Macro Analysis on how to Potentiate Experimental Competences Using VISIR*

Natércia Lima†
ISEP - School of Engineering – Polytechnic of Porto
Porto, Portugal
nmm@isep.ipp.pt

Clara Viegas
ISEP - School of Engineering – Polytechnic of Porto
Porto, Portugal
mcm@isep.ipp.pt

Arcelina Marques
ISEP - School of Engineering – Polytechnic of Porto
Porto, Portugal
mmr@isep.ipp.pt

Gustavo Alves
ISEP - School of Engineering – Polytechnic of Porto
Porto, Portugal
gca@isep.ipp.pt

Francisco Garcia-Peñalvo
Research Institute of Educational Sciences (IUCE)
University of Salamanca,
Salamanca, Spain
fgarcia@usal.es

ABSTRACT

Experimentation is crucial in science and engineering education, regardless the educational level. Nowadays experiments can be performed not only in traditional hands-on labs, but also using online resources, such as simulations and remote labs. This study was carried out, in several Higher Educational Institutions and at a minor extent some Secondary Schools, in Argentina and Brazil, in 25 different courses, where VISIR, a remote lab in the electric and electronics area, was introduced along with other resources. These 39 didactical implementation took place during 2016 and 2017 academic years, yielding 51 teachers and 1563 students. Teachers' perception about student performance in VISIR as well as VISIR usage in course, were cross-analyzed with courses' characteristics. Some important factors arouse teachers should pay extra care designing VISIR tasks accordingly to the learning outcomes/ competences they want their students to develop, taking into consideration if they represent group or individual activities. In fact, students tend to prefer group activities and there seems to be a strong association between this factor and teacher perception about students' satisfaction with the tool. Teacher introduction and support to VISIR along the semester is also an important factor.

CCS CONCEPTS

• Applied computing • Physical sciences and engineering • education

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† Natércia Lima, Clara Viegas, Arcelina Marques, Gustavo Alves, Francisco Garcia-Peñalvo. 2018

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KEYWORDS

Remote Laboratory; VISIR; Hands-on Laboratory; Computer Simulation; Experimental Competence Development; Engineering Education

1 Introduction

At the end of their college education engineering students are expected to have a set of professional skills related to teamwork, oral and written communication, and impact of engineering solutions, life-long learning and knowledge of contemporary issues [1], contributing to maintain and improve their country's social well-being and economic prosperity. When making the transition to the labor market graduates need not only to have a solid theoretical-practical knowledge in their field of specialization, but also have appropriate soft or generic skills, such as communication, teamwork, time management, problem-solving, learning aptitude and the ability to manage stress or heavy workloads [2], [3]. Lab experiments allow students to efficiently apply theoretical concepts to practical situations, as well as handling instruments, equipment and data. This practice contributes to build and consolidate knowledge and competences [4]. Simulation and remote labs provide an alternative and/or complementary way to develop knowledge and competences being a "blended" or "hybrid" approach to laboratory learning - a combination of hands-on labs, simulation and remote labs - the most effective [5]. These online resources offer new learning spaces and have three main advantages: accessibility, availability and safety [6]. They allow teachers to diversify their classes in a simple way – they don´t have to think if the lab is free and are suitable for classes with a lot of students. Likewise, they allow students to practice at their own pace, potentiating students' autonomous work, time management and responsibility [5], [7]. The use of these Information and Communication Technology

(ICT) tools in lower levels of education (basic or secondary) are likely to appeal young students as they are a generation of digital natives [8]. This usage may help to reduce some of the apathy and fear students feel concerning science and contribute to scaffold Science, Technology, Engineering and Mathematics (STEM) courses.

While with simulations the results obtained are from computational models, with remote labs the results are real, as a remote lab is a real lab in which the user and the equipment/instruments are physically apart. To perform an experiment the user has to access the internet and control the physical parameters of the experiment, through a computer or smartphone interface [9]. Remote labs, being tools that combine virtual access and real experimental results, have the advantages of simulations and hands-on labs. Its' disadvantage is the very limited ability to provide manual skills. Usually teachers do not need to do a huge effort to integrate these tools in the curriculum. Also the contextualization of the theoretical concepts can be easily achieved with remote labs, being quite powerful to address the nature of science and technology [10], [11], arising students' interest to learn the target topic. Remote labs potentiate education and collaboration between institutions sharing resources and didactical experiences [12]. On the other hand, they may also enhance students' interaction, cooperation, teamwork, communication and critical thinking as long as tasks using these resources are designed accordingly. Special attention should be given to it, considering the impact they have on student performance [13]. The groups or type and level of competences teachers expect their students to develop with these resources should be taken in to consideration in the task design [14]. It is important there is a perfect adjustment between the type/level of competence and the type of task, being the teacher mediation role fundamental to lead students in the process [14].

In the electric and electronic circuit's topic, VISIR (Virtual Instrument Systems in Reality) is amongst the most used labs. It was created in 2004 by the Bleckinge Institute of Technology (BTH) and can be considered a remote workbench with the same instruments and components that are available on a hands-on electric and electronic circuits lab, similar in all engineering schools [15]. Since then, several VISIR systems have been installed in Europe, India and Morocco [16] and more recently (2016 and 2017) in five Higher Education Institution (HEI) in Argentina and Brazil. The later have been installed in the scope of the VISIR+ Project [17]. The project intended to disseminate VISIR to these HEI in Latin America (LA) and some associate partners of theirs, sharing experiences with the European Partners (EP), installing VISIR systems and performing their own didactical implementations.

This work intends to be a step forward in understanding how VISIR can be used by teachers in their courses. It describes 39 didactical implementations that took place in several courses, in several education levels, under different contexts and with different goals, during 2016 (second semester) and 2017 (both semesters) academic years in several HEI and also some High and Professional Schools in Argentina and Brazil. These implementations involved 25 different courses, 51 teachers and 1563 students.

This paper is organized in 5 sections and its' aim is to study the characteristics of these 39 didactical implementations trying to identify success factors that impact in students' performance and motivation. Section 2 is devoted to the research methodology and includes a summary of the analyzed data and the main characteristics of the courses where the didactical implementations took place. Section 3 presents the results and in section 4 they are discussed. Finally, the conclusions arising from this work are presented in section 5.

2 METHODOLOGY

VISIR is a valuable resource in engineering education [6], [16], [18], [19] and this work addresses the first macro-analysis involving 39 didactical implementations with various different approaches taking into account the country, level of education, course topic, courses' characteristics, resources used, learning goals and implemented tasks. The study is focused in each didactical implementation, their characteristics and teachers usage and perception. Most courses just had one didactical implementation (one semester), but six of them undergone two editions (two semesters) and three of them three editions (three semesters) – in these situations, the evolution on consecutive editions was also analysed. Considering the 39 VISIR didactical implementation done in different contexts, the research question tackled in this work is: *"Which didactical implementation design factors seem to influence students' performance and motivation according to teachers' perception?"*

2.1 Research Methodology

The analysis performed in this work relies on a multicase study research methodology [20]. Each case represents a different course where VISIR was implemented.

For each course, the dimensions and categories analyzed are summarized in Table 1. This analysis intends to characterize teachers intentions while designing the VISIR implementation (Design), better understand how it was delivered (Implementation) and finally how did it result (in this work, only in terms of teachers perception).

The competence goal level related to their work with VISIR teachers pursued when they stated their course learning objectives were categorized in three levels [14]:

- level 1: e.g. obtain data, measurements, establish the proposed experimental circuits, doing some calculus;
- level 2: e.g. analyze data, compare the differences between simulation data and real data, master experimental techniques, predict results, develop soft skills (teamwork, cooperation, communication);
- level 3: e.g. design/ plan the experiments; confront model data with the experimental; understand the differences between simulation data and real data, research skills, critical thinking.

This competence level will be analyzed in terms of the teacher goal and in terms of the tasks proposed to students.

Table 1. Analysis Categorization of VISIR Usage

Dimensions	Categories	
Design	Course Implementation Edition	
	Resources Used	Simulation
		Hands-on
	Tasks	Number
		Weight in final grade
		Regime*
	Competence Goal Level	
Implementation	VISIR Introduction	In class
		None
	VISIR Support	Presential
		Email
		Support Material
	Implemented Tasks	Circuits Assembling
		Circuits Design
	Teachers logs to VISIR	
Teacher Perception	Students performance	
	Teacher satisfaction	
	External factors	

* If the tasks were in group or individual and if they were mandatory

A mixed analysis approach - quantitative and qualitative data - is used to analyze the 25 courses. Under the scope of the VISIR+ Project, a set of tools for collecting data were developed and validated [17]. In this work, we have used those tools.
The analysed data consisted on the detailed information about how VISIR was implemented on the course, in teachers' number of accesses to the remote lab VISIR and a teachers satisfaction questionnaire, which teachers were supposed to fill up at the end of the course didactical implementation. That questionnaire intended to evaluate teachers' satisfaction with VISIR, considering the didactical aspects as well as main advantages and disadvantages of the resource as well as teachers' opinion about students' performance with the tool. The open questions were qualitatively analyzed, following the procedure of the Grounded Theory [21], which gives a fundamental importance to what the teachers report to build the analytical categories. Some teachers' interviews and informal comments were also registered.

2.2 Case Studies Characteristics

The courses' characteristics in which the VISIR didactical implementations occurred are briefly summarized in Table 2 (split in three sub tables) by level of education: High School, Technological (post High School degrees, typical 2 years long) and Higher Education (HE). These tables include information about: country (Brazil (Br), Argentina (Ar)), implementation topic, course name, level regarding course contents (according to whether or not its contents is related to the degree scientific area (EE majors and other majors) if affirmative it will be distinguished between Scientific (S) for more advanced contents and Introductory (I) for basic contents of the scientific area); if not is considered Complementary (C), number of teachers (T) involved and number of students (St) enrolled in the course.

Table 2. Case Studies Characteristics

High School

Case #	Country	Implementation Topic	Course Name	Level	Number	
					T	St
C1	Br	Physics	Physics	C	1	65
C2	Br	Electricity	Basic Electronics	S	1	25
C2	Ar	Physics	Physics IV	C	4	118

Technological

Case #	Country	Implementation Topic	Course Name	Level	Number	
					T	S
C4	Br	Electricity	Circuits Theory	S	1	15
C5	Br	Electricity	Electricity I	S	3	164
C6	Br	Electricity	Electricity II	S	1	8
C7	Br	Electricity	Instrumentation	S	1	35

Higher Education

Case #	Country	Implementation Topic	Course Name	Level	Number	
					T	S
C8	Br	Mathematics	Calculus IV	C	1	124
C9	Br	Mathematics	Probabilities and Statistics	C	1	84
C10	Br	Electronics	Instrumentation I	C	1	45
C11	Br	Electricity	Circuits III	S	1	19
C12	Br	Electricity	Electronics II	S	1	18
C13	Br	Electronics	Amplifying Structures	S	1	4
C14	Br	Electricity	Electric Circuits Laboratory	S	2	36
C15	Br	Projects	Engineering Introduction	S	4	20
C16	Br	Electricity	General Electricity Laboratory	C	4	442
C17	Br	Electricity	Electric and Magnetic Measurements	S	2	50
C18	Br	Electricity	Applied Electricity	I	1	15
C19	Ar	Electronics	Physics of Electronic Devices	S	4	55
C20	Ar	Electricity	Circuits Theory	S	5	91
C21	Ar	Electronics	Devices & Electronic Circuits I	S	7	60
C22	Ar	Physics	Physics II	S	3	41
C23	Ar	Electronics	Electronics 2	S	2	13
C24	Ar	Electronics	Electronics 3	S	2	8
C25	Ar	Physics	Electronics 1	S	2	8

All implementations took place in the second semester of 2016 and/or first semesters of 2017 and/or second semester of 2017. Several teachers were involved in more than one didactical implementation – so the total number of teachers of Table 2 (3 sub tables) is higher than 51, which is the number of different teachers involved in the didactical implementations.

3 Results

Teachers introduced and used VISIR in their courses, which varied significantly in contents and level of difficulty, being some of them introductory courses (students' first contact with electric circuits) and some advanced ones, taking into account the learning goals they wanted to achieve. They developed tasks accordingly to the competences they wanted their students to develop. Table 3 summarizes some of these results, including the implementation edition number (of each course and each head teacher), the number of tasks involving VISIR as well as its contribution to the courses final grade (Q means that it counts as qualitative information) and if they were developed in groups and mandatory (they had to deliver the tasks involving VISIR to pass the course). It also includes the number of teacher VISIR logs/per task (teacher direct usage of the tool), including the task preparation phase and the support given along the semester. It is clear that this number shows a wide range of variability from 3 to 85 logs per task. Considering the courses in which there was more than one implementation (C3, C5, C8, C9, C16, C17 and C19) the number of logs per tasks tends to diminish or be about the same, from one implementation to the following one. The only exception is for case C5.

3.1 VISIR Design

Teachers combined VISIR usage with other resources in the didactical implementation of their courses, but in some of them (7,7%) VISIR was the only way for students to experiment with real equipment/instruments and components (Figure 1). Still, the majority of teachers managed to use/implement simultaneously simulation, hands-on labs and VISIR in their courses, allowing students to practice and develop competences in different manners. The number of tasks involving VISIR varied between 1 and 4. In terms of their weight contribution to final grade, in some Cases they were merely qualitative, others varied from 5 to 27% weight. This happened regardless the level of education. In 44% of the implementations the proposed tasks were to be developed in group, allowing students the opportunity and time to discuss their ideas and communication with others – high school teachers (except in case C2) opted for it. In 33%, the tasks were individual and we do not have that information for the remaining 23%. Just 28% of the Cases opted for mandatory task(s) involving VISIR – they had to deliver it in order to be able to be approved in the course.

Table 3. VISIR Usage

Case #	Course Name	Edition Number		Tasks				# teacher logs per task
		Course	Teacher	#	Weight	Group?	Mandat?	
C1	Physics	1	1	2	Q	Yes	No	Na
C2	Basic Electronics	1	1	1	Q	No	No	Na
C3	Physics IV	1	1	4	Q	Yes	No	4,75
		2	2	3	19%	Yes	Yes	4,67
		2	1	3	19%	Yes	Yes	5,33
		2	1	3	19%	Yes	Yes	4
C4	Circuits Theory	1	1	1	Q	Na	Na	Na
C5	Electricity I	1	1	2	6%	No	No	Na
		2	2	2	6%	No	No	9,5
		3	3	2	6%	No	No	18,5
C6	Electricity II	1	1	1	Q	Na	No	Na
C7	Instrumentation	1	1	3	Q	Na	No	Na
C8	Calculus IV	1	1	1	10%	Yes	No	15
		2	2	1	11%	Yes	No	25
		3	3	1	10%	Yes	No	6,5
C9	Probabilities &Statistics	1	1	1	11%	Yes	No	12
		2	2	1	10%	Yes	No	6,5
C10	Instrumentation I	1	1	1	10%	Yes	No	9
		2	2	1	10%	Yes	No	Na
C11	Circuits III	1	1	2	5%	No	No	15,5
C12	Electronics II	1	1	2	5%	No	No	13,5
C13	Amplifying Structures	1	1	3	Q	Na	No	10,7
C14	Electric Circuits Laboratory	1	1	3	15%	Yes	No	5,25
C15	Engineering Introduction	1	1	4	27%	Na	Yes	10,25
C16	General Electricity Laboratory	1	1	4	20%	Yes	No	33
		2	2	4	20%	Yes	No	27,7
C17	Electric & Magnetic Measurements	1	1	3	Na	Na	Na	Na
		2	2	2	Na	Na	Na	Na
C18	Applied Electricity	1	1	Na	Na	Na	Na	Na
C19	Physics of Electronic Devices	1	1	1	Q	No	No	6
		2	2	1	Q	No	Yes	8
		3	3	1	Q	No	Yes	9
C20	Circuits Theory	1	1	1	Q	Yes	Yes	85
		2	2	1	Q	Yes	Yes	3
C21	Devices & Electronic Circuits I	1	1	1	Q	No	No	12
C22	Physics II	1	1	1	Q	No	No	Na
C23	Electronics 2	1	1	2	5%	No	Yes	21,8
C24	Electronics 3	1	1	2	5%	No	Yes	12,8
C25	Electronics 1	1	2	2	Q	No	Yes	10

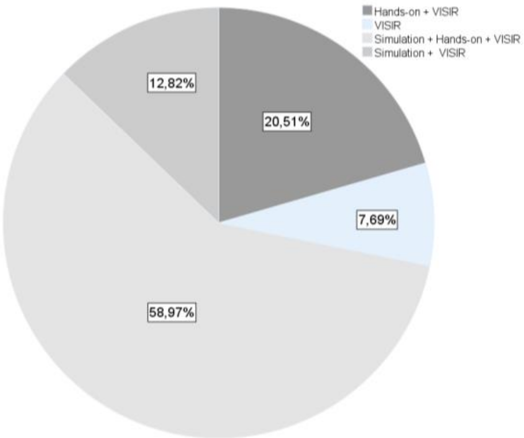

Figure 1. Resources used in the implementations

The level of competence teachers wanted students to develop with the tasks involving VISIR is described in Figure 2 and the connection between the level to the type of competence teachers identified was already described in section 2.1. In all high school Cases (except partially in the second course edition of Case C3) and technological course implementations, teachers wanted their students to develop essential experimental competences (establish the proposed circuits and do some measurements and obtain data) and do some calculus while allowing the students to know and use several resources (level 1) and in some Cases they wanted them to develop analysis competences (analyze and compare the data obtained using the different resources) and some soft skills (level 2).

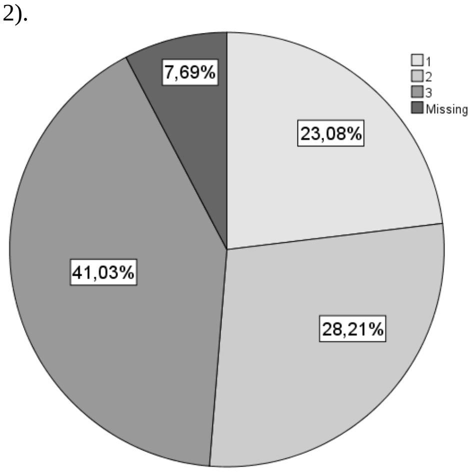

Figure 2. Level of competence development

In 41% of the didactical implementations, teachers wanted students to develop higher order competences (level 3) – all of these (except partially in the second course edition of case C3) are higher education course implementations. In all, these teachers wanted their students to develop critical analysis and thinking and the ability of solving problems and proposed tasks in which students had to confront model data with real data and explain its differences. In case C3 teacher also wanted their students to implement/design the circuits autonomously accordingly to a previously proposed problem.

3.2 VISIR Implementation

Teacher introduction to VISIR was mainly done in class by teachers – in 22 out of the 39 implementations, teachers decided to introduce VISIR in a class explaining the basics of the tool and doing some assembling and measurements (students have a role of observers). In 12 implementations teachers have introduced it in classes, but while they were explaining VISIR and doing some assembling and electric parameters measurements, students were doing the same in their own computers, trying it by themselves (students have a participant role). In 3 implementation (one of the C3 and C8 course implementation editions and case C13) teachers did not perform any introduction to VISIR – in C3 and C13 students were supposed to use the support material available and explore the tool, by themselves; in C3, although there was not a formal activity to introduce VISIR, the tasks involving VISIR were develop during class time. And for 2 of them it was not possible to have that information.

Considering VISIR support along the semester, although it is trusted that teachers accompanied students in their work with VISIR, we do not have the precise way how this support was carried out for 28% of the implementations. In some, teachers opted to answer students' doubts via email (15%) or by uploading specific support material (33%), such as tutorial videos or documents, in the Course Learning Management System (LMS). For the remaining, the tasks were fully performed during regular class time or at least partially performed in extra class time - all high school and technological course implementations, except case C6 (doubts via email and a written doc in LMS) are in this category (teacher full support).

When preparing tasks with VISIR teachers must be aware that VISIR mainly allows three types of setups:

- pre-designed circuit, where teachers do all the setups: students' interaction with the tool is minimal as all the connections were already performed by the teacher and students just observe the result of the measurement
- pre-defined circuit, where students design the circuit on their own, making the connection and the measurements (similar to the experience they do in the hands-on lab), but they have access to a restricted number of components previously defined by the teacher
- non-defined circuit, where students have full freedom to design the circuits - they can chose components, add components, and make all connections with the measurement equipment, solving autonomously the proposed tasks.

Just in one Case (C13) the teacher opted for non-defined circuits. The remaining chose pre-defined circuits.

In 12 implementations, the VISIR tasks consisted of doing some circuits assembling and some parameters (current, voltage, etc.)

measurements (Task type 1) (all high school and technological course implementations opted for it, except C1, C4 and C7). In 23 implementations, the tasks were more ambitious. In addition to circuits assembling and some parameters measurements students were supposed to compare those results with the theoretical expected results (C1, C4 and C7) and/or results obtained with other resources: simulation and/or hands-on (Task type 2). This last category covers only higher education course implementation, although not all higher education teachers opted for this type of task in their courses – some of them opted for the simpler one (task type 1). In Case C13 the teacher was really determined and students had to design a circuit to solve a specific problem and then compare the results with the theoretical ones as well as with the results obtained with simulation and hands-on lab (Task type 3). For 3 implementations it was not possible to have information about the type of tasks teachers proposed.

3.3 Teacher Perception

A qualitative analysis was carried out to the open questions of the teachers' satisfaction questionnaire. The point was to identify for each teacher comment a category (or eventually more than one) which accounted their opinion. So what is important is not the number of teachers/answers, but the opinions expressed - semantic clusters within responses, given the teachers expressed opinions, in spite of the minor variants with which they were formulated or the internal aspects to which they refer [21] .

Teacher perception about student's acceptance and performance with VISIR is highly motivating. We have split it in 4 levels of hierarchy (from 1 to 4), accordingly to teachers perception (Figure 3). Just in Cases C11 and C14 teachers reported students had difficulties and/or disliked (level 1) the tool. In Cases C23, C24 and C25 teachers stated students accomplished the task goals without difficulties (level 2), solving the proposed issues/problems. In the majority, teachers testified students were highly motivated, challenged and enthusiastic with the tool, (level 3) which naturally lead to a good performance with it. In Cases C7 and C10 teachers commented that after using VISIR, students felt much more at ease in the hands-on lab, being faster and committing less errors (level 4). For the remaining 8 implementations it was not possible to have that information.

Considering teachers' opinion of VISIR accordingly to teachers' answers about VISIR main advantages and disadvantages (What advantages and disadvantages do you find in the use of VISIR?) a qualitative assessment [20] of the open answers allowed the identification of 10 factors: 6 positive and 4 negative. We have the answers (for 37 implementations) summarized in Table 4.

The results highlight that teachers consider VISIR a valuable resource. The most positive referred factors were increase students practice and motivation. The negative factors more mentioned were some configuration issues and system instability.

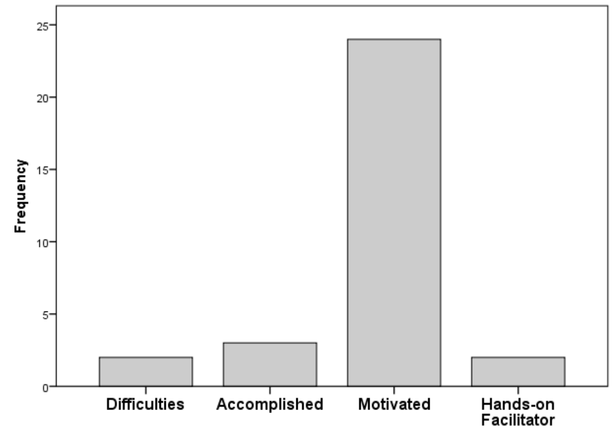

Figure 3. Students acceptance of VISIR

Table 4. Open Question Quality Assessment (positive and negative factors (in shadow)

Factors (positive/negative)

Teacher Satisfaction	Increase students practice	31
	Increase students motivation	8
	Diversify teaching methods	9
	Increase teacher autonomy	3
	Cost Free	3
	Damage Free	3
	Configuration Issues	6
	Instability	3
	Interface old fashionable/too simple	2
	Teachers experience with tool required	2
External Factors	Problems with Internet	7
	Computers and/or Computer room not adequate/available	5
	Nothing negative to highlight	10

4 Discussion

These 39 didactical implementations, embrace 25 courses, with different characteristics such as context, implementation topic, level regarding course contents, etc.

Considering the courses in which there was more than one implementation (C3, C5, C8, C9, C16, C17 and C19) it was supposed that if it was done by the same teacher, the number of logs per tasks would naturally diminish, as the teacher was already familiarized with the tool. Eventually if the teacher makes significant changes in the VISIR implementation in the successive course editions, this number may remain the same or even slightly increase. That was the case for all of them, except case C5 – the first two implementations were performed using a VISIR system from one of the EP, as their own system was not already been installed. In the 3rd implementation they used their own VISIR system, which implied some adjustments and mounting the experiments on the system.

In all Cases, except for Cases C3 and C8, there are not significant changes in the course editions. In the first C3 course implementation VISIR weight in final grade was only qualitative. The second edition of the course C3 occurred simultaneously with 3 different degrees, with the same team of teachers for all of them, (but each with one head teacher) being one of them the head teacher of the first course edition. From the first course implementation to the second, VISIR weight in the final grade gained considerable importance (19%) – teacher get to know the tool and perceiving its advantages not only used it again, but also persuaded other teachers to use it, giving them support. In case C8, the teacher tried several different ways of introducing VISIR to his students and considered that for his case (contextualization of mathematical concepts) it would be best to introduce it briefly in class (teacher expositive presentation) and deliver in LMS a tutorial video guiding for the circuits students were supposed to do. Teacher found VISIR so interesting for mathematical contextualization that he decided to use it in other Maths' course (C9) in the same way.

In all single edition courses it was teachers' first experience with VISIR and most of them occurred in the second semester of the academic year of 2017. Several teachers expressed their will to keep on using VISIR during the 2018 academic year. The number of teacher logs per task changes considerably amongst the different implementations, regardless the implementation topic, course contents level, type of task, etc. It is not clear which are the factors that influence this variation.

Teacher mediation in class and support/feedback in the proposed tasks also plays an important role in students' engagement with the tool and ultimately its success [22]. While using a new tool like VISIR, teachers enthusiasm and familiarity (teachers own usage) is crucial, not only to arouse student perception of its utility, but also to stimulate their enthusiasm and will to use it, as some students may be reluctant to use it and/ or may experience some difficulties in the beginning. Teachers should be aware of it and be prepared to help students overcome these initial difficulties quickly enough to avoid their disappointment. In fact, teachers' attention to VISIR – introduction and support during the tasks – plays a crucial role in students' engagement as it was already reported in literature [6], [16].

We wanted to determine if there was an association between teacher perception of students acceptance of VISIR with the way VISIR was implemented in the course including: VISIR introduction, VISIR support, type of task, regime of the task (in group or individual and if it was or not mandatory). We have used cross tables (a contingency table) to determine whether there was an association, considering each categorical variables (factors) with students' acceptance of VISIR - it was found there is just one association: the task being done in groups and students acceptance of VISIR (Figure 4). The level of acceptance is clearly higher for the implementations where the proposed tasks were developed in groups.

Accordingly to literature [23], it seems more usual students perform remote lab tasks on their own, with the obvious disadvantage of not potentiating teamwork and discussion/ communication skills. But accordingly to these results students seem to benefit from developing these tasks in groups, as they usually do in hands-on labs, even, if it sometimes, is due to time and resources constraints.

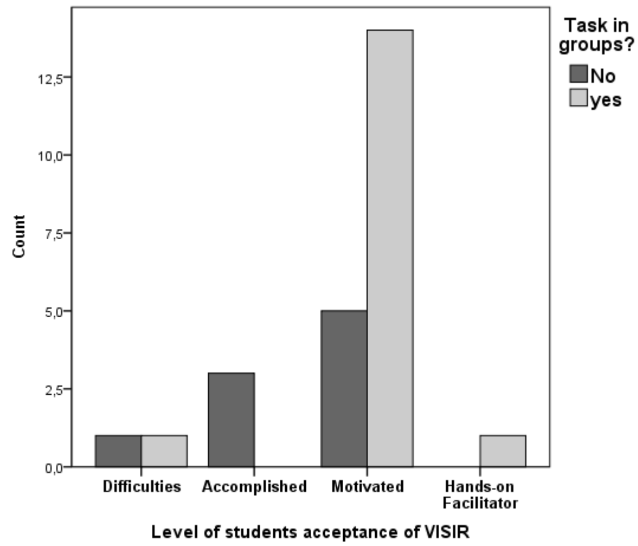

Figure 4. Association between Students acceptance of VISIR and task done in groups

In this study, it was not found any association between teachers introduction and support to VISIR to the level of students acceptance of it (accordingly to teachers perception). This result seems consistent with the effort teachers did in VISIR introduction – all teachers organized activities to introduce it in class, except for one of the C3 and C8 course implementation editions and case C13. Still, although in one of the C3 course implementations there was not a formal VISIR introduction, the tasks involving VISIR were performed during class time, so with full teacher support. In case C8 teacher tried different ways of introducing VISIR, trying to figure out which one was more adequate to his context. But, although in one of the implementation editions, he did not plan any activity to introduce it, he prepared a detailed tutorial video guiding students to the circuits they had to prepare. In the subsequent edition, he already introduced VISIR in class, as he realized it worked better for his case. Case C13 is an advanced course in the electronics area, so students are already very familiarized with circuits' components, equipment and measurements. Teacher considered, at this point, students were able to explore VISIR by themselves. Still he prepared a written document to guide them.

Besides teacher introduction to VISIR, teachers also developed different ways to support students during the semester: answering doubts via email, preparing tutorial videos or documents. In the lower levels of education by performing the tasks during class time. As already discussed in literature [6], [16], [18], it is crucial teachers design the tasks involving VISIR accordingly to the learning outcomes they want their students to achieve and the level/type of competences they want them to develop. In this study, teachers developed essentially three types of tasks, described in section 3.2. Using crosstabs (relation between two categorical variables), we have tried to figure out if the type of task was in accordance with the level/type of competence teachers wanted their students to develop (Figure 5). It is clear that, in some Cases, there is a mismatch between the level of competence teachers want students to develop and the type of task they implemented.

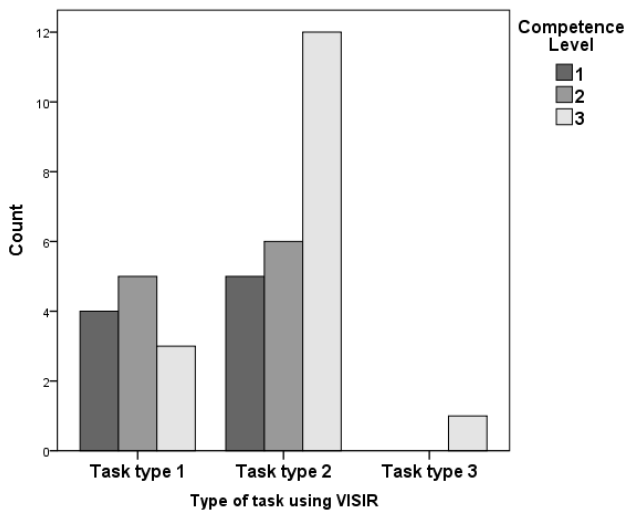

Figure 5: Competence level/type of task

When developing the Task type 1 (doing some circuits assembling and some parameters measurements) teachers are proposing to students level 1 competences achievements and eventually depending on the tasks details (developed in groups, requires a written report, etc.) some soft skills (level 2). The Task type 2 (tasks in which circuits assembling and parameters measurements are required and students were supposed to compare these results with the theoretical expected values and the results obtained with other resources) clearly may develop competences from level 1 and 2 and eventually level 3, depending upon the type of analysis required.
Still as we can observe in Figure 5, teachers planned to develop not only competences of level 1 but also level 2 and 3 competences with the Task type 1. The development of competences of level 3 were also defined by teachers while developing the Task type 2.
Several courses had several editions with the same teachers indicating teachers appreciated the resource. Teachers identified much more positive factors than negative factors when expressing their opinion about VISIR (Table 4); in fact in 10 implementations teachers did not mention any negative factor. The most mentioned positives factors were increase students practice and motivation and diversify teaching methods. The negative ones were some configuration issues and system instability. Teachers also mentioned 2 more negative factors: they needed time to learn how to use the tool – being a new tool teachers need to spend some time to gain the knowledge and confidence to use it and help students overcame their initial difficulties; the interface is old fashionable / too simple – VISIR was launched in 2014 and although during this period it has undergone some changes and updates, the interface may be considered a little old fashionable for this generation of digital natives. An external factor, which may compromise teacher satisfaction and usage of the tool was also identified: computers and/or computer room not adequate/available.

5 Conclusion

While analyzing the data from these courses' implementation results, some interesting factors emerge. The number of teacher logs per task differs substantially in the different implementations and it would be interesting, in a future work, try to explore the factors that may contribute to this variation. Factors like: teachers' background and experience in electric and electronic circuits, teachers' sensitivity to this type of resource and the support teachers have (or not) in the task preparation phase (in some HEI there is technical staff that can implement the circuits in the VISIR system while in others is the teacher that has that responsibility) may affect this number.
Teachers' introduction and support to VISIR was adequate, contributing to students' engagement and motivation. It seems that students also benefit from performing the tasks involving VISIR in groups – it has a positive impact in students' acceptance of the tool. Some mismatch was found between the learning goals, namely the level/type of competence teachers want students to develop with VISIR and the type of tasks proposed/ implemented. We realize that teachers must be extra careful while planning the activities with VISIR in order to diminish this difference.
Finally answering the research question: "Which didactical implementation design factors seem to influence students' performance and motivation according to teachers' perception?" some factors were identified:

- Teacher introduction to VISIR and support during the semester plays an important role in the implementation success.
- Students who developed group tasks were more motivated and engaged to use VISR.
- Teachers should plan VISIR tasks carefully, according to the type of competences they want their students to develop.

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