open.

B. *TA2 Participants*

The objectives set for TA2 recommended that at least one person from the associated partners (two per project partner) should also have attended TA1. In fact, while TA1 provided a first approach to VISIR, TA2 was supposed to train those teachers already willing to use VISIR in their classes, with a specific course in mind. As regards the TA2 audience, Santiago del Estero meetings had a high number of participants (about 30) who represented Partners and Associated Partners, both higher-education institutions and secondary schools. Some Higher Education participants came from different towns even some far away from Santiago del Estero such as Buenos Aires, Campana, Corrientes, Paraná, Reconquista and Tucumán (Fig. 2). They joined the TA2 as members of the Federal Council of Engineering Faculties Deans' (*Consejo Federal de Decanos de Facultades de Ingeniería* - CONFEDI) initiative designed to foster dissemination of VISIR in Argentina.

Fig. 2: Cities of origin of the attendees.

It is worth taking into account that not all attendees are supposed to adopt VISIR in their classes. It should be also pointed out that not all participants who had been enrolled could attend every module of TA2. Participants were given a certificate of attendance to TA2 issued by the local institution as responsible for the organization.

C. *Lecturers*

As stated in the VISIR+ project, Professors and technicians from European Higher Education institutions should be in charge of lectures in every TA2 session. In Santiago del Estero, there were two lecturers: a senior professional and a junior one. Beyond differences, both lecturers evidenced sound professional background and presentation skills.

They spoke the same language of the audience, a fact that stands as a great difference comparing communication during TA1, not just as regards listening comprehension but still most important as to the possibility of asking questions or sharing queries [17], [18].

The quality analysis of lecturers implies some aspects connected with oral presentations. Language and voice quality become important aspects in communication, and even when pairs of HE institutions share the language, there are notorious difference in dialects (Spanish and Rioplantense). For this reason, this quality of trainers' competences is included in the quality assessment. Apart from language aspects and presentation skills, the lecturers managed to create an empathetic atmosphere during TA2, which contributed to sustain the audience's interest. European professors' visits

were not unnoticed. They were welcome by UNSE authorities and were given presents and certificates Also interviews and articles were published on institutional website: http://erasmus-visir.unse.edu.ar/.

D. Training sessions

The time load of agenda covered eight shifts. During the sessions, lecturers presented the VISIR+ Project and developed technical, practical and didactic aspects of the VISIR remote lab. Training methodology was mainly interactive with the audience. Questions and comments about typical problems in the academic and technical fields were made from the start. The questions and queries posed by the audience facilitated the observation of attendees' attention and interest. The practice activities, such as accessing lab, designing circuits, measuring and analyzing results, got attendees involved in the lab use straightaway. The higher time load and the larger number of attendees at UNSE facilitated a fluid interaction between lecturers and audience. The presentation methodology was coherent with the enquiry-based principles which underpin the VISIR+ Project, i.e. "lecturers practiced what they preached". In fact, during lab practice activities lecturers encouraged both a trial and error approach and a heuristic process in the way questions were posed; attendees were asked about their own experiences with labs and they were invited to compare and contrast education and technical pros and cons in the use of labs (hands-on, remote and simulators), (Table II).

All presentations were supported by Powerpoint, a device that proved efficient: slides had signposts to guide the talk; slides also showed diagrams or charts summing up main concepts or key questions and activities. Images (photos, pictures, etc.) were also used efficiently to illustrate equipment or ideas. One of the lecturers handed out worksheets with activities to be worked out during the sessions, from simple circuits and examples to more detailed one, including some more complicated ones like switched converters using a black-box on board circuits connected to VISIR to allow the study of real components and circuits and the variation of the real characterization of some components with the heat and the temperature.

TABLE II: AN EXCERSICE COMPLETED AT TA2 BY THE ATTENDEES

	Advantages	**Disadvantages**
Simulator	*Flexible, generic, accessible* *More relaxed attitude* *It prepares for the real lab*	*Everything works* *Complexity*
Virtual lab	*It simulates something real*	*It's specific* *It depends on the internet*
Online lab	*It simulates something real through Internet* *No specific setup or configuration*	*Internet bandwidth use*
Remote lab	*It's real* *Access to expensive equipment* *I can see what others do.* *Safe design* *It needs less physical space* *Users' inversion is smaller.*	*It may not work or it may not be maintained.* *It relays on internet connection.* *They do not seem real* *They are usually unique users* *They may get burned* *Software messages*

As to the session organization, they started with a general presentation about the Project VISIR+, the Higher Education partner institution (UNED), the objectives and the local institution role. The institutional presentation -such the origins and careers- proved an effective decision to create a familiar environment and contextualize the project. As the sessions had much time allotted, this presentation did not interfere with the target training. The IEEE (Institute of Electrical and Electronics Engineers) [19] was also presented, taking advantage of one of the trainer's direct experience with that institution. The presentation included a reference to UNED's remote labs, especially VISIR. In regard to reference to own institutions, a description of CONICET [20] was also presented so as to let the audience know about the possibilities of financial support for scientific meetings or doctoral scholarship applications for young postgraduates. Although most participants were from Argentina, information proved new to most of them.

Resuming session content description, lectures described the characteristics of VISIR, pointing out the difference between remote and virtual labs. VISIR was presented as a complementary (not exclusive) instrument, emphasizing the essential role of the teacher, a premise that underlies the project objectives. Theoretical and technical aspects about VISIR performance were explained along with plenty of illustrations.

All sessions included practices, although some were negatively affected by inadequate Internet connectivity. It is also worth mentioning that due to administrative obstacles to a swift acquisition process, UNSE could not have a VISIR system physically installed on its site at the time of TA2.

E. Institutional Visits and Social dimension

TA 2 also included visits to Higher Education institution premises. UNSE decided to guide guests around their labs at their request.

Apart from strictly academic aspects, social relationships between Latin American and European members can be analyzed, as bonds were strengthened due to time available for free conversation. More than that, training sessions included social moments organized by the host institutions. All social meetings were in a cordial atmosphere at typical gastronomic and cultural sites in the host city. All events showed a careful and dedicated attention to visitors. Although these dimensions could appear detached from academic aspects, they turned out to be necessary to overcome temporal and space distance and suitable to support the agreement signed with the Project.

V. POST - TA2 STRATEGIES AND FUTURE CHALLENGES

Once TA2 finished, trainers shared their complete support documents so that Higher Education host could count on them. All Powerpoint presentations were uploaded into a VISIR+ Project Dropbox folder, not only for the attendees but also to share news about the sessions with other project partners. Trainers also invited participants to exchange their own experiments about circuits.

As an audiovisual record, UNED-UNSE TA2 was totally videotaped, and an edition of it will be available from the University website devoted to VISIR.

Taking into account that VISIR system has not been installed at UNSE yet, it is important to consider how the paired institutions have agreed on the post-TA2 working plans. The European lecturers have provided a user list with the TA2 participants' names and have given them credentials to access VISIR from UNED; they could then try experiments and eventually use the lab with students. In such a way, difficulties with VISIR equipment purchase and delays with the actual work with VISIR Lab may not be felt with disappointment, as it may be translated into professors' reluctance to planning and the year 2017 may take them unprepared.

In order to evaluate the impact of the training action, the team in charge of quality monitoring of the VISIR+ project implemented a satisfaction questionnaire elaborated ad hoc. Without going into any detail, from the results of TA2 Satisfaction Questionnaires, some conclusions can be drawn as to the satisfaction level reached by participants' answers. Most attendees express interest and understanding about the VISIR remote lab. However, planning and application remain as a road ahead. Although the number of participants at TA2 may imply a successful first step, the challenge now is to support a large group that is geographically scattered, due to the participants from the CONDEFI's sub-project. In this regard, local coordinator and his team need to set up channels for fluid communication and follow up of target courses where VISIR will be implemented. It is advisable to profit from the engagement that TA2 sessions prompted and to boost planning for active participation on VISIR implementation in classes.

CONCLUSION

This paper show the first steps in the introduction and delivery of new Remote Laboratories using VISR in Latin America sharing educational experiences that could be used inside classroom as well as they will be reinforced from a collaborative laboratory environments for the set-up and start-up of the new systems.

The VISIR+ project is in the middle of the development and is the first two training actions allow to collect a lot of information regarding the use of this new technology system at the new institutions.

VISIR+ developments and the implementation of the new VISIR labs as part of the system will increase the level of synergy that the new project, PILAR, will explode and will integrate within the European partners inside a federating system to provide a new level of service for internal and for external users.

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