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A teacher training workshop to promote the use of the VISIR Remote Laboratory for electrical circuits teaching

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***Abstract*— The learning of Physics involves building up and using lab experiments. In turn, teachers must be trained in experimenting and using several resources that enable them to design valuable teaching strategies and learning activities. Thanks to Information and Communication Technologies (ICT), virtual and remote labs can provide a framework where physical experiments can be developed. Altough remote labs have been in use for over a decade now in several countries and levels of education, its use at secondary schools in Latin America has not been reported yet. The Virtual Instruments System in Reality (VISIR) is one of these remote labs, suitable to practice in the area of electrical circuits. This paper aims at describing how this remote lab was used in a training workshop for secondary school level teachers of Physics in Costa Rica.**

Keywords—remote labs; VISIR; physics; teacher training; electrical circuits

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I. Introduction

In knowledge-based society there is consensus about the important role education plays in the development of peoples and undoubtedly technological progress is offering new learning spaces. During the process of selection, adjustment and/or design of teaching strategies by teachers, it is relevant to have the infrastructure that facilitates the use of technological resources, communication and administration of learning spaces, as well as specific technological resourses for teaching purposes.

At the same time, knowing the resource and its ability to promote the desired learnings makes it possible for the teacher to feel confident carrying out educational processes with that resource. The study developed by Nikolopoulou and Gialamas [1] identified three barriers to using computers in the classroom seen by secondary school teachers in Greece: “lack of support”, “lack of confidence” and “lack of equipment”.

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On the Costa Rican scale, in a study carried out by the National State Programme relevant data have been found concerning teachers’ training; among them, it stands out the need for teachers to know about the most recent advances linked to theories, strategies and resources on their own field of knowledge, as well as research, systematisation and testing strategies in order to think about their own work and thus improve their teaching practices [2].

Furthermore, it is clear there is need for greater use of digital resources in the classroom in order to improve students’ learnings [3]. The scarce use of those resources turns out to be limiting when willing to take part in updating processes [4].

Teachers’ continuing training is clearly necessary so that they are able to use the available technological resources accurately.

In order to understand the issue concerning Costa Rican secondary school teachers’ updating, the Ministry of Public Education (MEP) set out the ongoing training plan aimed at optimizing, systematizing and creating clear courses of action on the fields of continuing training [5].

In spite of the interest for improving teachers’ training and increasing the use of technological resources in the teaching process, in Costa Rica the number of secondary level institutions that have science labs is small, and there is a great concentration of institutions with labs en the Big Metropolitan Area [6] and much less in the rest of the ground.

In the case of Mexico, secondary school teacher training actions in the use of information and communications technology have been started, with encouraging results [7].

On the other hand, in Costa Rica the Internet range rises up to 83,7% of the population and an even bigger percentage in territorial range [8], thus being the leading country in Latin America, so they can take a chance on this means and use online technological resources to promote experimental work at secondary school. In this context, Remote Labs (RL), might play an important role and have a beneficial impact on the Costa Rican and Latin American secondary school teaching, as is the case of Brazil and Europe [9], [10], [11], [12], [13].

VISIR is a well-known remote lab especially developed to experiment on electrical and electronic circuits. It is a client-server architecture where measurements are carried out by using a server. The front panels of the instruments are displayed on the personal computer screen [14].

Whereas a student in a real lab working on electrical circuits must wire up circuits and connect instruments, a remote student must use an accurate telemanipulator instead of a welder in order to carry out such activities. VISIR specifies a relay switching matrix and a virtual breadboard combination [15].

With the goal of spreading the knowledge about the VISIR, in the framework of the VISIR+ project funded by the Erasmus+ Program, European universities that have the experience of using this RL will transfer it to Latin American institutions. Teams from the Facultad de Ciencias Exactas, Ingeniería y Agrimensura at Universidad Nacional de Rosario (UNR) in Argentina and from Deusto University (Spain), among others, take part in this project [16].

One important stage in the project consists of exploiting the remote lab teaching resources, sharing the experiences of the European groups with their peers in Latin America, through workshop training actions. During the first training action that was held in Rosario (Argentina) in September, 2016, staff from Deusto University introduced the VISIR remote lab to more than 25 trainers, lecturers and professors from different parts of Argentina that were interested in discovering the possibilities offered by the VISIR [17].

One of the participants of this training action belongs to the Universidad Estatal a Distancia (UNED) from Costa Rica and is part of the team at UNR in the framework of the VISIR+ project. He himself developed a teachers' training workshop about the use of remote labs for the teaching of electrical circuits, in the framework of the II Seminar of the Latin American Association of Research on the field of Education in Sciences (LASERA), held in San José de Costa Rica.

The workshop was addressed to secondary school and university teachers, from Costa Rica and Mexico with two aims: firstly, to announce the VISIR RL through the experimentation with such resource, and moreover, to know about the participants' perception about it.

The aim of this work is to show the results of the workshop mentioned before, as well as to value the potential use of the VISIR in the teaching of Physics at secondary school in Costa Rica.

II. METHODOLOGY

Eighteen teachers of Physics took part of the workshop; fifteen out of them were Costa Rican who work as secondary school teachers, two of whom work as science advisors as well; three are from Mexico who work respectively at the secondary, pre-university and higher educational levels.

The training consisted of two two-hour-long meetings each during two non consecutive days. The work was coordinated by a teacher member of the UNR team, previously trained through the beforementioned training action held in Rosario.

During the workshop, the following activities took place:

- An introduction about the concept and use of RL, showing the participants some projects containing remote practices aimed at the teaching of Physics displayed in a recent study [18].

- Usernames to enter the RL were provided; they were used to work on the VISIR WebLab-Deusto environment, at Deusto University (Spain).

On the very first workshop day an introduction to the RL was done and a tour around the VISIR, its commands, the building up of single circuits and the working of the protoboard was carried out through some instructional-like activities.

On the second meeting, two days later, those present worked on the building up of series and parallel circuits with resistors and on the measuring of the value of the equivalent resistance, as well as RC circuits in direct current in order to check Ohm's law through experiments. In this instance, a guided-learning methodology was used.

- The topics treated were dealt with as problems to be solved through experiments: Resistances measurement and Ohm's law.

- The instructions given on a printed guide were to do the following activities:

1. Place a 1-kΩ resistance and measure its value. What conclusion can you draw from such measurement?

2. Build up a series circuit with values resistance: 1 kΩ and 10 kΩ. Calculate the equivalent resistance and measure the equivalent resistance value with the VISIR by using the multimeter.

3. Build up a parallel circuit by using the resistances in the previous paragraph; calculate the equivalent resistance and measure its value on the VISIR.

4. Build up a combined circuit. Place a 1 kΩ series resistance with two 10 kΩ resistors both in parallel. Measure the value of the resistance.

5. Build up a circuit by using three resistors, one 1 kΩ - series with two 10 kΩ resistors both in parallel, connected to 10V voltage. Measure the current circulating in each resistance. What is the difference with the results obtained by using Ohm's law?

- The circuits to be built up were suggested by the workshop coordinator, but each participant chose their own building on VISIR. Most teachers showed to have clear ideas about the theory involved, however in some cases the workshop coordinator or other participants were asked to help

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them. In other cases, despite having built up the circuit well, the reading on the multimeter was mistaken, so they were explained that the only suitable setting ups are the ones previously developed by WebLab-Deusto. In Figure 1 we can observe part of the group working in the workshop, and in Figure 2, we can see the screen snap-shot of a circuit built up by one of the participants.

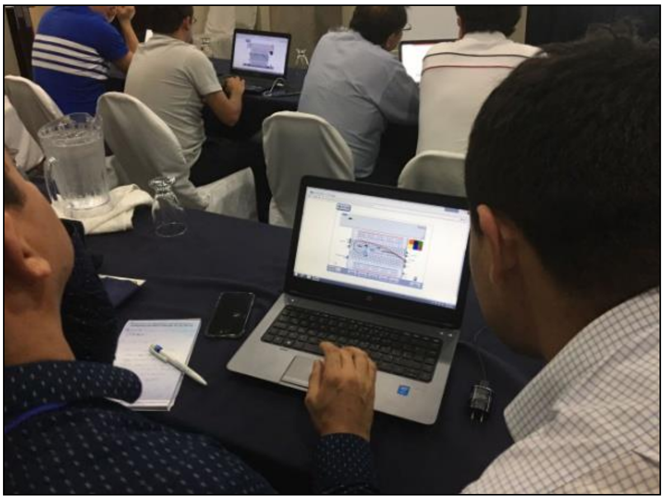

Fig. 1. Working with the VISIR.

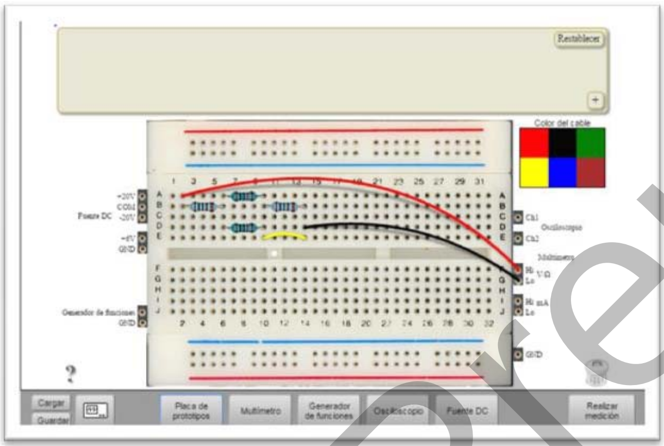

Fig. 2. Circuit built up on VISIR by a workshop participant.

At the end of the workshop a survey consisting of 13 items with multiple choice answers on Likert scale was carried out. Apart from the survey, participants were asked an open question, Q14. Which do you think are the advantages of these tools in the teaching and learning process? and they were invited to expose the comments they considered relevant. (Q15).

The results of the survey were analysed with the SPSS-18 Software.

III. RESULTS

Most of the participants work as secondary school teachers (89%), one of them performs at preuniversity level (5.5%) and another one at higher level (5.5%).

Table 1 shows the results of the survey, stated from a 1-5 Likert scale, being 1 Completely in disagreement and 5 Completely in agreement.

TABLE I. : LIKERT SCALE AVERAGES

SURVEY AVERAGES	
Question	*Average*
1. Knew what a Remote Lab is (RL).	1.68
2. Had used a RL before.	1.21
3. I believe I might use a RL in my lessons.	4.42
4. VISIR can help me in the subject: concepts learning, practices, projects, etc.	4.53
5. When using VISIR I have a feeling of reality and it is like I am inside it. I feel it is not a simulation.	4.32
6. It is a good idea to extend VISIR to other teachers and students.	4.68
7. I have enjoyed using VISIR.	4.68
8. VISIR is useful, what it provides is close to my teaching needs.	4.21
9. VISIR is easy to use, it is usable.	4.42
10. Measurement, feeding and assembling instruments are easy to use with VISIR.	4.37
11. Measurement, feeding and assembling instruments are well chosen with VISIR.	4.47
12. I would like to use VISIR in my lessons.	4.63
13. In general I am satisfied with VISIR.	4.63

Figure 3 shows the results of answers to question 1: 77.8% of participants expressed that they did not know about RLs, and only four participants (three of them secondary school teachers and the other one preuniversitary level teacher) point out that they know about them quite well. Two participants out of the last ones are Mexican and one of them is from UNED at Costa Rica.

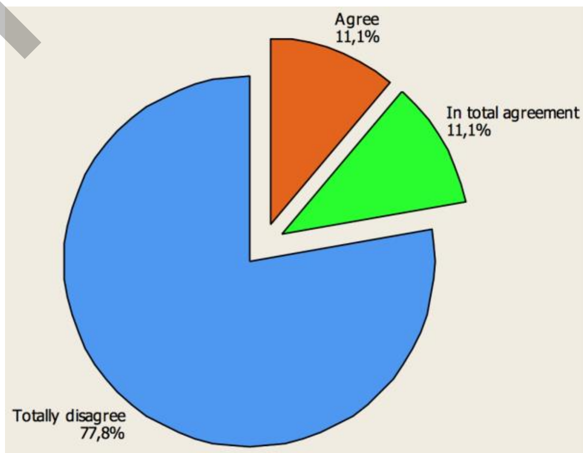

Fig. 3. Answers to question 1: Knew what a Remote Lab is (RL).

Figure 4 shows the results of answers to the second question. 88.9% of participants had not used a RL before. Only two participants (one from Mexico, preuniversity level and another one from Costa Rica, secondary school) mention having used them.

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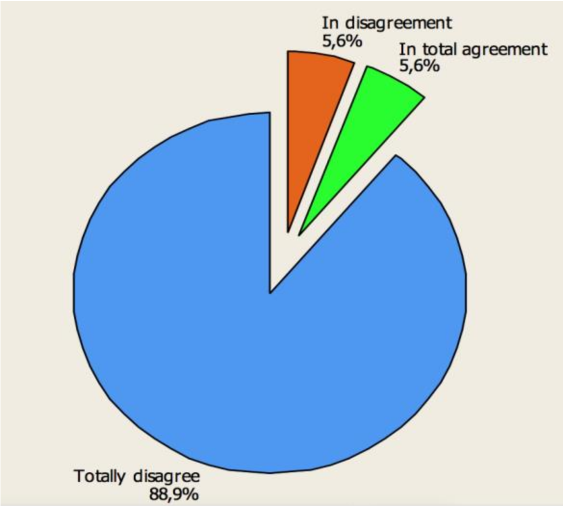

Fig. 4. Answers to question 2: Had used a RL before.

A. Experience of use of the VISIR

Figure 5 shows the amount of accesses per user. Three with over 10 accesses each, nine with between 3 and 9 accesses and six with only 1 or 2 accesses were recorded, which means an average of 5 accesses per participant.

Taking into account that the workshop was developed in two meetings and that it also had a very good Internet connection, which allowed us to work continuously without Internet drops, the average 5 accesses per participant shows VISIR accesses after the workshop.

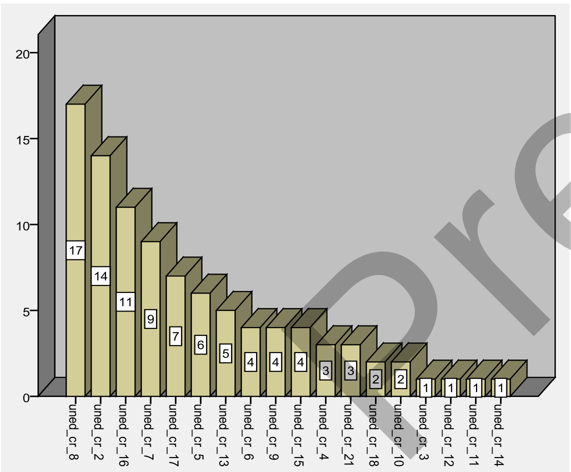

Fig. 5 Amount of accesses per user to WebLab-Deusto VISIR.

A total of 95 accesses were recorded (Figure 5), being user codified as uned_cr_8 the one with the highest amount of accesses to RL (17 accesses), recording a total 3996 s. use time. However, user uned_cr_13 was the one who recorded the highest total connection time to RL, 7880 s, with five accesses. The total use time by users was 72233 s, with an average 4013 s, that is, over an hour.

Items 5, 7, 11 and 13 in the survey belong to issues related to experiments carried out by participants with the VISIR. The average score given to this group was 4.44, which shows that participants greatly agree with the experience of using VISIR in the workshop.

The highest items score in this group belongs to question 7, which refers to the fact that participants have enjoyed using VISIR.

B. Potential use of VISIR

Questions 3, 4, 6 and 12 in the survey try to explore the expectations and posibilities of using VISIR in the teaching of Physics, within the context of the educational reality for each one of the participants.

The average score obtained in these items was 4.56, showing excellent prospects for the use of VISIR in the future.

The highest score in this group belongs to item 6, relating to the use of VISIR by other teachers and students. Although we could think that this highly favourable answer is the result of the enthusiasm shown after the experience of using WebLab-Deusto VISIR in the workshop, it is worth mentioning that one of the participants of the workshop is already using the WebLab-Deusto VISIR at the Instituto Tecnológico y de Estudios Superiores de Monterrey, popularly known as Tecnológico de Monterrey (TEC) in Mexico. Furthermore, the VISIR will also be used during the first four-month period in the Physics IV class at UNED in Costa Rica.

The answers to open question Q14, referring to the advantages participants consider RL might have on the teaching and learning process, illustrate the competences students can achieve. Some of the answers were:

- *It brings to reality theoretical processes which are more tangible through testing.*
- *It allows us to verify by manipulating elements.*
- *There is the possibility to carry out experiments in institutions where there are no labs.*
- *Students can work individually and create their own circuits.*
- *It is useful, but a good Internet connection is necessary.*
- *I think they would motivate students.*
- *Carry out experiments that cannot be done at secondary school due to lack of labs.*

Among the additional comments, one of the participants pointed out that at secondary school there is no training where tools for experimental work in class are suggested; it matches the results obtained in a recent study in which the inquirements turned around some technological resources used at Costa Rican secondary school [19]. RLs, like other resources, are practically unknown by the sample studied. In this regard, it is a good idea to promote the use of VISIR at Costa Rican secondary schools, taking into account that the academic advantage offered by VISIR is its adaptability both to the university level context and to the secondary school level [20].

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IV. Conclusions

According to the results mentioned before, the general assessment on the use of VISIR in this workshop was highly positive, both as regards the participants' point of view about the potentiality of the resource as about their interests and/or motivations to use it in their lessons in the future.

Most teachers taking part in the workshop did not have previous knowledge about RLs, and after a four-hour workshop, they showed great satisfaction experimenting with VISIR and they agreed that it is a resource that can be used in secondary level education and thus involve students in experimental work.

After these results, the next step is to carry out a pilot experience on the use of VISIR at secondary school level in Costa Rica; for this the use of the RL can be established from Deusto University or from Universidad Nacional de Rosario (Argentina), with whom the Universidad Estatal a Distancia (Costa Rica) already has an international cooperation agreement focused on Physics remote teaching [21].

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