

# Prototyping Feedback for Technology Enhanced Learning

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**Abstract** — The development of new educational technologies, in the area of practical activities is the main aim of the FP7 PELARS project. As part of the constructivist learning scenarios, according to the project proposal, the development and evaluation of technology designs are envisaged, for analytic data generation for Science, Technology, Engineering and Mathematics (STEM) subjects, such as: technology solutions, infrastructure, activities, assessment, curricula, and classroom furniture and environment designs. Inside four EU national settings, three separate learning contexts are being dealt with – from secondary-level high school STEM learning environments to post-secondary level engineering classes and design studios. Given this experience and framework, the present paper provides a perspective on the importance of using such research experience and iterative prototyping in real learning environments for engineering students.

**Keywords** — educational technology, experiential learning, prototype feedback.

## I. INTRODUCTION

The PELARS EU funded FP7 research grant envisages the development of new educational tools. According to the project proposal [1], [2], research rolls around the analysis and feedback generated by hands-on analytics, project-based and experiential learning scenarios (Fig. 1). Focused on technical subjects in the fields of Science, Technology, Engineering and Math (STEM) such as: technology solutions, infrastructure, activities, across the EU, for four national areas [3], project research determines and evaluates, from different perspectives, available options in terms of technology designs for analytic data generation for constructivist learning scenarios. The main instruments for such an activity are the teacher, learner engagement, but also studies and evaluated trials. These tools provide activity data such as moving image-based and

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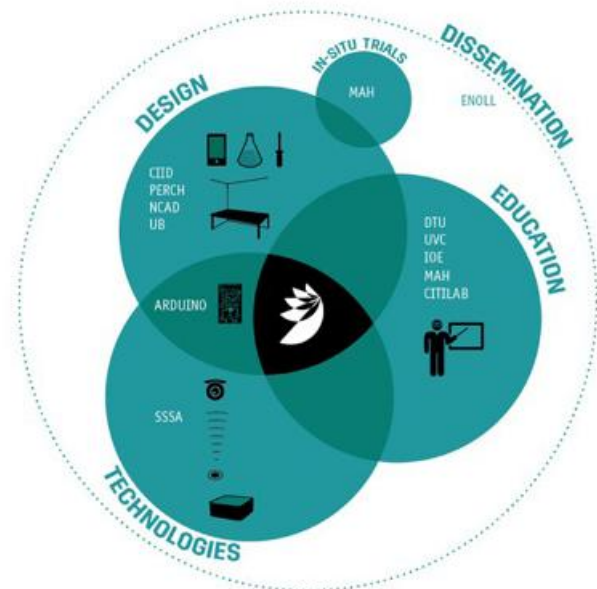


Figure 1 PELARS

embedded sensing - for all technological tools and ICT-based methods and learning analytics such as data-mining and reasoning for practice-based and experiential STEM. The obtained data represents the main input in building support tools for professors, learners and administrators, but also in designing the necessary framework required by existing learning ecosystems and by evidence-based curriculum design.

Leaving from the research partner's experience, the main aim of the project [4]-[8] is to provide a prototype for real learning environments. In achieving this aim, a dedicate work package has been included in the proposal consisting in the design of an iterative process meant to create such a prototype. It contains mainly ethnography methodologies designs and on-site experience prototyping, integrated into three parallel contexts: Interaction Design Education, postsecondary engineering education, secondary - level high school learning environments, and involving groups and individuals from the STEM subjects teaching and learning areas. The development of a new educational furniture and the placement of dedicated equipment was required by this need to put into practice the new learning environment. At the same time, aiming to ease self-documentation, multimedia collection and learning analytics retrieval and feedback (real-time and offline),

possible classroom restructuring designs have been assessed. Furthermore, hardware & lab ware kits are necessary in developing the new learning environment and in implementing the new educational technology.

According to the program description, this work package should finally provide an integrated kit useful for the teaching of STEM subjects on two different levels - high school and post-secondary engineering, but also in interaction design. ARDUINO hardware and IDE will represent the basis for such a kit, and also “non-technological” learning materials or “lab ware” will be involved.

Results of the research proposal are meant to be tested under the reality of existing educational processes, and thus, PELARS envisages implementing real-world trials of technologies and designed systems. Feedback would finally be evaluated under the above stated three STEM learning contexts: interaction Design Studio Education, post-secondary Engineering laboratory, and high school-Level Learning Environment. Criteria and guidelines for such testing are the ones provided by the European Association for Education in Electrical and Information Engineering [9], given the need for coherence of formats and communications with accreditation standards.

## II. ITERATIVE PROTOTYPING FEEDBACK - POST-SECONDARY ENGINEERING

### A. General Description

University of Craiova (UCV) from Romania and Technical University of Denmark (DTU) from Denmark are the two

engineering higher education institutions where the new PELARS technology is tested. In this paper we are focussing on the UCV involvement in this process. At UCV we used three ways to perform the research regarding the needs of rethinking the way in which we are developing the practical activities, the solutions we are proposing, and the possible impact of the implementation of the resulting educational technology: direct activities with students and teachers along the study year 2014-2015, one workshop organized at Craiova in the summer of 2015, and the brainstorming organized during the participation to three international scientific conferences [10].

Some findings confirmed the advantage of the educational technology proposed by PELARS system, but we identified also concerns regarding the effects of the proposed educational technology meaning future investigation are needed in order to find the answers and/or solutions. We identified a number of interesting suggestions from the points of view of organization of the activities, and of system development. Similar activities were performed at DTU in order to put in work the idea of having two complementary ways to test the PELARS prototype in the engineering field: one at an university from east of Europe, from a country recently aligned to EU policy regarding higher education, and the other from a western country having a longer tradition in implementing these policies.

The overall objective for the user experience research and iterative prototyping in real learning environments is to engage, through design ethnography methodologies and on-site experience prototyping, with groups and individuals involved

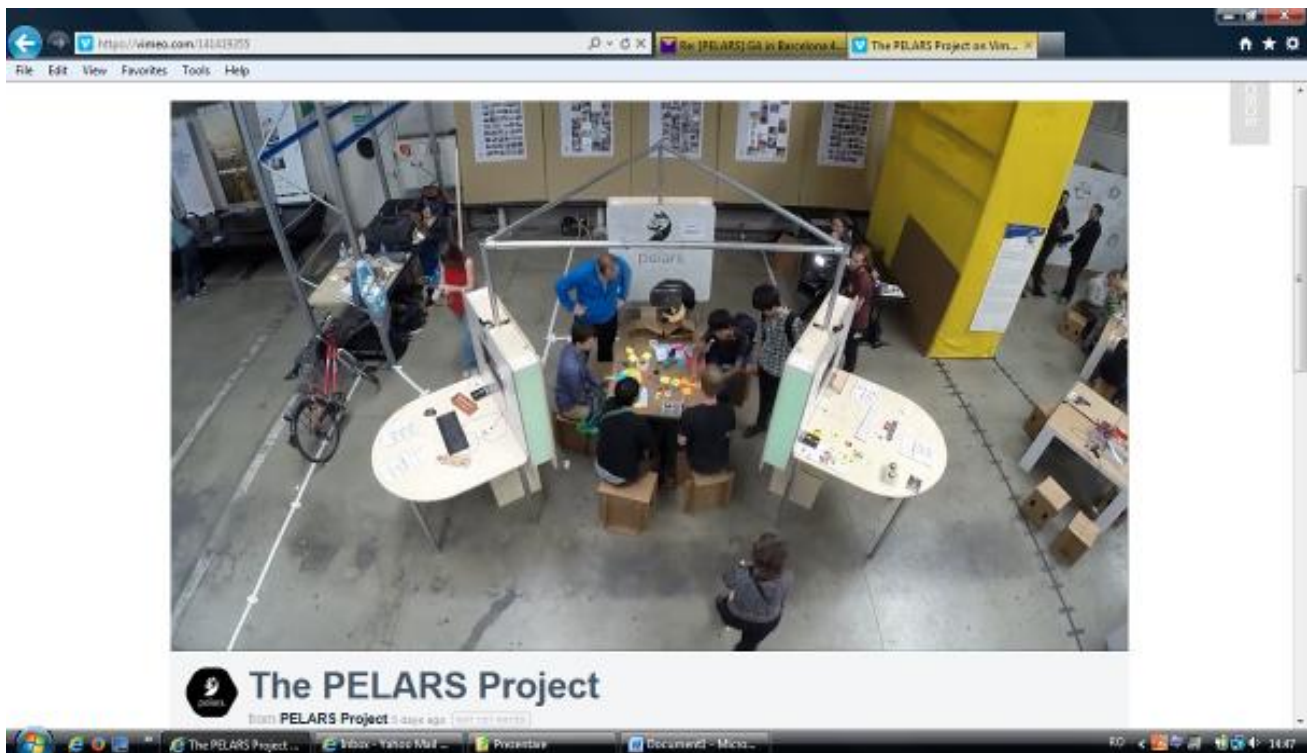


Figure 2 PELARS Environment

in teaching and learning of STEM subjects in three different contexts: secondary-level high school, interaction design and post-secondary engineering education – the subject of this paper. The major outcomes of this activity are setting opportunity spaces for the research and development work to follow through other PELARS activities, as well as situating the on-going work in the context of real users throughout the project.

The PELARS partners used a variety of research, ideas and concepts, as well as prototyping methods to examine and challenge the project's research questions and propositions within the context of real world learning environments. This way they provided the planning, scheduling and conduct of intermittent prototyping, orientation and design feedback sessions with students and teachers from existing educational contexts, including engineering higher education, established during the contextual user-research phases of the project.

### B. Aim of Deliverable

In the frame of PELARS we are working to develop new technologies and processes for teaching and learning for design, engineering (as part of STEM) through practical applications. UCV acts to fulfil two objectives of PELARS, first, we collected and analysed the information to defining the actual way in which the laboratory/workshops activities are performed at higher university engineering. Second, we evaluate the use of the PELARS prototype in the frame of the education for engineers. Taking into consideration the PELARS objectives we are interested to investigate the different users (students and teachers) opinions regarding the features offered by PELARS technology and what could be added or modified. An important aspect in our definition is use of learning analytics resulting from the use of these new educational technologies. Finally, after testing the new systems offered by PELARS, we will address the need to modify the educational context: to adapt the curricula and to propose new formative assessment procedures that potentially change the accreditation process.

Each program, in order to offer a recognized diploma, must be checked, evaluated, at the beginning and periodically after that, by a quality assurance body recognized in every country, and in many cases in EU. This is called "the accreditation", the term widely used to ensure the free movement of workforce in the world [11], [12].

In order to fulfil the upper objectives, UCV can act directly in the field of his bachelor and master programs. Performing common actions at Craiova or abroad, UCV cooperated with the other partners from PELARS consortium. The team's members have useful links in the academic and research world and during scientific meetings could disseminate the objectives, actions and accomplishments of PELARS. Useful information are collected, analysed and synthesized regarding the experience of our partners from Romania or from other EU or non EU countries in implementing new educational technologies in the field of engineering higher education [13].

### C. Core Research Questions

Analysing the technological changes occurred in the last century and comparing with the teaching method evolution, we are able to state that the need to modernize and adapt the educational system is very important. There are two main targets identified by PELARS: first to improve the abilities to cooperate and second to give students the skills needed to self-solve practical problems. In this context, we are interested in find answers to the following questions:

- What it is needed to change in the actual methods to perform practical experiments at engineering higher education in order to support the achievement of the upper motioned skills?
- How PELARS technology could contribute to design and implement the identified changes?
- What is the impact of the PELARS' technology seen from the final users: students and teachers?
- What is useful, what will be difficult to apply and/or what could imply unexpected (maybe unpleasant) consequences?
- Will the new technology change the accreditation procedures?

## III. RESEARCH ACTIVITIES AND METHODS

As we already mentioned, at UCV we used three ways to perform the research regarding the needs of rethinking the way in which we are developing the practical activities, the solutions we are proposing, and the possible impact of the implementation of the resulting educational technology:

- Direct activities with students and teachers along the study year 2014-2015,
- One workshop organized at Craiova in the summer of 2015, and
- The brainstorming organized during the participation to three international scientific conferences.

### A. Longitudinal Engagement with Educators and Students

During the academic year 2014-2015 the teachers from UCV involved in PELARS organized informal meetings with students (especially during practice activities) and teachers (especially during department meetings). The students were enrolled in 7 bachelor programs and 3 master programs, including Mechatronics, Robotics, Multimedia Systems, Control Systems, and Electronics.

During these informal meetings, our researchers presented the PELARS new educational technology. Suggestions for improvements and discussion focused on the PELARS project in context of designing the trials for UCV using the full system for summer 2016. We paid important attention to the students participating to mechatronics and robotics competitions because they have a valuable experience for PELARS taking into account that the subjects of these competitions are very similar with the scenarios proposed by our new educational technology.

The UCV team's members are performing labs and practical works with students from many study programs. During these activities, mainly practical stages, we presented PELARS to

our students and teachers colleagues and we discussed with them about this subject. The goal of this daily research at UCV during the academic activity (interaction between teachers and students) was to find answers/opinions to some of the following problems:

- How to select the theoretical support, how to give access to the theoretical references, how to formulate the target of the lab.
- What type of data/feedback support can be meaningful for students?
- What type of data/feedback support can be meaningful for teachers?
- How to evaluate the activities performed during the lab in term of cooperation, discovering new things and error solving.

### *B. Learning Activities Prototyping*

In the summer of 2015 we did not have a working prototype to test directly at UCV. We know the structure and the functions of the PELARS prototype. In these conditions, we organized a workshop at Craiova having the support and direct participation of two partners from Sweden and UK. We had a two day workshop at UCV with students from two programs: Mechatronics and Robotics (more practical oriented) and Multimedia Engineering Systems (more software oriented and with a better theoretical background) and two group interviews with teachers (mixed subjects) at UCV. We used the context of a summer school organized at UCV during July 2015 to run a workshop with students and teachers with the following intentions:

- To collect data about UCV students' ideas regarding the potential learning activities which can be applied with the PELARS technology we aimed to develop. We also collected students' feedback on the latest learning activities we had developed at that time. We wanted to hear, in a dialogue with other people than their own teachers, how they consider the actual way to perform labs compared to PELARS proposals. We attempted to experiment on how engineering students from different programs are able to work together in proposing solution for different problems without using a specific theoretical base. The main goal was to obtain and to discuss few proposals generated by students for practical scenarios that can be possibly used to teach with for labs using PELARS technology, methods and equipment.
- To collect some data from UCV teachers' about their current practice of laboratory sessions and their ideas about how to integrate PELARS technologies in their teaching practice. The data collection was done in an informal focus group interview setting and it was audio recorded.

Workshops are video and audio recorded and interviews are audio recorded for future references.

Student workshops were planned as follows:

- Introduction to PELARS project,
- Presentation,
- Research consent forms,
- Introduction to visual programming platform,
- Presentation of educational scenarios,

- Introduction to brainstorming,
- Brainstorming about the learning activities,
- Three questions about the learning activities.

Regarding the participation of students and the resulting information, we can synthesize as it follows. The number of participants was 14 for 13th of July, and 15 for the 14th of July. Students were from the programs of Mechatronics & Robotics (third year of study), respectively from Multimedia Engineering Systems (second year of study). Both programs offer a bachelor diploma in engineering after 4 year of study.

Not all students had done brainstorming before so some found it very hard in the beginning. There was also language barrier for some students, even though lecturers from UCV put a reasonable effort to translate. Overall, the brainstorming as a workshop strategy is welcomed by students with great enthusiasm.

After the introduction of the learning activities we had in mind so far, with the purpose of getting students' feedback on them and refining them, we asked students to answer the three questions below. Thinking about this learning activity:

- What would you keep exactly the same?
- What would you change?
- What would you get rid of completely?
- We asked specific questions which were always the same ones and the presenter (the researcher) raised them.

The brainstorming was inspired by different methods [14], [15] where different teams generate ideas and other teams add to these ideas flushing out and evolving them. After breaking into groups, we started brainstorming with a warm-up exercise like a smart pet toy, and then each group did small individual brainstorms and as a group choose, a good, a wild and bad idea to present to everyone. Researchers decided on the fly which 3 or 4 ideas to pass around for the second brainstorming session. Each group got an idea to be further developed, but had to pass it on while they further developed one of the other ideas.

From the students' perspective, in the previous page, workshop plan explains the actual task of the workshop for students as being brainstorming about the learning activities. At the end of the first day of the workshop students generated a few interesting learning scenarios including touch less bathroom, sound activated smart car and smart environment which helps people lead a healthy life. However, those learning activities were not limited with the visual technology modules we had at that moment.

In the second day of the workshop we limited students to brainstorm about learning activities could be done with the ARDUINO technology we already developed. They struggled even more during brainstorming but in the end came up with three more learning scenarios: A smart shoe scenario which can adapt to different temperatures, a smart gym tool which counts reps and indicates when it is time to clean the surface and a smart toddler bed (crib) scenario. Students were given feedback on how their ideas evolved after the workshops in a design critique format.

There were two significant outcomes of the student workshops.

First of all, it gave us a better idea about which subject and what year students we will use for the trials. Hence, for the trials we would like to recruit as many third year Mechatronic and Robotics students as possible.

Second, many of the students were aware of the time limitations and technology related problems occurred during their lab projects. New ARDUINO modules with visual programming interface which allow students to design faster with less technology related problems were introduced to students during the workshop. Students commented that they can spend more time and effort on different designs and be more creative in their projects using new modules. The most of the learning activities suggested by students were not novel for us. However, considering the fact that students did not point out any potential problems with the application of those learning activities, they somehow (please also see student finding number 9) confirmed the potential of the learning activities we designed as appropriate for PELARS.

During the workshop a number of six teachers from UCV (two professors, two associate professors, and two assistant professors), all with PhD in engineering, were involved.

On the other hand, teacher interviews were unstructured and only audio recorded with the permission of lecturers. We attempted to generate an informal and friendly discussion environment to gather genuine opinions of the lecturers. Some insights generated from the teacher interviews are presented below. Although, many of them were not novel to us, they helped us to confirm our assumptions:

At the moment, students' practical work activities in engineering context are very well structured, strongly connected with the learning outcomes of the curriculum and assessed with reports.

There is very little explorative practical work due to limited resources, time limitations and problems with the assessments of explorative practical work. Teachers argue that there should be more explorative work as the current system does not teach students to 'transfer' their knowledge.

The engineering teachers have some experience in teaching visual programming (mainly with LEGO Mindstorms).

The engineering teachers find it very hard to control groups which have different levels of knowledge, skills and talents. In addition, the idea of setting up the PELARS system within a competition context was identified by PELARS representatives participating to the workshop as being extremely stimulating. The idea appeared taking into consideration, first the experience of UCV in organizing this type of competitions involving students but also candidates for higher education in engineering (young boys and girls from high schools), and second the similarity between the scenarios proposed for these competitions and the ones proposed by PELARS.

There seem to be deeply rooted cultural and historical reasons for the appreciation of competitions and this decision was taken into consideration while designing and organising

trials. The working concept for the trials in the summer of 2016 will be based on idea of competitions and hackathons. For instance eight groups of students will compete over several days. First day in short heats (60-90 minutes) the teams will compete in pairs. In the next round (semi-finals) the four winners will compete in another heat. The following day will be the finals, and teams will compete for first, second, and third place in slightly longer heat (90-120 minutes). The projects will be judged by a group of experts (teachers, industry partners, and students).

### C. Expert Feedbacks

In addition to the feedback collected continuously at the UCV, Faculty of Automation, Computers and Electronics and during the specific prototyping session in July 2015, we obtained expert feedback from educators and researchers in the field of engineering during three international conferences. These feedbacks was merged with the information acquired from the teachers from UCV in order to obtain a more comprehensive point of view and even to validate our proposals regarding the new teaching technology proposed for the higher education in engineering.

Similar activities were performed at DTU in order to put in work the idea of having two complementary ways to test the PELARS prototype in the engineering field: one at an university from east of Europe, from a country recently aligned to EU policy regarding higher education, and the other from a western country having a longer tradition in implementing these policies.

The first venue where we engaged with teachers and researchers from robotics higher education was the participation to the 24th International Conference on Robotics in Alpe – Adria - Danube Region, RAAD 2015, Bucharest, Romania, 27<sup>th</sup> – 29<sup>th</sup> of May, 2015.

The second one venue where we engaged with education experts from electrical engineering and information technology was the participation to the 26<sup>th</sup> EAEEIE Annual Conference, 1-3 July 2015, Copenhagen, Denmark, and to the meeting of the European Association for Education in Electrical and Information Engineering (involved in LLP SALEIE program).

The third one was the 19th International Conference on System Theory, Control and Computing, Joint Conference SINTES 19, SACCS 15, SIMSIS 19, October 14 - 16, 2015, Cheile Gradistei - Fundata Resort, Romania. In the program of this conference was introduced a special session "Objectives and Achievements of a FP7 Program – Practice-Based Experiential Learning Analytics Research and Support - PELARS"

The goal of the expert feedback from the international conferences was to elicit colleagues' opinions to some of the following questions:

- What type of data can be collected from the intelligent sensorial and communication system (including computer vision system) in order to evaluate the cooperation between students, the access to the source of information, the response to unusual situation (errors, lack of information, not enough

time to finish the task, concurrent use of resources)?

- What type of learning analytics must be added in order to adapt to the new teaching technology?
- How to evaluate the new teaching technology from the point of view of accreditation procedure for the engineering program. It is possible to satisfactory answer to the existing accreditation procedure or it is needed to propose different procedure for the new proposed technology?

#### IV. FINDINGS

The following section presents a summarized list of the findings from the workshops at UCV with students and teachers and the three conferences. The workshops at UCV were conducted together with University College London (UCL) and Malmo University (MAH). While the conferences workshops were organized by UCV.

##### A. Students

Below in table 1 the findings from the students are summarized. In general the findings point towards opportunities for different parts of PELARS project to have real-impact on their education in future exploitation.

Starting from the analyse of the actual way to develop the practical application at the UCV we search to adapt the new education technology proposed by PELARS in order to support both the cooperation abilities of the engineering students and the their skills needed in self-solving practical tasks. Current, research findings show that the competition format fits the culture of University students in Romania and would provide a good opportunity for the PELARS to explore different types of learning activities.

<b>Findings from Students (UCV Workshops)</b>	
Student finding 1	Usually UCV students do not practice brainstorming or other prototyping techniques as much as they like in school (teachers and students report). The new way to perform the labs seems attractive and interesting.
Student finding 2	UCV students use mostly LEGO Mindstorms as their intro to embedded systems. This should be an advantage in performing the labs in an interactive way and constructing systems starting from parts.
Student finding 3	Another advantage is that students from UCV use Arduino for their final thesis project due to costs, ease of use, and community of support compared with the more commercial mechatronics systems the school has in its labs.
Student finding 4	UCV engineering course for embedded systems has 7 or 14 laboratory (depending on the program) and project in their semester. Students asked if the new way to perform the labs will be compatible with this crisp way to divide the time allocated to this activity.
Student	At UCV Labs are connected to theory and students

finding 5	need to submit reports (with graphs and solutions e.g. code) as part of their assignments, a typical lab has a topic of computer vision and students need to complete a task with software and hardware. Also from this point of view, the new way to perform the labs seems attractive and interesting (confirming the hypothesis known indirectly before the workshop).
Student finding 6	The main outcome of the UCV students meeting was a number of scenarios for lab activities but also good as themes for student competition: Smart Car Scenario Prototype with 6-axis Accelerometer as the key module, Smart home, smart voice, Smart bathroom, Smart baby crib, Smart Shoes.
Student finding 7	The fact that a student is better in learning theoretical knowledge it is not enough to be better in practical application, cooperative work or discovering new thing was confirmed during the debates with students from the two programs.
Student finding 8	Students are concerned about the fact that acting under PELARS system surveillance they will need to learn a new way to act during labs, other than solving their own task. They proposed to have some training period at the beginning of each cycle of using PELARS technology.
Student finding 9	Students did not point out any potential problems about the learning activities we plan to use in PELARS trial sessions.

Table 1: Summarized findings from Student workshops.

##### B. Educators

Below in table 2 the findings from the educators are summarized. In general the educators provided constructive feedback to the PELARS concept. They raised concerns about what type data is being collected and the impact that has their assessment and the student's learning outcomes.

Interestingly, the educators see the need for learning analytics and the support that future systems can have (scaffolding and expert like systems) for practice-based learning.

<b>Findings from Teachers (Workshops and Conference)</b>	
Teacher finding 1	The main outcome of the teachers meeting at UCV, was a general idea to create a mini-competition in the July practice period where 8 teams would compete using the PELARS system over 3 heats, with different projects/tasks for each. The idea being that we could create, analyse, and visualize the winning strategies based on the quality of the solutions.
Teacher finding 2	To track faces and hands is useful. Tracking eyes looking to some region of interest, if possible, should be also useful.
Teacher finding 3	To track objects is useful. Pose estimation for some objects of interest, if possible, should be also

	useful.
Teacher finding 4	Some participants to the conferences (strongly oriented to academic approach) fear that may happen a lowering of the academic education and maybe this way we will produce technician instead of engineers.
Teacher finding 5	Teachers believe that it is not a good idea to try to create a technology good for any type of lab. The best way is to create few pilot applications in order to get the trust of the users and to continue to add, step by step, new type of application increasing the performance together we the trust of users. They suppose that the best way to promote the PELARS achievements is to have in each partner institution a room organized in the PELARS way (equipment and scenarios) and then the students to perform some lab activities from different disciplines in this room instead to do there all the labs activities from one or for many disciplines. This way to organize the lab activities should be an answer for the concern signalled one question before and could help to increase the trust in our proposal by supporting a good start of his application.
Teacher finding 6	Teachers have a big concern regarding how the PELARS proposals will act in purely software labs.
Teacher finding 7	Some teachers are also concerned, somehow in a similar way we students, regarding the effort they need to use / to process the data collected during the labs. They are asking if they will need more time after the lab to fulfil the PELARS teaching technology demands.
Teacher finding 8	Teachers have different opinions regarding the evaluation of creativity. Many of them believe that only the final result could receive the label of creativity and no the actions during the lab activity.
Teacher finding 9	Some of the teachers signalled that a contradiction could arrive between “cooperation” and “creativity”. The cooperative style of work could be appreciated by the exchange of objects and information between partners during the work. Creativity could be equivalent with a result obtained by yourself, in your own way to act different from the way in which act the others.
Teacher finding 10	Regarding the evaluation process for the accreditation, one opinion is that if we are mainly focusing in final achievements / skills than will not be supplementary problems from this point of view.
Teacher finding 11	If the PELARS teaching technology will provide new skills that usually are not considered by the classical way to teach, than a proposal for changing the older evaluation procedure must be proposed to the quality evaluation bodies.

Teacher finding 12	An observation was formulated by EAEEIE members involved in the LLP SALEIE program: the new educational technology could have problems when students with special needs are involved. We suppose that some of the features proposed by PELARS could also help the students having special needs. We need to investigate this problem in the future. During the EAEEIE Conference in Copenhagen, naturally the majority of participants were members of the EAEEIE (European Association for Education in Electrical and Information Engineering) organization and by consequence the information acquired during this scientific meeting could be considered representative for the way in which this problem is considered inside this organization.
Teacher finding 13	Another observation from EAEEIE members [9] involved in the LLP SALEIE program [13]: to connect the new educational technology, supporting the cooperation and discovery by doing, with educational policy at university, national and European levels. EAEEIE organization is focussing in fulfilling are two major objectives: one is related to the problem of the student with special needs (see the upper item), and the other is the problem of designing and implementing coherent educational policies across EU.

Table 2 summarized finding from teachers and educators.

## V. CONCLUSION

Some findings confirmed the advantage of the educational technology proposed by PELARS system. The proposed educational technology looks attractive and interesting compared with the old methods based on learning too much theory and not doing enough creative and cooperative practice. A number of UCV students have a good experience in using ARDUINO components and building systems using mechanical and electronics parts, and by consequence they appreciated the new proposal. Students with good skills in doing practical applications see in the new educational technology a way to recover what was until now a disadvantage in the comparison with students with better skills in acquiring theoretical knowledge. (See tables 1 and 2 and points Students 1-3, Student 5, Student 7, and Teacher 10)

Concerns were formulated and future investigations are needed in order to find the answers and/or solutions. Following the received concerns we must discuss if the length in hours of one lab must remain to 2 hours or we can merge and redefine the length of the labs.

We must find if the proposed technology could be applied or not in some particular fields like software applications (e.g. application similar with visual programming where students could cooperate in connecting already existing blocks in order to design and test an application) and in regard with students with special needs.

We must find a way to apply and to present the new educational technology in a way to assure the educators from higher education system that this technology will not decrease the academic level of the system. Also to assure them that the new technology will not bring an extra effort in processing the data acquired during the labs. We must find a way to measure in a proper way the creativity. (see tables 1 and 2 and points Student 4, Teacher 4, Teacher 6 & 7, Teacher 9, and Teacher 12)

From the point of view of organization of the activities, we identified interesting suggestions. We defined a number of scenarios suitable for the new technology and we are working to improve them after the first trials. It should be useful to organize a training séance at the beginning for each group of students in order to improve understanding of the new technology and how to use it. Our proposal is to run some of the labs with new technology and some with traditional old methods.

After the implementation of the pilot application, the analysis and the validation of the results will be used in order to promote a change in educational methods (PELARS) in the accreditation procedure. The PELARS technology could be included in engineering programs at different levels, like Bachelor- and Master-levels. (see points Student 6, Student 8, Teacher 1, Teacher 5, Teacher 8, Teacher 11, and Teacher 13 in table 1 and 2)

We also identified interesting suggestions from the point of view of system development:

- Tracking eyes looking to different region of interest,
- Pose estimation for the different object (not only the position) are two features that were considered to very interesting if possible to be determinate from the point of view of the electronics technology. (Points Teacher 2 & 3 in tables 2).

When the consortium of PELARS was designed we had in mind the idea of having two complementary ways to test the PELARS prototype in the engineering field: one at an university from east of Europe, from a country recently aligned to EU policy regarding higher education, and the other from a western country having a longer tradition in implementing these policies. By consequence, the UCV from Romania and DTU from Denmark were selected as partners for the engineering field of PELARS.

The Engineering prototyping continues and we are currently running tests on the educational activities of the smart home and the sorting scenarios in engineering courses at MAH. Additionally, an educator from DTU is coming to MAH and as researchers we will run through the educational scenarios with them. Work continues on the ARDUINO kits to test compatibility with motor controllers and relay boards.

Once we have collected data from these meetings some partners will discuss how to refine the materials to fit both the needs of the trials, dissemination, and interface with the partners involved in implementation of the visualization's techniques.

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