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Adapting the Accreditation Procedures to a New Educational Technology

Dorian Cojocaru, Razvan Tudor Tanasie, and Anna Friesel

***Abstract*—The FP7 PELARS (Practice based on Experiential Learning Analytics Research and Support) project deals with the problem of developing a new educational technology for practical activities. As it is stated into the project proposal, the project produces and evaluates technology designs for analytic data generation for constructivist learning scenarios in Science, Technology, Engineering and Math (STEM) topics, including: technology solutions, infrastructure, activities, assessment, curricula, and classroom furniture and environment designs. The project addresses three different learning contexts (postsecondary design studios, postsecondary engineering sciences classrooms, and secondarylevel high school STEM learning environments) across four national settings in the EU. In the upper defined context, this paper deals with the problem of adapting the accreditation of the engineering programs to the new educational technologies.**

***Index Terms*—Educational technology, experiential learning, accreditation.**

I. Introduction

The reality of our times includes the process of globalization not only from an economic point of view, but also from academic perspective [1]. The higher education institutions work hard to align their academic procedures to the global academic environment. An important part of this effort is monitoring the international initiatives which ensure that quality evaluation procedures support the integration into the international higher education environment.

Let suppose the following scenario (Fig. 1). Before the Great War, greatgrandfather John had been frozen using a cryogenics technology. At the beginning of the 21st century, greatgrandfather John was revived. Greatgrandfather John was super stressed given the technological novelties: communications, multimedia facilities, computers, transports and a lot of other changes (Fig. 1). A refugee is needed to offer greatgrandfather John a place to recover. A museum! Or better a school! Even though, nowadays, in many places the students are placed the same, often teachers teach similar subjects on mathematics, physics, chemistry, history even appeared some new chapters, in many cases teachers examine in the same manner.

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II. PELARS

A. General Description of the Project

PELARS is a FP7 EU program proposing to contribute to introduce new educational technologies. A short description of this program will follow as it is presented within the proposal [2], [3].

The PELARS project generates analyses uses and provides feedback for analytics derived from handson, projectbased and experiential learning scenarios (Fig. 2). The main purpose of PELARS is to design new education technologies. In order to perform this tasks, insitu trials are performed by partners (small letters in Fig. 2 identify the partners institutions). The project produces and evaluates technology designs for analytic data generation for constructivist learning scenarios in Science, Technology, Engineering and Math (STEM) topics, including: technology solutions, infrastructure, activities, assessment, curricula, and classroom furniture and environment designs. The project addresses three different learning contexts (postsecondary design studios, postsecondary engineering sciences classrooms, and secondarylevel high school STEM learning environments) across four national settings in the EU [4]. This is done through teacher and learner engagement, user studies and evaluated trials in all three of these contexts. The PELARS project provides technological tools and ICTbased methods for collecting activity data (moving imagebased and embedded sensing) for learning analytics (datamining and reasoning) of practicebased and experiential STEM. This data is used to create analytics support tools for teachers, learners and administrators, providing frameworks for evidencebased curriculum design and learning ecosystems.

The PELARS project creates behavioural recording inputs, proving a new learning analytic that is scalable in application, and bridge qualitative and quantitative methods through reasoning and feedback from input data. The project serves to help better understand learners' knowledge in physical activities in laboratory and workshop environments, as well as informal learning scenarios. PELARS traces and helps assess learner progress through technology enhancement, in ways that have been unattempted and unscalable until now. The project results in learning analytics tools for practicebased STEM learning that are appropriate for realworld learning environments.

One of the main purposes of the project is to use partner’s experience and design a prototype materialized in a real learning environments.

A special work package was dedicated to the iterative process of developing this prototype. The objective of this work package is, following the description from the proposal,

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to engage, through design ethnography methodologies and onsite experience prototyping, with groups and individuals involved in teaching and learning of STEM subjects in three different contexts: Interaction Design Education, postsecondary engineering education, and secondary level high school learning environments.

Fig. 1. Great-grandfather revived.

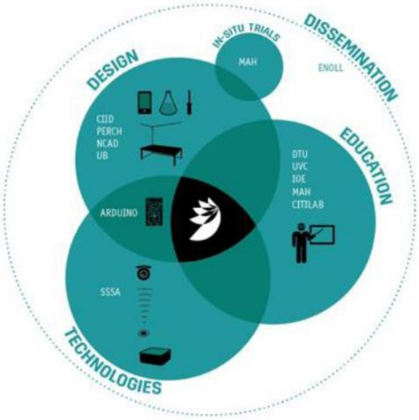

Fig. 2. PELARS: Design, education, technologies.

In order to implement the new learning environment the design of a new educational furniture was needed and the placement of dedicated equipment there was also necessary (Fig. 3). Furniture, and architectural elements, as well as designs for the restructuring of the classroom, towards the ease of selfdocumentation, multimedia collection and learning analytics retrieval and feedback (realtime and offline) were investigated.

Having the new learning environment, in order to implement the new educational technology, hardware & lab ware kits are needed. As stated in the program description, the objective of the dedicated work package is to develop and implement an integrated kit for the teaching of STEM topics in high school, postsecondary engineering and interaction design. The kit development will include Arduino hardware and IDE (Integrated Drive Electronics), as well as “nontechnological” learning materials, or “lab ware”. The kit is to integrate learning analytics and autodocumentation concepts. The “nontechnological materials” are to supplement the base electronic interface systems and software (e.g.: laboratory glassware, vegetation for biological study, the design and implementation of simple ‘probes’) and allow for a sensor system that is both integrated with the interfacing hardware.

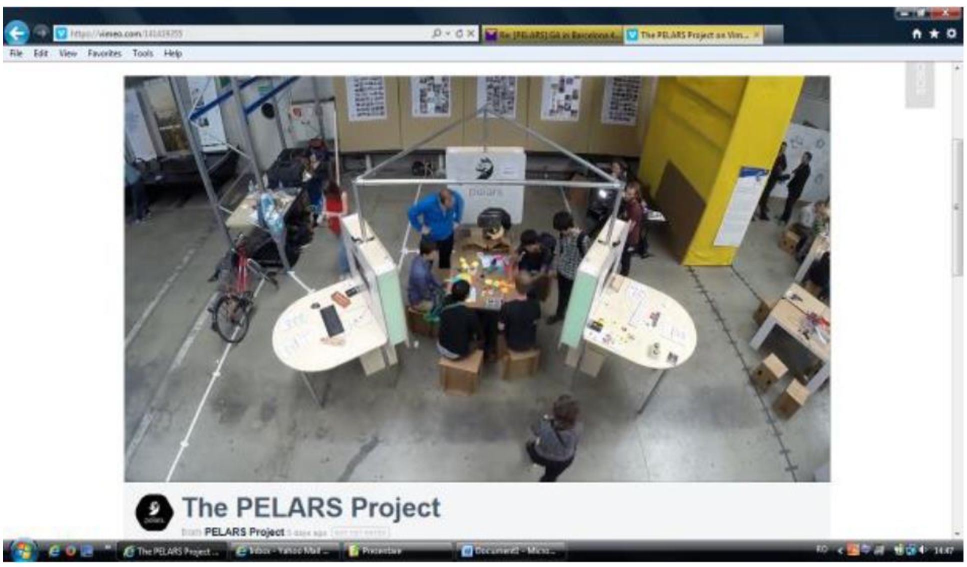

Fig. 3. PELARS environment.

PELARS focuses on a new educational technology and by consequence, using the already mentioned resources, the partners will contribute designing learning activities, including new curriculum. In the PELARS official documents, these activities are described as it follows.

The learning analytics derived from the project technologies must be integrated with curriculum learning objectives in STEM classrooms. This includes examining how curriculum objectives shape design of learning activities, and formative and summative assessment, with a particular emphasis on the use of technologies in and outside of the classroom. These elements of curriculum and practice will be examined from the perspectives of the teachers and school management, thus encompassing both practice and policy, and the processes of interaction between them.

B. Objectives

The work will involve four main objectives:

To examine current curriculum objectives practice and inquirybased learning, teaching practice / learning designs and school policy, and through this to understand current processes in assessing curriculum objectives, with an emphasis on the use of technologies both within and outside the classroom.

To examine current processes for innovation within STEM classrooms to better meet and assess curriculum objectives, with an emphasis on technologies both within and outside the classroom.

To research new curriculum models made possible by the tools developed in the PELARS project.

To develop support material for STEM classroom activities enhanced by the PELARS learning technologies.

The idea is to find a way to align curricular objectives to the possibilities for formative and summative assessment and support for 21stCentury skills arising from the learning analytics tools created through PELARS, and to create a tighter coupling between curriculum and how it is practically implemented in the classroom, and the measures developed within PELARS for the tracing of learning process in project and inquirybased learning.

The proposed solution must be tested in real educational processes. By consequence, the PELARS proposes to develop, design, run, and evaluate realworld trials of technologies and designed systems. These trials will focus on three different STEM learning contexts: interaction Design Studio Education, postsecondary Engineering laboratory, and high schoolLevel Learning Environment.

From the point of view of dissemination, community and communications, PELARS assumes to use the existing potential for PELARS learning analytics to deliver metrics for the accreditation processes of design, engineering and other postsecondary degrees. In order to accomplish this task, a plan of interfacing with professional bodies of accreditation will be put in work.

Project partners will use criteria and guidelines for experiential learning format from the European Association for Education in Electrical and Information Engineering), in order to develop formats and communications of project research for engineering accreditation standards and bodies.

III. PELARS Prototype Testing

University of Craiova from Romania and Danmarks Tekniske Universitet from Denmark are the two engineering higher education institutions where the new PELARS technology will be tested.

At the University of Craiova were 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 20142015, one workshop organized at Craiova in the summer of 2015, and the brainstorming organized during the participation to three international scientific conferences.

Some findings confirmed the advantage of the educational technology proposed by the PELARS system, but we have also identified concerns regarding the effects of the proposed educational technology meaning future investigation is needed in order to find the answers and/or solutions. A paper concerning this subject, including the methodological issues, was already published [5].

We identified a number of interesting suggestions from the points of view of organization of the activities, and of system development. A results' analysis regarding this task represents the subject for another paper.

University of Craiova, as one of the PELARS partners, is involved in the design, testing and implementation of the new educational technology at the level of higher education institutions.

The University of Craiova is a comprehensive university integrating different higher education branches, e.g. economics, laws, natural sciences, agriculture, and engineering.

The engineering higher education in Romania is very standardized, meaning that the engineering programs all over the country are very similar, from the point of view of the organization of the teaching activities. Because of this fact, we can conclude, that the University of Craiova is a representative example for the Romanian teaching system. The University of Craiova has got three engineering faculties, without considering the agricultural one. The PELARS partners are from the Faculty of Automation, Computers and Electronics. The other two engineering faculties are in the fields of Mechanics, and Electrical Engineering.

The educators involved in PELARS are connected to the Mechatronics and Robotics Department, and one educator is connected to the Computer and Information Technology Department. However, all of them teach, and have a direct contact to students from all engineering programs of the faculty at bachelor, master, and doctoral levels.

IV. Accreditation for Engineering Programs

A. Romanian Study Case

The Romanian Agency for Quality Assurance in Higher Education (ARACIS) was established in 2005 and is an autonomous public institution, of national interest, whose main mission is the external evaluation of the Romanian higher education's quality, at the level of study programs, as well as from the institutional point of view [6]. As of

September 2009, ARACIS is a full member of the European Association for Quality Assurance in Higher Education – ENQA and is registered in the European Quality Assurance Register for Higher Education EQAR.

The agency’s strategy reflects the mission assumed by ARACIS in order to constantly assure and improve quality in the Romanian higher education, as well as its own activity, and may be described by the following major objectives:

Improving the external evaluation methodology, in full compliance with the European Standards and Guidelines for Quality Assurance in Higher Education – ESG.

Increasing the role of students and employers, as final beneficiaries, within the process of evaluation and assurance of education quality.

Creating a quality culture in the Romanian higher education.

Establishing a permanent partnership with all institutions in the national higher education system as well as with the economicsocial environment, in order to correlate higher education with the labour market.

The Agency is carrying out its activity according to the best international practices, which are taken in its own Methodology and whose implementation is focused towards quality assurance and evaluation of the Romanian higher education, as part of the European Higher Education Area.

The accreditation of the study programmes (Bachelor’s degrees) follows the following steps of external evaluation [7]:

Stage I study programs temporary authorisation external evaluation (program authorisation) – for the first two years of a new program,

Stage II study programs accreditation external evaluation (program accreditation) – each 5 years.

On the basis of the application to start the external evaluation procedure for the temporary authorization / accreditation, submitted to the accreditation department of ARACIS by the education provider, the ARACIS Council decides the starting of the external evaluation procedure if the following conditions are cumulatively fulfilled:

Together with the application, the education provider also submitted the internal evaluation report,

The education provider proves with relevant documents to have paid the fee provided for by the law for the temporary authorization procedure, respectively the accreditation; for the accreditation, it shall respect the condition that it must be a 2year period between the graduation date of the first series of graduates and the application’s date of submission for accreditation. We must also specify that overrunning this time limit implies the proposal to cancel the temporary functioning authorization.

Compulsory normative requirements for the study programmes temporary functioning authorisation referring to: the legal organisation framework, teaching staff, educational process content, the students, the scientific research, the material basis.

From the point of view of compulsory normative requirements for the study programmes temporary functioning authorization and taking into account the PELARS objectives, we shortly describe here only two of the six criteria listed above.

With regard to the educational process content the requirements are:

In order to obtain the temporary functioning authorisation, educational curricula must comprise fundamental disciplines, speciality disciplines in the field, as well as complementary disciplines, also grouped in compulsory, optional and elective disciplines, in compliance with the specific normative requirements on domains established at national level.

The disciplines of study within the educational curricula are provided for in a logical succession and aim at the fulfilment of the following requirements: the defining and precise determination of the general and speciality competences according to the academic degree study fields, related to the competences corresponding to the master university studies; compatibility with the national framework of qualifications; compatibility with plans and study programs similar with those in the European Union countries and other countries of the world, the disciplines’ share being expressed in ECTS study credits.

The disciplines of study comprised in the educational curricula have analytical syllabuses which comprise the discipline’s objectives, the basic thematic content, the distribution of classes, seminars and applicative activities etc., according to topics, the students’ evaluation system, the minimal bibliography.

The classified list of disciplines comprised in the educational curriculum and the content of these disciplines, specified by the analytical syllabuses, correspond to the academic degree field and to the study programme the respective educational curricula were drawn up for, and are in compliance with the stated mission.

The academic year shall be structured on two semesters of 14 weeks on the average, with 20– 28 hours / week, for the 1st cycle of academic degree studies, according to the academic training domains.

Each academic year shall have 60 credits transferable in the European system (ECTS) for the compulsory disciplines, regardless of the type of education – fulltime education, part time education, distance learning; taking into account that, by the law, the evening classes duration is one year longer than of the equivalent fulltime program, a semester may have less than 30 credits, but within the total of academic degree cycle, the number of transferable study credits must remain 180 or 240, as the case may be.

Fig. 4. PELARS Data analytics (general example of a screen with information).

The types of education such as “evening classes”, “parttime education”, “distance learning” or other types of educations, which do not presume the compulsory presence in the university campus, cannot be organized unless “fulltime education” is also organized.

Elective disciplines, irrespective of the study semester they are provided for in the educational curriculum, finish by an “examination test”, and the credits they are allocated are over 30 of the respective semester.

The proportion between the class hours and those concerning applicative didactic activities (seminars, laboratories, projects, practice periods etc.) must be 1/1, with an accepted deviation of ± 20 %.

The academic degree study program the education plans were elaborated for comprises practice stages of 2 – 3 weeks per year, starting with the 2nd year of study, as well as stages for drawing up the academic degree paper, for the last year of study.

For the practice stages, the higher education institution concludes collaboration agreements, contracts or other documents with the practical training units, which stipulate: the place and period of practice, the type of organization and guidance, the persons in charge at the educational institution and at the training unit etc.

Examinations represent at least 50% of the verification types of the disciplines of study provided for in the educational curriculum.

Analysing the upper criteria we identify the ones which could be taken into consideration in regards we PELARS’s objectives.

General and speciality competences are mentioned but between these competences there is no precise reference to skills related to work together in a team, discovering things and solving practical problems. The problem is how define these skills and how to measure them.

The analytical syllabuses should comprise, between others, the discipline’s objectives, the distribution of applicative activities etc., and the students’ evaluation system, the minimal bibliography. The PELARS proposes a new educational technology which could support new objectives (sew the upper mentioned skills), a new evaluation system for practical activities (In Fig. 4, see an example of data supporting new data analytics that could be used for a better evaluation of the student’s activities during practical works – in this paper we are not focussing on details regarding this subject), and a new way to provide to students the needed information (using mobile devices on line available).

With regard to the material resources the requirements are:

The material basis of the higher education institution submitted to evaluation must comply with the standards ensuring the performance of a quality educational process.

In order to obtain the temporary functioning authorization, the higher education institution must prove by adequate documents (property deeds, lease contracts, inventories, invoices etc.) that, for the study program submitted to evaluation, for at least two years before the academic year, it possesses the following: owned or rented spaces which are adequate for the educational process; owned or rented laboratories, with the adequate equipment for all the compulsory disciplines within the educational curriculum, whose analytical syllabus includes activities of this kind; adequate software for the disciplines of study included in the educational curriculum, with utilization licence; library equipped with reading room and its own book stock according to the disciplines; included in the educational curricula; the educational spaces’ capacity for the study program submitted to evaluation is: minimum 1 sqm./seat, in the lecture rooms, minimum 1,4 sqm./seat, in the seminar rooms, minimum 1,5 sqm./seat, in the library reading rooms, minimum 2,5 sqm./seat, in the IT laboratories and in those of speciality disciplines using the computer, minimum 4 sqm/seat, in the technical, experimental, project etc. discipline laboratories.

The number of seats in the lecture, seminar rooms and laboratories must be related to the study groups’ size (series, groups, subgroups), according to the Ministry of Education and Research’s standards;

The applicative activities for the speciality disciplines included in the educational curricula are carried out in laboratories equipped with IT equipment. Thus, at the level of a study group, there must be a computer for 2 students at most.

The educational institution’s libraries must ensure: a number of seats in the reading rooms corresponding to at least 10% of the total number of students; their own book stock from Romanian and foreign speciality literature, enough to completely cover the disciplines from the educational curricula and out of which at least 50% should represent book titles or speciality courses for the field submitted to evaluation, appeared during the last 10 years in recognised publishing houses; a book stock within its own library with a sufficient number of books so as to cover the needs of all students in the cycle and year of study the respective discipline is provided for; a sufficient number of subscriptions to Romanian and foreign publications and periodicals, according to the assumed mission.

As it is possible to remark from the beginning, the demands are very strict or even bureaucratic ones. The adequate equipment, software, and the library equipped with reading room and its own book stock according to the disciplines are natural requirements, but implementing the new educational technology proposed by PELARS some discussion are needed. Are the equipment and software used in such a way in order to support the cooperation between students working in a team? Are the professors able to evaluate the student’s activities other way than judging the final results? It is possible to find how many tries a student performed in order to solve an error? It is still needed to go as often as before to the library to read a book if you have an online connection to the exact needed source of information dedicated to a specific practical work? It is important to know when, how long and in which sequence the available information was accessed? Is the new educational technology useful for all the practical works of an engineering discipline or it is better to used it only in a certain percentage for each discipline in order to support objectives as team works, and practical problem solving by discovery? It is the new educational technology suitable for practical activities in the field where students are specialized or it is better to used it for applications where students do not have the strongest theoretical background?

B. Other Case Studies

The PELARS partners from University of Craiova, Romania and from DTU Diplom, Campus Ballerup, Copenhagen, Denmark are also members of EAEEIE European Association for Education in Electrical and Information Engineering. They were also partners in another European program, SALEIE Strategic Alignment of Electrical and Information Engineering in European Higher Education Institutions [8]. During this cooperation, the authors of this paper acquired a valuable experience regarding the European policy in the field of engineering higher education [9]-[13].

We studied the accreditation procedure used in France [14] for the technological branch of engineering diploma "Evaluation des instituts universitaires de technologie et des diplômes universitaires de technologie". The template file contains six chapters with more than 40 different sub chapters. We tried to identify the demands which should be subject of discussion regarding the PELARS proposal.

There are three main objectives where the new educational technology proposed by PELARS could have a major contribution:

Answering to the needs of higher qualification by initial and continue education (Programme 150 objectif 1: « Répondre aux besoins de qualification supérieure par la formation initiale et continue »)

Supporting a higher percentage of success for students (Programme 150 objectif 2: « Améliorer la réussite des étudiants »

Increasing the efficiency of operators (Programme 150 objectif 6 : « Améliorer l'efficience des opérateurs »)

In the field of practical works there also three items where the PELARS contribution should be clearly specified:

What are the methods for de ongoing and control of the practical stages? (Quelle méthode dans la mise en place et le suivi des stages et des projects?)

Which are the equipment used during the practical stages? (Les équipements de travaux pratiques)

Which are the sources of information: how are used the pedagogical resources, availability, link between the documents inside the project. (Les ressources documentaires: Quelle utilisation des ressources pédagogiques du Centre de Documentation: disponibilité, association des documentalistes dans les projets pédagogiques)

But the most important item, demonstrating the importance given to the new educational methods, is the dedicated paragraph to Pedagogical innovation – A different way to learn. (L'innovation pédagogique – Apprendre autrement). Here we have the confirmation that PELARS focussed into the right direction. This kind of demands should be introduced in all procedure regarding quality assurance in engineering higher education.

Another type of evaluation concerns the program for professional engineering, a more practical orientated type of diploma (Dossier d'évaluation externe d'une spécialité de licence professionnelle) [15]. The procedure asks for a description of specific pedagogical methods used during the study (Modalités pédagogiques particulières mises en œuvre au niveau de la spécialité). In the same idea, the procedure makes a demand for what PELARS (see the reference about data analytics offered by PELARS) could contribute in finding a better answer: activities based on digital pedagogy (Activité en matière …. Pédagogie numérique au niveau de la spécialité). Once again we appreciate the fact the evaluation of French engineering programs take into consideration the innovation concerning educational technologies.

In Belgium, but not only there the main difference between the "pure university engineering" and the other "more technical levels" is argued to be the "higher concern towards practical aspects" and therefore studies themselves concentrate more on true practical problems, and studies outcomes are more concerned by practical skills and know how [16]. Starting from this observation we could try to find out if the PELARS educational technology is better for "pure university engineering" or for "more technical levels". If we consider that the first category of universities gives a better theoretical background than, the PELARS methods are adequate to support practical skills and by consequence to help fulfil the requests formulated often by companies trying to employ this type of diploma holders. By consequence the criteria used for the evaluation of such engineering programs should include specific demands concerning this subject.

From Spain, we analysed the evaluation procedure applied to one of our partners by EQANIE European Quality Assurance Network for Informatics Education (Information for Institutions of Higher Education, Procedural Principles for the Accreditation and Reaccreditation of Bachelor's and Master's Degree Programmes in Informatics) [17]. We identified once again what we have already found during the research performed by PELARS partners: the solution proposed by PELARS it is not applicable in any engineering field and the information technology is a domain asking a particular precaution if someone intend to apply the PELARS technology there. Of course, we can find even in this quality checking procedure a number of items where the objectives of PELARS could be integrated if the technology could be adapted: ability to function effectively as an individual and as a member of a team, ability to communicate effectively with colleagues, the practical application of the stateofthe art technology, different teaching formats should be used to achieve the target qualification, skills: cognitive and practical skills which make use of the knowledge.

We analysed the content of the Guide to programme accreditation elaborated by Denmark Accreditation Institution [18]. The general strategy of this quality evaluation body is orientated towards the final outcomes, mainly to the relevance of the programme in relation to the demand on the labour market. The other criteria analysed are knowledge base, goals for leaning outcomes, organisation and completion, and internal quality assurance and development. No specific details regarding alternative educational technology, selfdiscovery or cooperation are present. We identified few points where the PELARS technology could bring useful results for the accreditation report of an engineering program: what teaching and working methods are currently used, which programme facilities and material resources are relevant for the realisation of goals for learning outcomes, the degree up to which the education institutions illustrate the practice applicable to the programme or the local provision of a programme, whether teaching is pedagogically competent and which is the practice for ongoing pedagogical upgrading of teachers at the programme or local provision of a programme.

V. Conclusion

PELARS is an EU FP7 program working to design, implement, test and promote a new educational technology. Based on following and measuring the movement of students and equipment parts during practical works (labs or projects), new data analytics are produced and offered to students and teachers. Modern engineering technics are involved: image processing and recognition, wireless communication, multimedia. The pedagogical, teaching, and educational aspects very important subjects for the researches conducted in the PELARS frame.

In this paper we generated a discussion regarding the link between this new educational technology and the procedures of accreditation for engineering programs. We have identified cases where specific demands concerning cooperation between students, their ability to discover them selfnew things or to solve practical problems are present in the template of accreditation documents. In many cases the achievements obtained by applying the new educational technology could be included in nonspecific, but general, items of the accreditation procedure regarding the quality of the teaching methods.

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