USING A 3-TIER TRAINING MODEL FOR EFFECTIVE EXCHANGE OF GOOD PRACTICES IN AN ERASMUS+ PROJECT

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Abstract

VISIR+ is an Erasmus+ project that aims to develop educational modules for electric and electronic circuits theory and practice following an enquiry-based teaching and learning methodology. The project has installed five new VISIR remote labs in Higher Education Institutions located in Argentina and Brazil, to allow students doing more experiments and hence acquire better experimental skills, through a combination of traditional (hands-on), remote and virtual laboratories. A key aspect for the success of this project was to motivate and train teachers in the underpinning educational methodology. As such, VISIR+ adopted a 3-tier training process to effectively support the use of VISIR in the Institutions that received it. This process is based on the "train the trainer" approach, which required the participating partner institutions to identify and engage a number of associated partners, interested in using their newly installed remote lab. To measure the quality of the training process, the same satisfaction questionnaire was used in all training actions. This paper presents a detailed description of the training actions along with the analysis of the satisfaction questionnaire results. Major conclusions are that the quality level of the training process remained practically the same across all training actions and that trainees sometimes considered the practical use of the VISIR remote lab as difficult, irrespectively of where and when the training action took place.

Keywords: teachers training, remote and virtual labs, VISIR

1 INTRODUCTION

The Virtual Instruments Systems in Reality (VISIR) is a remote laboratory for conducting real experiments, at distance, with electrical and electronic circuits. It was originally developed by the Blekinge Institute of Technology (BTH), Sweden, in 1999, under the mentorship of Ingvar Gustavsson, and since then it has been installed at and used by several Higher Education Institutions (HEI) in Europe, namely in Austria, Portugal and Spain [1]-[10]. These two last mentioned countries have strong academic cooperation links with Latin American (LA) countries, which continuously favour the exchange of good practices among HEIs and its staff members.

The Key Action 2 (KA2) of the European Union (EU) Erasmus+ Programme aims to support the cooperation for innovation and the exchange of good practices, in particular through projects with Partner Countries in the field of higher education. These projects should support participating organisations/institutions and systems in their modernisation and internationalisation process.

The initial VISIR+ project proposal followed two motivational dimensions: a top-level, strategic one corresponding to problems identified by the Brazilian Association for Engineering Education (*Associação Brasileira de Educação em Engenharia*, ABENGE) and the Argentinean Federation of

Engineering Faculty Deans (*Consejo Federal de Decanos de Facultades de Ingeniería*, CONFEDI); and a low-level, operational one corresponding to instructional needs identified by the lecturers and researchers involved in the VISIR+ project consortium.

At the strategic level, both ABENGE and CONFEDI have identified the need to promote the adoption of Information and Communication Technologies (ICT) -based educational tools to increase the quality of the teaching & learning methodologies used at Higher Education (HE), in particular those promoting a shift from teacher-centred to student-centred approaches, aiming for self-regulated learning, learn-by-doing, and learn everywhere and at anytime scenarios.

At the operational level, a number of Brazilian and Argentinean teachers with lecture duties in the subject of electrical and electronic circuits were lacking an adaptable and customisable technology-enhanced educational solution able to bring the lab into the centre of the teaching & learning process. Students, in their turn, were lacking more opportunities to use their digital competences in traditional universities, because of the limited offer of internet- and mobile-accessible educational contents and tools, capable of motivating them into complementary and scaffolding learning experiences.

In the realm of this situation, remote labs (e.g. VISIR) have been identified as one of the main instructional technologies adopted and valued in engineering education, this corresponding to one of the major shifts in engineering education in the last 100 years [11].

In sum, the partner countries (Argentina and Brazil) identified an increased demand for high-skilled professionals in the areas of science, technology, engineering, and maths (STEM). This fact combined with the limited number of students opting for STEM-related degrees in HE and the dropout rates in the initial years has led the Partner Countries governments to define a policy of massive investments into HE, and within it in Engineering degrees [12]. As a technology-enhanced educational tool, remote labs serve the three previous demands. First, they allow serving more students by supporting a blended training modality, where practical experiments can be done remotely (engineering requires lab-based skills and competences). Second, they can be used at the secondary education level, promoting an interest in STEM-based careers [13]. Third, they potentiate learning gains, thus helping to increase students' engagement and reduce dropouts [14].

Considering it would not be possible to address the entire broad area of engineering, in a 2-years project, the VISIR+ project proposal restricted its application domain to a specific field (Electrical and Electronics Engineering), and within it a specific subject (circuits theory and practice). This allowed justifying why the consortium would only consider one specific remote lab, i.e. VISIR.

2 TRAINING ACTIONS IN THE VISIR+ PROJECT

There are findings already reported in literature that suggest teachers' commitment and adherence to technology-enhanced educational tools, such as remote and virtual labs, are key elements for their success in education [15]-[17]. In order to effectively use a given educational technology, teachers first need to feel confident they are able to understand its functionality, when to and when not to use it, and, finally, to develop their own materials to support the use of that technology on their own courses.

With this in mind, the VISIR+ project adopted a "train the trainer" model, where those already experienced in using VISIR would first train a number of teachers willing to use this remote lab, and then, on its turn, these teachers would produce and use their own materials to train other teachers. This led to a 3-tier training process, with a 1st training action (TA1) held at BTH, during the project Kick-off Meeting (KOM), that involved all the (5) participating European HEIs that already had a VISIR system, acting as trainers, and two elements from each of the (5) participating partner HEIs, acting as trainees. Additional elements from the LA partners also participated remotely. After the installation of the VISIR system, on each LA partner HEI, a 2nd TA (TA2) was conducted locally by a European HEI, targeting not only those elements that participated (locally and remotely) on TA1, but also additional teachers from the host institution and at least one teacher from two Associated Partners (AP). Forming this sort of "training pairs" was crucial to a project timely execution, while it also enabled creating the sort of social bonds that facilitate peer interaction during a technology-transfer process [18]. Finally, after having used VISIR in one or more courses, the LA partner HEIs run a 3rd TA (TA3), this time with materials produced from their own experience, for teachers from the AP. At TA3, the European HEI participated as observers.

In order to ascertain the quality of the training process, one project partner, i.e. the Research Institute in Educational Sciences of Rosario (*Instituto Rosario de Investigaciones en Ciencias de la Educación*, IRICE), part of the National Council for Technical and Scientific Research (*Consejo Nacional de Investigaciones Científicas y Técnicas*, CONICET) of Argentina, was commissioned to define, apply and later analyse the results of one satisfaction questionnaire (SQ) used in all the TA. Table 1 presents the 9 questions (Q1-Q9) that form this SQ, and the corresponding scale.

Table 1. Satisfaction questionnaire used in the TAs

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*	

A thorough description of both TA1 and TA2, and its preliminary results, has already been published in [19]. This paper describes TA3 and adds the results obtained from it. Table 2 presents the complete numbers of all 3 TA for a better understanding of the evolution of the attendance and the number of SQ returned. The acronyms used stand for the Federal Institute of Santa Catarina (IFSC), the Federal University of Santa Catarina (UFSC), the Pontifical Catholic University of Rio de Janeiro (PUC-Rio), the National University of Rosario (UNR), and the National University of Santiago del Estero (UNSE).

Table 2. VISIR+ Project TA's participation and number of SQ returned.

Participation	IFSC	UFSC	PUC-Rio	UNSE	UNR	Total
TA1	2	5	4	4	3	18
SQ1	3	7	6	7	6	29
TA2	8	50	7	31	28	124
SQ2	8	31	7	22	19	87
TA3	19	54	33	49	68	223
SQ3	18	32	11	39	15	115

In TA1, even though the number of teachers from each LA HEI who could participate locally was limited, some teachers were able to access remotely. TA's number of participants and SQ answers can be observed in Table 2 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.

Regarding TA2, there were some differences among the several instances that took place in LA HEI, in particular concerning: (1) language used; (2) TA duration; (3) TA presentation approach used; and (4) TA attendees' perception (both in terms of quantitative and qualitative assessment). These differences are explained in detail in [19].

Concerning TA3, the results are depicted in Fig. 1, which was updated from [19]. Fig. 1 presents the average results, Fig. 2 presents the median value of each SQ answer.

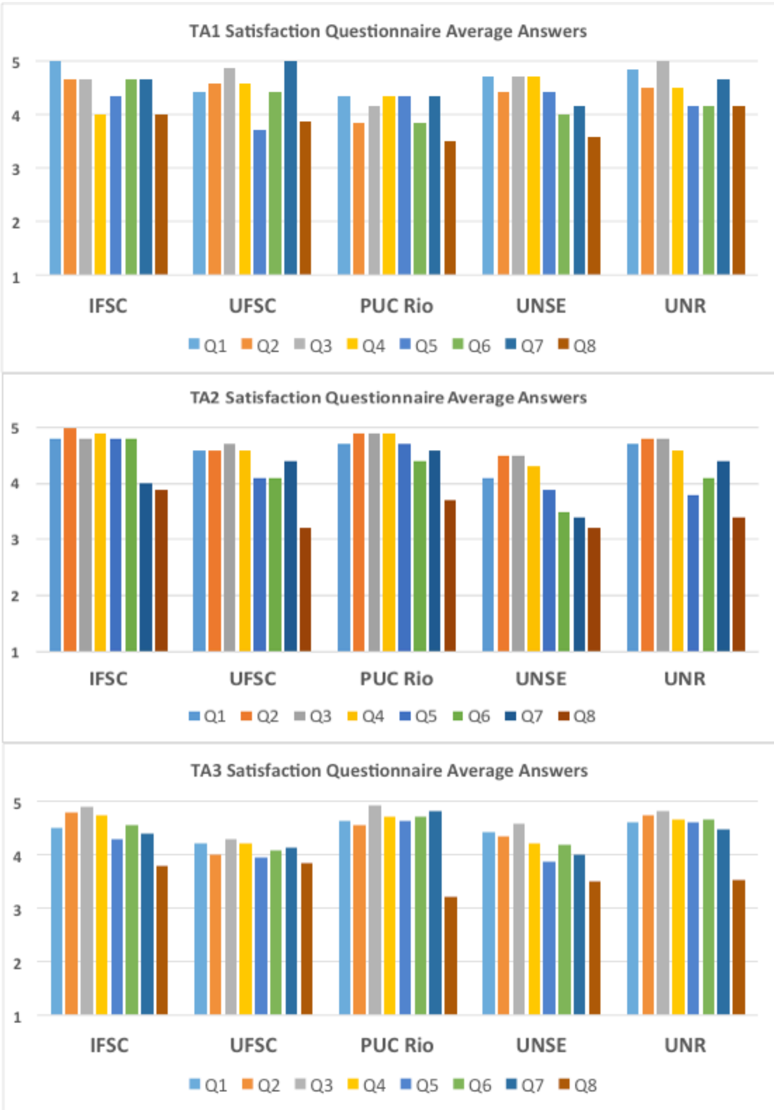

Figure 1. SQ Average – TA1, 2, and 3 – all LA HEI

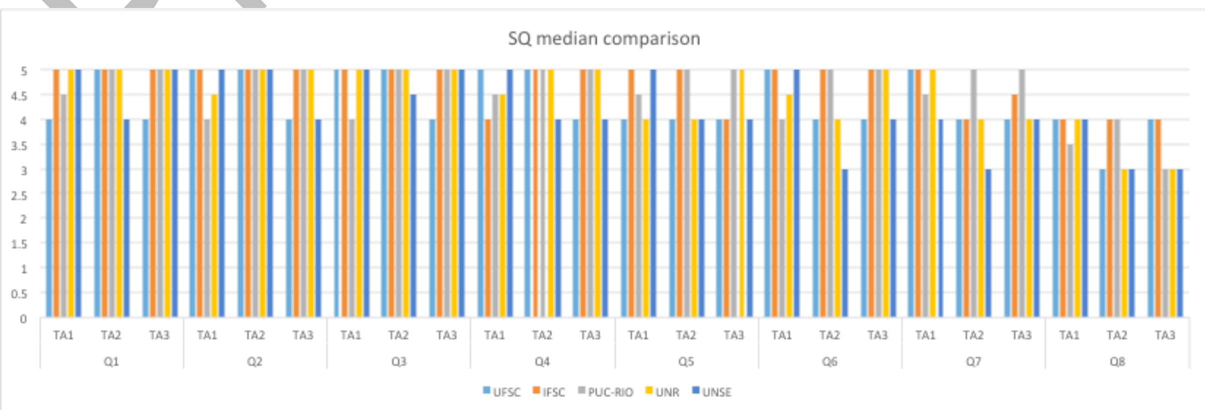

Figure 2. SQ Median comparison – TA1, 2, and 3 – all LA HEI

3 ANALYSIS

The results presented in Fig. 1 and 2 will be analysed in two directions: per LA partner (considering the three TA and each SQ answer – quantitative dimensions) and per SQ answer (considering the three TA and each LA HEI).

3.1 Regarding the evolution per LA HEI

Table 2 shows the number of teachers engaged in TA has clearly grown from TA1 to TA2 and from TA2 to TA3. This is clearly noticeable in all LA HEI, although some exhibit higher numbers (e.g. UFSC, UNR, and UNSE) when compared to others (e.g. IFSC, and PUC-Rio). In total numbers, the evolution from TA1 (18) → TA2 (124) → TA3 (223) is in accordance to the initial strategy of involving the LA HEI and its AP in successive editions. The number of returned SQ does not follow exactly this trend (29) → (87) → (115), in particular considering TA3, which exhibits the lower percentage of returned SQ (52%).

§1 Regarding IFSC, in overall terms, the averages per TA do not vary much. Different evolutions according to the SQ answer under consideration are noticeable, for instance Q1 and Q3 decreases from TA1 → TA2 → TA3; Q2, Q4, Q5 and Q6 show a positive peak in TA2, while Q7 shows a negative peak in TA2.

§2 As for UFSC, there is a tendency to obtain lower scores, in all questions, when moving from TA1 → TA2 → TA3. Two peaks are noticeable, one positive regarding Q7 in TA1 (perhaps due to the fact there was more time to talk about VISIR) and one negative regarding Q8 in TA2 (where there was some negative feedback concerning the amount of time dedicated to practical sessions with VISIR).

§3 Concerning PUC-Rio, it is noticeable the lower values obtained in TA1, when compared to TA2 and TA3. Also noticeable are the two lowest values of Q8 in both TA1 and TA3.

§4 Respecting UNSE, a broad analysis indicates TA2 to have received lower scores in almost all questions, when compared to TA1 and TA3. The positive evolution from TA2 to TA3 may have benefitted from a survey made before the delivery of TA3, which involved all the potential attendees of TA3. The survey results are available in [20].

§5 Finally, UNR results show a very similar pattern in Q1, Q2, Q3, Q4, and Q7 in all TA, with the exception of two peaks, a positive one of Q3 and a negative one of Q2, in TA1. Q5 and Q6 got better results in TA3, and Q8 shows the same tendency (lower values) observed in all other LA HEI.

3.2 Regarding the evolution per SQ answer

Considering Fig. 2 and first examining Q1, there are no noticeable differences regarding IFSC, PUC-Rio, and UNR. The median is 5 (with a slight lower value – 4.5 – for PUC-Rio on TA1) for all these LA HEI and TA. The two exceptions, i.e. UFSC and UNSE show an inverted pattern when compared against each other. While UFSC denotes a 4 → 5 → 4 pattern (considering TA1 → TA2 → TA3), UNSE presents a 5 → 4 → 5 pattern, which is in line with the findings already mentioned in §1 and §4 (section 3.1). Moving to Q2, UFSC and UNSE now show the same pattern, i.e. 5 → 5 → 4, while the differences among the other LA HEI are only noticeable in TA1, with all 3 showing a median of 5 in TA2 and TA3. Q3 has the highest medians, all being 5, except for the UFSC | TA3, PUC-Rio | TA1, and UNSE | TA2 medians, respectively: 4, 4, and 4.5. Together with Q2, and Q3, Q4 completes the "Interaction between lecturers and participants" assessed dimension. Again, all LA HEI show two medians of 5 (in the three TA), with the exception of UNSE that shows two medians of 4 (and one of 5). Nevertheless, one can state that all received a very positive feedback in this assessed dimension with no large differences.

Moving to the "Time allotted" assessment dimension, i.e. Q5, the total number of medians equal to 4 surpasses that of medians equal to 5. This means that, on average, participants considered this dimension to be below the level of the previous dimension ("Interaction between lecturers and participants"). In broad terms, PUC-Rio exhibits the highest scores (4.5 → 5 → 5) while UFSC obtains the lowest scores (4 → 4 → 4), although stable across all TA.

The two following assessment dimensions, i.e. "The use of technological equipment" and "Participants' expectations" are the first to obtain a median of, 3 in two instances, both from UNSE | TA2. This aspect was already highlighted in §4 of the previous section. In addition, the TA2 SQ report produced by the two project members from IRICE (in charge of the Quality Assurance work package), already indicated that a considerable number of participants evaluated the TA2 delivered at UNSE as “Fair” (2 points), this being unique when compared to all other LA HEI | TA2 instances.

Finally, on the last assessment dimension (“Practical use”) there is a tendency to obtain lower scores with a higher number of trainees. TA1, with 18 trainees, and all TA done at IFSC, with 8 participants in TA2 and 19 in TA3 – see Table 2 –, obtain higher scores, which confirms the tendency.

3.3 Implementations

An important aspect from TA2 was the resulting number of implementations, i.e. the courses delivered at the participating LA HEI that adopted VISIR, in combination with both hands-on and virtual labs. The VISIR+ project proposal established as a goal at least one implementation per LA HEI after TA2 and at least one implementation per AP, after TA3. While [19] already reported more than one implementation in some LA HEI, with 13 implementations in total, Table 3 shows that the number of implementations has grown after | during TA3, especially in AP. This number is close to the initial goal of having at least one implementation per AP (2 AP per LA HEI gives a total of 10 AP), as in addition to the 8 implementations listed in table 3, there is one already running since the 2016 academic year at the Higher Polytechnic Institute (*Instituto Politécnico Superior*, IPS) of Rosario, an AP of UNR.

Table 3. List of courses using VISIR – Academic year 2017 (LA) – 2nd Semester

Course	Degree	LA HEI	AP
Calculus IV	Computing, Electrical Engineering	UFSC	
Introduction to Electronics and Robotics	Secondary level (Goal: to attract students to STEM careers)	UFSC	
Circuit Analysis	Industrial Automation	SATC	UFSC
Instrumentation	Mechatronics Engineering	SATC	UFSC
Physics	Computing Engineering (*)	IFC | Sombrio	UFSC
Electronics	Electromechanics (*)	IFSC | Araranguá	UFSC
Circuits Theory, Physics of Electronic Devices, and Electronic Circuits and Devices I	Electronics Engineering	UNR	
Electrotechnics	Operation and Maintenance of Electrical Energy Networks (**)	UTN | Rosario	UNR
Electronics I	Electronics Engineering	UNSE	
Electrical circuits and networks	Electronics (*)	Technical School nr. 8	UNSE
Operational amplifiers, and Circuits III	Electronics (*)	IFSC	
Electricity I, and II	Electronics Engineering	IFSC	
Electronics II, and Amplifying Structures	Industrial Electronics (*)	IFSC	
Instrumentation	Electronics (*)	IFSC | Itajaí	IFSC
General Electricity	Civil, Chemical, Industrial, Mechanical, and Petroleum Engineering	PUC-Rio	
Applied Electricity	Electrical Engineering	UCP	PUC-Rio

(*) Corresponds to Level 4 (or 5) of the European Qualifications Framework (EQF).
(**) Post-graduation. Corresponds to EQF Level 7.

This and other implementations are referred in Table 4, which lists the conferences where actual implementations, particularly from the 2016 academic year and from the 1st semester of the 2017 academic year, have been presented. This opportunity to disseminate the work done with VISIR was thought to act as an extra motivational factor for those teachers willing to include the VISIR remote lab in their course instructional plan. Besides this initial dissemination plan, a more thorough analysis, i.e. comparing consecutive implementations in one same LA HEI or transversal comparisons, is now being done, with results expected to be submitted for publication, during the 1st half of 2018.

Table 4. List of conferences where VISIR implementations in LA HEI and AP have been presented

	REV	EDUNINE	exp.at	TAEE	CLADI	COBENGE	TEEM	IMCL
2016				[21]		(*)		
2017	[22]		[23]-[25]		[26], [27]	[28], [29]	[30]	[31]
2018		(**)		(**)				

(*) Book chapter. In press
(**) 2 submissions.

4 CONCLUSIONS

This paper described a 3-tier training model adopted in the VISIR+ project. The planned training methodology follows the "train the trainer" approach and adds one unique satisfaction questionnaire used in all TA, in a total of 11 instances, i.e. one TA1 plus five TA2, plus five TA3 (one per LA HEI). In total, 231 SQ were analysed, enabling to verify the quality of the training process. One initial conclusion is that there are no major differences from TA1 → TA2 → TA3, which indicates the initial trainees from TA1 were able to maintain the same quality level of the training process. Another conclusion is that the major differences among the distinct assessment dimensions remained the same from TA1 → TA2 → TA3, in particular a tendency to obtain higher scores on the "Objectives" (Q1) and "Interaction between the lecturers and participants" (Q2, Q3, Q4) assessment dimensions, and then decreasing scores with the following assessment dimensions, almost irrespectively of the TA number and LA HEI where the TA took place. The last quantitative assessment dimension, i.e. "Practical use" of VISIR, obtained the lowest score, which indicates trainees to have experienced some difficulties in using this remote lab. Determining the possible cascade effect of this difficulty is certainly one aspect to consider in future analysis.

In addition to the TA analysis presented in this paper, all implementations have also been evaluated through questionnaires directed to teachers and students. These evaluation instruments were developed by IRICE and have already been described in [32]. Results have also been published in e.g. [23], [25], [27], and [30].

A final remark is that the planned multiplier effect of having two AP per LA HEI attending TA2 and then running TA3 on these AP produced good results. The results are actually twofold: on one hand the LA HEI received an extra motivation to do their implementation, to be used as a source for producing their own training materials, describing the instructional plan associated with the combined use of traditional (hands-on), virtual and remote labs (i.e. VISIR); on the other hand, the AP gained the opportunity to use the VISIR remote lab installed in the LA HEI and also had its own teachers trained on how to do it, following a local example (i.e. an actual implementation in a nearby HEI).

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