

# *The VISIR+ Project – Preliminary results of the training actions*

M.C. Viegas<sup>1</sup>, G. Alves<sup>1</sup>, A. Marques<sup>1</sup>, N. Lima<sup>1</sup>, C. Felgueiras<sup>1</sup>, R. Costa<sup>1</sup>, A Fidalgo<sup>1</sup>, I. Pozzo<sup>2</sup>, E. Dobboletta<sup>2</sup>, J. Garcia-Zubia<sup>3</sup>, U. Hernandez<sup>3</sup>, M. Castro<sup>4</sup>, F. Loro<sup>4</sup>, D. Zutin<sup>5</sup>, C. Kreiter<sup>5</sup>

<sup>1</sup>Polytechnic of Porto –School of Engineering, Porto, Portugal: mcm@isep.ipp.pt; <sup>2</sup>National Council of Scientific and Technical Research, Rosario, Argentina; <sup>3</sup>University of Deusto, Deusto, Spain; <sup>4</sup>National University of Distance Education, Madrid, Spain; <sup>5</sup>Carinthia University of Applied Sciences, Villach, Austria

*Abstract—Experimental competences allow engineering students to consolidate knowledge and skills. Remote labs are a powerful tool to aid students in those developments. The VISIR remote lab was considered the best remote lab in the world in 2015. The VISIR+ project main goal is to spread VISIR usage in Brazil and Argentina, providing technical and didactical support. This paper presents an analysis of the already prosecuted actions regarding this project and an assessment of their impact in terms of conditioning factors. The overall outcomes are highly positive since, in each Latin American Higher Education Institution, all training actions were successful, the first didactical implementations were designed and ongoing in the current semester. In some cases, instead of one foreseen implementation, there are several. The most statistically conditioning factors which affected the outcomes were the pre-experience with remote labs, the pre-experience with VISIR and the training actions duration. The teachers' perceptions that most conditioned their enrollment in implementing VISIR in their courses were related to their consciousness of the VISIR effectiveness to teach and learn. The lack of time to practice and discuss their doubts and the fulfillment of their expectations in the training actions, also affected how comfortable in modifying their course curricula teachers were.*

**Keywords—Remote Labs, VISIR, Didactical Approaches**

## **1 Introduction**

Engineering students need to perform experiments in order to full understand theoretical concepts thoroughly as well as to interact with instruments and equipment efficiently [1], [2]. These experimental competences, which traditionally could only be developed in hands-on laboratories, allow students to consolidate knowledge and skills, preparing them to their futures jobs as engineers. The use of simulations and remote labs has been growing exponentially over the last decades. They provide not only an alternative and/or complementary way to develop experimental competences, but also becomes a resource that potentiates students' autonomous learning activities and supports lifelong learning [3], [4]. Furthermore, the use of Information and Communication Technology (ICT) tools can provide a stimulus for today's generation since they have been immersed in a world infused with network and digital technologies [5].

Although there is still some controversy about web-based laboratories efficacy [6], a recently and exhaustive study main conclusion [3] is that student learning outcome achievement is equal or higher in non-traditional simulation and remote labs versus hands-on traditional labs. Nowadays, these resources are being widely used by teachers who are aware that the educational objectives associated with each of these resources differ, as each allows the development of different competences [7]. Remote labs are becoming a popular learning tool, as they allow to get real experimental results as opposed to computation model results obtained by simulations. A remote laboratory is a real lab, in which the user and the physical apparatus are physically apart. To perform the experiment, the user has to access the Internet and usually a particular user interface to operate the remote equipment [8], being able to configure and control the physical parameters of a real experiment.

Considering the advantages of this educational resource, which include education and research collaboration between institutions all over the world, several remote labs have been developed and enhanced over the years, in many different areas [9]. Within scientific disciplines, this resource is most widespread used in electrical and mechanical engineering [10]. Virtual Instrument Systems in Reality (VISIR), developed by Blekinge Institute of Technology (BTH) in Sweden, is one of the most used labs in Engineering Education. It deals with experiments with electrical and electronics circuits and was considered in 2015 the best remote lab in the world by the Executive Committee of the Global Online Laboratory Consortium [11]. Several VISIR systems already exist in Europe as well as in Asia (India), and with the support of the VISIR+ project, a consortium between the European countries using VISIR, Brazil and Argentina [12] it became possible to spread its usage throughout these two Latin America countries. Reaching the midterm point, the VISIR+ project is now assessing the preliminary results in order to improve and tune the following tasks.

This work presents the preliminary results of the Training Actions (TA) within the VISIR+ project. First the VISIR remote lab and the VISIR+ project will be presented in section 2, with a special focus in the description of the TA's. The problematic tackled in this work, assessing TA impact, is fully explained in section 3. In section 4, some results are presented and analyzed in section 5. Finally, in section 6 some preliminary conclusions are drawn.

## **2 VISIR Remote Lab and the VISIR+ Project**

As previously stated, VISIR system is a widespread remote lab used mainly in the study of electrical and electronic circuits, with increased popularity in the last 5 years [13], mainly due the intrinsic advantages of being a remote lab: accessibility, availability and safety - since the users are not exposed to any electrical signal, and in turn they are not able to damage the physical equipment, due to a series of protection layers that prevent this. The only physical interaction between the user and the real equipment is through a computer interface (or more recently, a smartphone or tablet) which replicates a physical breadboard, showing all available components and the instrument front panels (Fig.1), which enables the user to connect the desired circuit and analyze its behavior with several instruments [14], [15].

The feeling of immersion in this remote lab is provided by accurate replication, either of the breadboard or the instruments front panels [8]. Dragging the available component with the mouse and positioning in the breadboard, replicates the action of grabbing a

component with the fingers and mounting it in the breadboard, in real labs. It is mainly this similarity to a real lab working environment that leads to user's opinion of considering VISIR as a complementary and useful resource to hands-on, simulation or other resources, such as calculus or theory. Each one of this type of resources can address different skills and develop distinct competences during the learning process. Being a remote lab, the major unpredictable drawback can be the quality and reliability of the network/internet connections, which can become a handicap in regions or countries with a less efficient internet service provider. This aspect, although not directly related to the VISIR system itself, has been considered a cause of the loss of interest and subsequent lack of motivation among teachers and students.

Some of the published work related to VISIR [8], [13], [16], [17], [18], [19], [20], [21] although also concerned with aspects related to the use of computer-based tools or systems, has been mainly focused on the learning process, either from the student's or teacher's perspective. The overall perception of the students is positive, although in many cases, this was not directly reflected in their final results within the course, in spite of teachers' perception considering VISIR as a good complementary tool for hands-on practice. In fact, globally, VISIR is considered a need-to-have tool whenever teachers are interested in diversifying their teaching methodologies by addressing in this way an increasing number of students with various learning styles, as well as by easily motivating the new tech-savvy student generation. On the other hand, teachers of this new generation have to share the same technological interests, being willing to learn new technological based approaches.

The VISIR+ project aims to define, develop and evaluate a set of educational modules related to the subject: electrical and electronic circuits theory and practice, comprising hands-on, virtual and remote lab (VISIR), together with calculus, applying an enquiry-based teaching and learning methodology. The stated aims of the project are threefold: to contribute in providing the labor market with high-skilled professionals in the area of Electric and Electronics Engineering; to contribute to student's dropout's reduction; to contribute to the increase of STEM careers appeal. The main goal is spreading the usage of VISIR among Brazil and Argentina, first with the Latin American (LA) partners and then replicating the phenomenon amongst their associated partners (AP). The specific objectives aim at helping teachers to enrich their course curriculum on electric and electronic circuits including hands-on, simulation and remote-labs and at encouraging teachers scaffold students' learning and foster their autonomy. They also aim at increasing students access to lab experiments with no restrictions on time, schedules or availability, providing them opportunities to improve their competences development (namely when comparing experimental results from different resources) and contributing to the support of their continuous assessment and success rates. Since VISIR is being used by several Higher Education Institutions (HEI), mainly in Europe, for the past years, the technical and didactical experience gained by the five Europeans Institutions partners (EU partners) in the project, is now being shared with five Latin American Institutions (LA partners). Their characteristics and main role within the Project are described in Table I.

Apart from spreading VISIR usage, the project includes the VISIR system purchase by each HEI in LA, fostering their sense of ownership and contributing to enlarge the VISIR community. BTH is the EU partner in charge of technical support during installation and organizing a training technical workshop for each technical team. Overall, the project purpose is to enlarge the VISIR usage community by progressively enlarging its coverage: firstly, through a one-to-one relation between EU and LA partners, where the EU partner acts as the tutor; and secondly each LA HEI partner with their AP, working

closely with LA HEI, also implementing VISIR in their courses. These AP involved serve different education levels (higher, secondary and professional).

TABLE I. VISIR+ PROJECT PARTNERS INSTITUTIONS DESCRIPTION

Partner	Higher Institution Characteristics	Main Role in the Project Liaisons
IPP-ISEP (Porto, PT)	Public Higher Education Institution > 18,500 students (6,500 engineering students) Eng. Courses: 11 BSc + 11 MSc + 10 R&D Units	Leader + Tutor of IFSC and UFSC
UNED (Madrid, ES)	E-learning Academic Institution > 260,000 students 27 Grad. St. including Eng. + 43 MSc + PhD Programs	Tutor of UNSE
UDEUSTO (Bilbao, ES)	Private Non-profit University 11,000 students 23 BSc + 5 deg. + 39 MSc + 12 MSc + 10 PhD Programs	Tutor of UNR
BTH (Karlskrona, SE)	Public Higher Education Institution 5,900 students	Technical Support to all LA Partners
CUAS (Carinthia, AT)	Public University 1,700 students in Engineering, Health and Business 30 BSc + MSc	Tutor of PUC-Rio
IFSC (SC, BR)	Public Higher Education Institution 24,000 students	VISIR installation + VISIR implementation
UFSC (SC, BR)	Public Federal University 34,000 students	VISIR installation + implementation
PUC-Rio (RJ, BR)	Private Non-profit University 15,000 students	VISIR installation + implementation
UNSE (Santiago del Estero, AR)	National Public University >12,000 students (1,200 engineering students) 19 Undergraduate courses + 4 postgraduate courses	VISIR installation + implementa- tion
UNR (Rosario, AR)	National Public University > 74,500 students 124 grad courses + 10 undergrad eng courses + 19 post graduate eng. courses	VISIR installation + implementation
ABENGE (BR)	Engineering Education Association > 40 years > 4,000 members	Dissemination & Exploitation
CONICET – IRICE (AR)	National Council of Scientific and Technical Research > 50 years > 9,000 researchers	Data Collection and Quality Monitoring

In order to guarantee the implementations success in all LA HEI partners and AP, three TA's were defined in different project stages. The first two have been performed by the EU partners and the third one will be carried out by each LA HEI partner in their AP. The objective was to replicate and enlarge the community of usage, share experiences, render its advantages and contextualize their implementations. In order to better understand the outcomes obtained from the different approaches and the insights, an external observer was present in all TA's. TA1 took place in Europe and its goal was to introduce VISIR and its capabilities, where each EU partner shared their experience. The TA2 meant to specifically address teachers' needs (in each institution), particularly to those implementing VISIR in their classes. TA2 took place in each target LA HEI. The TA3 was designed to be delivered by LA HEI teachers who used VISIR and to take place in their AP, with the objective of sharing their own contextualized experiences and involving more teachers. The TA's are sequential and intended to support the different implementation phases, where the 1<sup>st</sup> implementation phase is meant to be unique - one course per LA HEI, and the 2<sup>nd</sup> phase is meant to spread into several implementations. The 3<sup>rd</sup> phase is meant to occur both on LA HEI partners as in AP. In sum, the major

outcomes of the VISIR+ project will necessarily be: trained local technicians, trained local teachers, educational modules development and enlargement of the VISIR facilitators group.

### 3. Assessing TA's impact Methodology

At the present stage of VISIR+ Project development, not all planned actions for each LA HEI partner took place, namely the VISIR acquisition. In most cases economic and administrative constraints delayed the acquisition procedure. Still, and due to the remote lab characteristics, the project actions "TA2" and "1<sup>st</sup> implementation" could be performed successfully by using the EU partner's VISIR system. In order to better understand TA impact in those circumstances and preview steps to corrective/redirect the development process, the action results were assessed.

#### 3.1 Focus

This paper presents the preliminary results of two Training Actions (TA1 and TA2). As in most didactical implementation, teachers' perception of different tools, their receptivity and motivation to change their classes, strongly conditions the outcomes. So, the global impact of these TA is probably a good indicator of teachers' interest and the success of subsequent implementations. The goal of this study is to assess each LA HEI implementation and analyze their differences in order to adjust the following phase of implementations. The research questions are: *Which factors can be considered important in terms of conditioning the TA and the didactic implementations using VISIR? Is there any relation between TA characteristics and the implementations designs?*

#### 3.2 Approach

The research methodology used is a Multi-Case Study [22], in which five cases (LA HEI Partners) will be presented and assessed. Due to the diversity of contexts, backgrounds and experience, there were natural differences between TA's, even though a common base had been established. In order to characterize these differences three categories were defined according to their timeline: pre-TA; during TA and post-TA (Table II).

TABLE II. CATEGORIZATION OF POTENTIAL FACTORS OF IMPACT

	Factor	Categorization
Pre-TA	HEI type	Public / Private
	HEI dimension	Big / Medium / Small
	Pre-experience with ICT tools	large / some / none
	Pre-experience with remote lab	large / some / none
	Pre-experience with VISIR until TA2	large / some / none
	Owned VISIR in TA2	yes / no
During TA	TA Dissemination among HEI	large / focused on target teachers
	EU team approach in TA	interactive/ some interaction/ interaction postponed to the end
	TA duration	1 day – 4 days
Post-TA	TA language use	Native / English
	Number of on-going implementations	
	Number of teachers involved	
	Number of students involved	
	VISIR usage in the course	sporadic /frequent /continuous

### 3.3 Collected Data

The quantitative and qualitative collected data includes information about each TA, teachers' participation as attendees and their feedback (collected through a satisfaction questionnaire (SQ) [22]). The SQ, designed by researchers of IRICE, had 8 closed and 1 open question, all questions expressed in statements about the TA (Table III).

TABLE III. SATISFACTION QUESTIONNAIRE USED IN THE TA

Subject	Questions	Scale
Objectives	Q1. The objectives for the session were clearly explained	1. Unsatisfactory; 2. Below average; 3. Average; 4. Above average; 5. Excellent
Interaction between lecturers and participants	Q2. The instructor raised questions and posed problems for workshop participants	
	Q3. The lecturer was sensitive to the participants' interests, priorities, and concerns	
	Q4. There was a genuine effort to get participants involved in discussions about the use of VISIR	
Time allotted	Q5. The time allotted for presentation and discussions was enough	
The use of technological equipment	Q6. The technological equipment enhanced the effectiveness of teaching and learning	
Participants' expectations	Q7. Overall, the presentation about the VISIR system met my expectations	1. Poor, 2. Fair, 3. Satisfactory, 4. Highly satisfactory, 5. Excellent.
Practical use	Q8. How difficult do you feel about the practice for VISIR?	1. Too difficult, 2. Difficult, 3. Just right, 4. Easy, 5. Too easy.
Open question	Q9. Please write other comments you think are relevant for future workshops	

Regarding the followed activities, data also included teachers' schedule implementations of VISIR in their classes, the number of teachers and students involved in each case and the kind of VISIR's usage interaction that would be asked from them.

## 4 Training Actions and Implementations Results

### 4.1 Institutional Characteristics pre-TA

Among the five cases there were several differences in terms of the starting point of each LA HEI. This characterization identified potential factors of impact: the status of the VISIR's acquisition; Project and TA dissemination among the HEI staff and AP; past experience with ICT tools remote labs and VISIR.

Regarding VISIR's acquisition, only PUC-Rio was able to perform the planned sequence of actions: TA1 → VISIR acquisition → Technical Workshop → TA2 → 1<sup>st</sup> Implementation. In all other cases, the administrative constrains within each Institution, Governmental and European directives, forced them to resort to an alternative plan. This plan was made possible due to the resourcefulness of remote labs: each European tutors made available their own VISIR system in order to allow to plan TA2 and didactical implementations. In this case, the sequence was altered to: TA1 → TA2 → 1<sup>st</sup> Implementation → VISIR acquisition → Technical Workshop.

Concerning the Project and TA2 dissemination, there were cases where the partners assumed a general dissemination to all potential teachers and, especially in TA2, profit from the EU partners visit to enlarge the bounds with LA institutions and associated partners. This was the case for instance in UFSC and UNSE. Others, like PUC-Rio or

IFSC interpreted that TA2 was meant for the teachers already motivated to use VISIR and did not centered their efforts on encouraging more teachers to attend.

Finally, in terms of past experience with ICT tools, remote labs or VISIR, some differences are worth mentioning. UFSC uses remote labs since 1997 and were responsible for the development of the RexLab project [23]. IFSC and UNR have already used VISIR together with their tutors (IPP-ISEP and UDEUSTO, respectively) in the past [24]. Another example of previous experience is PUC-Rio, that have been using ICT tools in education for 21 years with their Maxwell platform [25]. And even though they did not have past experience with VISIR, PUC-Rio was the only HEI who actually performed a pre-implementation (within the VISIR+ Project scope), using their tutors' VISIR system, before the project-planned implementations.

#### 4.2 Training Actions Characteristics Results

TA1 was held in Europe (Karlskrona, Sweden) during the project kick-off meeting in February 2016. The EU partners shared their experience with VISIR, presenting the results of their implementations and addressed VISIRs' added-value and also some constraints to be aware. In addition to this session there was a hands-on session. TA2 took place in the LA HEI during August and September, 2016. The time load of agendas varied. During sessions, lecturers presented the Project and developed technical, practical and didactical aspects of the VISIR remote lab. In general, all attendees showed interest in VISIR. The rich outcomes of every experience exceed the present overview which focuses on Project development and quality indicators.

- Regarding TA's participation

In TA1, even though the number of teachers from each LA HEI who could participate locally was limited, teachers were able to access remotely (video streaming). TA's number of participants and SQ answers can be observed in Table IV and Fig. 1. SQ1 was taken two times, one per part of TA, which was on different days; since it did not correspond to exactly the same sample, the average was considered.

TABLE IV. VISIR+ PROJECT TA'S PARTICIPATION

Participation	IFSC	UFSC	PUC-Rio	UNSE	UNR	total
TA1	2	5	4	4	3	<b>18</b>
SQ1	3	7	6	7	6	<b>29</b>
TA2	8	50	7	31	28	<b>124</b>
SQ2	8	31	7	22	19	<b>87</b>

- Regarding the language used in TA

In all institutions, lecturers and audience spoke the same language, though some dialectal differences (Spanish and Rioplantense Spanish, Portuguese and Brazilian Portuguese) which did not interfere with communication. Only in PUC-Rio the sessions itself were in English and the interactions with the audience in Portuguese. This fact stands as a great difference comparing communication during TA1 (all in English), not just regarding listening comprehension but most important, regarding the possibility of asking questions or sharing queries.

- Regarding TA's duration

TA varied in terms of time allocated to the event itself (Fig. 2): from 1 to 4 days. Some partners thought it would also be useful to use some of the time to establish contacts and scheduled visits to other institutions (mainly associated partners).

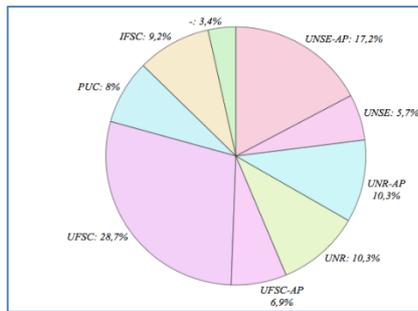


Fig. 1. Distribution of TA2 participants (HEI partner and AP) between HEI holder.

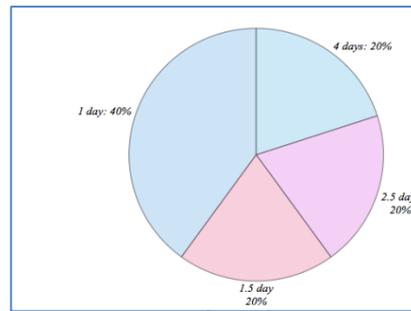


Fig. 2. Distribution of TA2 time duration (in days) in each HEI.

- Regarding TA's presentation approach used

In every TA2 session, lecturers were senior professionals, junior professionals or both. Beyond differences, all lecturers evidenced sound professional background and presentation skills. Training methodology was mainly expository, with varied interaction with the audience about typical problems in the academic and technical fields. In some HEI, interaction between lecturers and audience was postponed to the end (more notorious in UFSC and IFSC) while in some others, questions and comments were made from the start (more meaningfully in UNR and UNSE where the presentations became more interactive). This distribution is showed in Fig. 3 relatively to the five cases. The questions and queries from the audience facilitated the observation of attendees' attention and interest. The practical activities, such as accessing lab, designing circuits, measuring and analyzing results, got attendees involved in the lab use straightaway, and their questions and queries were readily answered by the lecturers.

- Regarding TA's attendees' perception (quantitative assessment)

The global feedback in both TA was highly positive which evidences the satisfaction of LA HEI. Even though EU partners were present in TA and some also answered the satisfaction questionnaire, the results shown in Fig. 4 only refers to LA' answers. In general, the global average level of satisfaction even grows in IFSC, UFSC an PUC Rio. About presentation interaction with the audience (Q2), the level of satisfaction maintains or increases in TA2. On the other hand, participants' expectations (Q7) and difficulties in practical use (Q8), maintains or decreases in almost every case. The answers in this last question had a more notorious decrease in UFSC, UNSE and UNR. PUC-Rio was the only one who had a slight increase in this question.

- Regarding TA's attendee's perception (qualitative assessment)

The purpose of the open question of the TA Satisfaction Questionnaire aimed at eliciting qualitative information about positive and negative aspects of the TA. Four main categories about aspects of the TA1 became salient after analyzing participants' an-

swers: content of presentations, VISIR practice, time management and sharing experiences. As regards content of the presentations, most answers referred to their relevance and clarity while some pointed out the fact that the content of each presentation was discrete and failed to reach common objectives (“[...] the training session is not the addition of few sessions, this must be a common session, with a set of objectives. Each of these objectives will be reached by each presenter, and so on”; “Maybe first pedagogy and after technology”). Most participants agreed that more practice with VISIR Lab equipment could have been introduced: “We had no practice hands-on”; “hands-on activity is mandatory to understand better the possibilities”; “the time allotted for practice/hands-on was null”; “I would have liked to have real practice on the setting up of components in the lab, not just using it” (our translation); “Maybe a training session with PC's doing circuits/experimenting in VISIR could be really interesting”. Timing was the aspect of the presentation which most participants referred to, although it was considered from multiple perspectives: time assigned for each presentation slot (“Speakers did not fit to their time slots, this disturbed the following speakers”; “Not enough time for all presentations and questions”; “Time allocation was uneven, so some speakers ended up with little time to explain their results” and “The time for the conference was not enough for all”); time lost (“The time to set up the presentations could be avoided by using the same computer for the entire session”) and time for more actual practice with VISIR. Finally, most participants found the presentation of EU HEI experiences an asset in the training action (“[positive] Present experiments and experiences at different institutions using VISIR”), although some argued more opportunities for open interaction could have been present (“Everything was clearly explained, however we should have kind of round table to discuss more about the experience the colleagues had had”). TA1 also had virtual streaming. Virtual attendees found the videoconference positive (“interesting”, “excellent”) although when answering Question 9, they referred mostly to technical problems: sound problems; questions asked by participants were not heard; only slides were shown during the presentation.

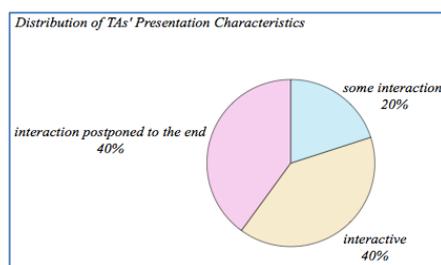


Fig. 3. Distribution of TA2 presentation approach in each HEI.

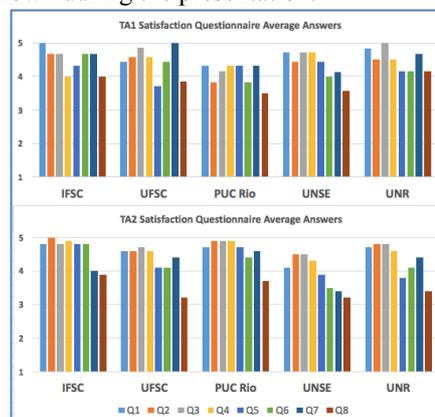


Fig. 4. Distribution of TA1 and TA2 satisfaction questionnaires results for each case.

It is worth mentioning that perspectives in the answers from EU and LA participants seem to vary widely as regards expectations and VISIR experience. Even when LA HEI attendees had experience in the use remote lab, most of them were being acquainted with VISIR Remote Lab. On the other hand, EU participants not only had a wealth of experience with VISIR Lab in their own institutions but they had also already shared

know-how with other Project EU partners by the time TA1 took place. Unlike TA1, results from TA2 Open Questions were 71 answers out of 87, which represents 81,6% total of the survey, and provided very rich information. On the positive aspects there is reference to the learning environment as regards lecturers' assets (*"kindness"*, *"clarity"*, *"feedback"*) and their presentations (*"I could understand information about VISIR and how to use it"*; *"Visual presentations were very effective"*). Also some positive comments refer to the value of VISIR Lab as a tool (*"the potential usefulness of VISIR could be observed"*). The TA organization and the possibility of attending them was also pointed out. As to the aspects to be improved, most comments refer to the need to count on more time availability to practice the use of the remote lab, to exchange experiences and to explore the possibilities VISIR has. *WiFi* connection was also highlighted as a key aspect to facilitate or hinder lab use (*"There was saturation in WiFi connection making the online use slow"*). Finally, some recommendations for extension of the experience were given: *"I hope VISIR could be taken to Angola, my country"* and *"The lab has to be promoted to many departments of electric engineering careers"*.

### 4.3 Implementation Results

TA2 took place in the middle of the second semester of the LA HEI, as their academic year starts in March and ends up in the last week of November. By that time, classes were already on going and most teachers still didn't have the opportunity to get acquainted with VISIR. Nevertheless, and accordingly to the Project definition, a course implementation per HEI partner should be started after TA2. Table V, summarizes the implementations that are ongoing, presenting the course's name, the number of teachers and students involved in each course as well as the type of VISIR's usage.

TABLE V. IMPLEMENTATIONS PER LA HEI PARTNER

Courses	LA HEI	Teachers Team	Students	VISIR's Usage
Calculus IV	UFSC	3	40	Sporadic
Probability and Statistics		1	50	Sporadic
Electronics II	IFSC	1*	13	Frequent
Basic Electronics			13	Frequent
Amplifying Structures		10	Frequent	
Electric Circuits I		1	31	Frequent
Electric Circuits I		1	40	Frequent
Electricity I		1	50	Frequent
Electric and Electronic Circuits	PUC-Rio	1	18	Frequent
Complementary Activity		1	Eng. students	Continuous
Physics of Devices	UNR	2	17	Sporadic
Electronica 1 (+)	UNSE	4*	15-20	Frequent
Electronica 2 (+)			15-20	Frequent

\* same teachers team

(+) to be implemented soon

As it can be observed, more than one implementation per LA HEI is already ongoing, which exceeds positively the Project's request. In fact, at IFSC, there are six simultaneous implementations occurring. These results - the amount and variety of courses, in a total of 10 courses involving 12 teachers and 282 students - are quite above our expectations for each individual LA HEI. Teachers still need to get better acquainted with VISIR is patent in VISIR's usage - in 3 courses, VISIR was only used in one lab class to cover a specific topic although in the majority it was already used in several. UNSE

didn't feel comfortable to start it this semester. PUC-Rio already made a pilot implementation last semester, after TA1, with the help of CUAS and EU VISIR system. This semester, and after their VISIR acquisition, PUC-Rio shows a cared integration of VISIR in the course, using their material which was already designed to accommodate several different resources, in which students can complete their tasks (in a similar way as the VISIR project stimulates teachers to use simultaneously hands-on, simulators, remote labs and calculus). PUC-Rio also implemented a Complementary Activity using VISIR, open to all engineering students from various backgrounds: an online course, covering up basic electricity concepts. So, even though not in a large number, the quality of these implementations cannot be underestimated. Several AP are also already using VISIR, but mainly to test it and implement it next academic year.

## 5 Analysis

### 5.1 How pre-TA factors affected TA satisfaction level

In relation with the identified pre TA factors, a statistical analysis was performed to assess the significance each factor has in the different cases. Table VI shows the significant correlations (using a Chi-square test with 95% confidence interval). Questions related to "Interaction between lecturers and participants" (Q2, Q3 and Q4) show almost total independency on the identified factors. The same is visible with Q8 about the difficulty. Q1, Q7, Q5 and Q6 are the questions that show dependency mainly with pre experience with remote labs in general, and VISIR in particular. Curiously, the fact of already having their own VISIR system installed or using the VISIR's system of the EU partner did not influence the results.

TABLE VI. TA'S SATISFACTION QUESTIONNAIRE CROSS ANALYSIS WITH IDENTIFIED FACTORS

	HEI	Pre-exp. ICT	Pre-exp. RL	Pre-exp. VISIR	Own VISIR	TA Dissemination
Q1	p=0.043	p=0.009	p=0.003	p=0.003		
Q2			p=0.032			
Q3						
Q4						
Q5	p=0.042		p=0.025	p=0.025		p=0.028
Q6			p=0.009	p=0.015		
Q7	p=0.004	p<0.001	p<0.001	p<0.001		
Q8						p=0.013

### 5.2 How TA related factors affected TA global satisfaction level

This analysis was made in terms of the language used by EU partners in TA, the duration of the TA in each case and the global approach used. The only factor that shows correlation with attendees' answers to the satisfaction questionnaire was the duration of the TA (using a *Chi-square test* with 95% confidence interval): questions Q1, Q6 and Q7 shows p-values of 0.009; 0.0034 and 0.002, respectively.

### 5.3 How pre-TA and TA factors affected post-TA actions (implementations)

Regarding the influence pre-TA identified factors had in promoting the implementations development in each LA HEI, the analysis does not show any statistically dependency relatively to the number of courses, teachers involved, number of students and VISIR usage. As for the TA identified factors (which differentiate the cases) they seem to have no significant correlation with the type of implementations that are being developed. As for the factors that can be inferred through the satisfaction questionnaire, the level of TA participants' satisfaction shows some positive correlations with some aspects of the implementations: "number of courses" with Q5 ( $p=0.022$ ); "number of students" with Q5 ( $p=0.040$ ) and Q6 ( $p=0.008$ ); and "VISIRs' usage" with Q1 ( $p=0.036$ ) and Q7 ( $p<0.001$ ). The correlation test used was *Fisher transformation test* (using a confidence level of 95%).

## 6 Discussion and Conclusions

The challenge endured in this work, was to assess in which terms external and internal factors to the VISIR+ project was affecting the ongoing actions. In particular, at what extent the pre-project experience of the LA HEI partners and particular aspects that made TA different in each case were significant in terms of affecting teachers involvement and the developing VISIR's harmonious integration in their course curricula.

Since the main turning point in each case was the TA, the analysis was divided into three chronological stages in which cases could be differentiated: pre TA; during TA and post TA. Pre TA characterization showed some differences between cases, namely: PUC-Rio was the only one who managed to acquire VISIR system on schedule; UFSC, UNSE and UNR performed a larger dissemination of the Project and TA among their HEI fellows and including their AP; PUC-Rio shows a high level of performance while ICT tools users; UFSC shows a vast experience using remote labs; UFSC, IFSC and UNR shows some experience with VISIR.

TA characterization was made regarding attendees' participation, the language used by EU partners, as its duration and presentation approach. TA where assessed through a satisfaction questionnaire in which quantitative and qualitative data was collected. The major results are now summarized: UFSC, UNSE and UNR had a large number of participants, including their AP; A significant difference in terms of language used by EU partners was possible from TA1 to TA2. Due to their affinities, EU partners performed their presentations (or in case of PUC-Rio, their discussions) in participants' native language; The time allocated in each case to TA2 varied from one day (in UFSC and IFSC) and four days in UNSE; In UFSC and IFSC the presentation approach was less interactive (questions were mostly postponed to the end); Global feedback in both TA was highly positive; The global participants' perception of the presentations interaction with the audience level (Q2) maintains or even grows in some cases from TA1 to TA2; Regarding the level of achievement of participants' expectations (Q7) and the sensed difficulty in using VISIR (Q8), the results shows a maintenance (of the lower level in the satisfaction questionnaire) or even decreases, more notoriously in UFSC, UNSE and UNR; This fact is in accordance with the previous result in terms of their dissemination efforts and their higher participation levels (a more significant number of participants who have never interacted with VISIR); The quality overview of the participants' perception shows that TA should have more time to questions and practice.

The cases were categorized and the major results showed: Even though TA2 was performed in the middle of LA semester, teachers from all HEI managed to embrace

the Project and start planning their implementations; In all cases there is already on-going experiences with students (with the exception of UNSE, who planned but did not start yet); In IFSC there are six simultaneous course implementations and in UFSC and in PUC-Rio there are two; The level of confidence showed by these teachers can be considered high when they embrace the implementation to a great number of students or plan to use VISIR more frequently, as is the case in IFSC.

After cross analyzing these results and the research questions, we can identify:

*Which factors can be considered important in terms of conditioning the TA and the didactic implementations using VISIR?* The factors that most significantly affected TA were: the “pre-experience with remote labs” and “pre-experience with VISIR” in particular. These two factors are significantly correlated with what participants referenced about the objectives of TA (Q1), their expectations (Q7), the time allotted of the TA (Q5) and their acknowledgment of VISIR as a useful tool to enhance effectiveness of teaching and learning (Q6). In fact, the identified TA factor duration of the TA (1-4 days) is analyzed it is found to have a significant correlation with Q1, Q6 and Q7, but not with Q5. This might seem odd at a first glance, but it means that probably participants who had more experience with VISIR or remote labs, might feel more comfortable with the period of time allocated, but in the overall, TA duration was not perceived significantly different between the participants. Again, the “ownership of VISIR” factor appears to not have significant influence on the obtained results.

*Is there relation between TA characteristics and the implementations designs?* No statistical correlation was found between the identified pre-TA factors or TA factors and the on-going implementations. Even though not statistically significant, the quality analysis suggests that in HEI with more historical knowhow with ICT tools or similar didactical implementations, their teachers were more at ease modifying their courses to include this new tool. However, when analyzing data regarding TA through the satisfaction questionnaires, the post-TA factor “number of courses” is significantly correlated with Q5. The “number of students involved” correlated with Q5 and Q6 and the “degree of the integration: VISIR usage” correlated with Q7.

Concluding, the pre-experience with remote labs or with VISIR and the TA duration were the most conditioning factors that affected the outcomes of the TA. Teachers’ perceptions that most conditioned their involvement in developing their implementations were related to the lack of time to practice and discuss their doubts in TA (as was also referenced in the quality analysis), the teachers’ consciousness of the effectiveness of VISIR to teach and learn (as discussed in literature about any didactical tool, this teacher’s awareness is fundamental [2]) and finally, if their expectations in TA were more fulfill, most likely they feel comfortable modifying their course curricula.

## **Acknowledgment**

The authors would like to acknowledge the support given by the European Commission through grant 561735-EPP-1-2015-1-PT-EPPKA2-CBHE-JP.

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