Work-in-Progress: European Platform for Innovation and Collaboration between Engineer Students (EPICES)

Alexis François, Antoine Lanthony
Institut Supérieur de Mécanique de Paris – Supméca
Saint-Ouen, France
alexis.francois@supmeca.fr, antoine.lanthony@supmeca.fr

Françoise Côme
SEFI
Brussels, Belgium
francoise.come@sefi.be

Katrina Nordström, Marko Nähri
Aalto University – School of Chemical Technology
Espoo, Finland
katrina.nordstrom@aalto.fi, marko.nahri@aalto.fi

Stanislao Patalano
Università degli Studi di Napoli Federico II
Naples, Italy
stanislao.patalano@unina.it

Ilmars Viksne
Riga Technical University
Riga, Latvia
ilmars.viksne@rtu.lv

Marco Fioriti
Politecnico di Torino
Turin, Italy
marco.fioriti@polito.it

Jeroen Buijs, Wim Van Petegem
Katholieke Universiteit Leuven
Leuven, Belgium
jeroen.buijs@kuleuven.be, wim.vanpetegem@kuleuven.be

Luis Manuel Sanchez Ruiz
Universitat Politècnica de València
Valencia, Spain
lmsr@mat.upv.es

***Abstract*— EPICES is an Erasmus plus strategic partnership project (September 2014 – August 2016) co-funded by the EU. There are seven academic partners and one association engaged in this project. The purpose of EPICES is to develop a European collaboration on at-a-distance project-based learning framework and method, based on already existing and still developing technical platforms, i.e. collaborative and engineering tools. A special focus will be made on teachers' role and students' coaching, from the analysis of what a coach should be in project based learning to training packages for teachers and development of assessment methods. This focus is a key issue to be discussed in order to develop project based learning for engineer students, especially in international and/or industrial context, which requires strong and effective collaboration of all actors to succeed and innovate within the project based learning framework. In EPICES, sub-projects are developed, which place students in the middle of real industrial European at a distance projects, i.e. in the heart of the future job of every current engineer student. These sub-projects are study cases, study materials, and allow many feedbacks and intellectual outputs on coaching, teachers' role and assessment issues. Since its beginning, EPICES has gained in maturity and in this work-in-progress the objective is to present the first achievements of three intellectual outputs: establishing a model of facilitator roles and skills in project-based learning in European engineering education; studying teacher facilitation in preparation for training of teacher, creating assessment methodology for project-based learning in engineering studies and development of tools for assessment of skills.**

Keywords—Teacher roles, project-based learning, assessment.

I. CONTEXT

EPICES is an Erasmus plus strategic partnership project (September 2014 – August 2016) co-funded by the EU[a]. Partners in the project are ISMEP-Supméca (France, coordinator), Katholieke Universiteit Leuven (Belgium), Riga Technical University (Latvia), Aalto University (Finland), Politecnico di Torino (Italy), Università degli Studidi Napoli Federico II (Italy), Universitat Politecnica de Valencia (Spain), and the European Society for Engineering Education – SEFI (Belgium). The implementation of EPICES is partially based

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on the French PLACIS project[b] (September 2012 – August 2017) [1]. PLACIS is a pedagogical research project with already and still developing technical platforms, and sub-projects using these platforms. In every sub-project, on a multidisciplinary subject submitted by a company, a team of students (from 2 institutions from different countries) is formed. Students work in their home university and use the latest collaborative and engineering tools. EPICES will extend and develop new themes and outputs and fully Europeanize PLACIS. In addition to PLACIS, the other background is the progressive change of the structure of engineering studies, switching from the trilogy "courses – supervised practical work – lab work" to a more complex and open teaching and learning way, including MOOCs and different types of projects, which have to be taken into consideration. Therefore, especially in engineering, it is very important to elucidate how projects done by students can be improved, so that the projects are pedagogically successful, support deep learning and allow students to experience both innovation and learning in practice. This requires also a paradigm change in the role of teachers, for which teachers also need support and coaching. Accordingly, as the focus of EPICES is also on development of coaching for teachers, the role of the teacher and development of tools for assessment is an area of the work in progress presented below. Enhancing teacher facilitation skills leads to a mutually beneficial relationship with students, which forms the relationship with students platform for effective project based learning.

II. PURPOSE OR GOAL

The purpose of EPICES is to develop a European collaboration on a distance project-based learning framework and method, based on already existing and still developing technical platforms, i.e. collaborative and engineering tools. A special focus is on the teachers' role as a facilitator and the coaching of students. The project focuses on an analysis of different coaching roles and approaches in project based learning in order to develop training packages for teachers and development of assessment methods. This focus is a key issue to be discussed in order to develop project based learning for engineering students, especially in an international and/or industrial context, which requires strong and effective collaboration of all actors to achieve successful learning outcomes and innovations within the project based learning framework.

In EPICES, sub-projects are developed, which place students in the middle of real-life industrial European at a distance projects, i.e. in the heart of the future job of every current engineering student These sub-projects are study cases, study materials, and allow many feedbacks and intellectual outputs on coaching, teachers' role and assessment issues.

The main objectives of EPICES will be the development of PLACIS like sub-projects and the use of these sub-projects as study materials in order to:

- Analyse the coaching/facilitation in project based learning in European engineering education and, based on the collected data present a first model of what coaching approaches would best suit individual teachers.
- Enhance teachers' role as facilitators, competencies of teachers in project – based learning, with the development of methods and training packages for teachers, creation of a platform for the implementation of best practices in coaching, and testing on sub-projects with teachers and students.
- Perfect assessment methods in project based learning, with the development of toolboxes/toolkits toolkits for teachers.

III. APPROACH AND FIRST RESULTS

EPICES has been divided into 6 intellectual outputs :

- O1: Model of facilitator roles and skills in project-based learning in European engineering education
- O2: Initiation of training packages for developing effective facilitation skills for teachers involved in project-based learning in European engineering education,
- O3: Creation/adaptation of a platform for teacher networks for sharing best practices of facilitation in different media,
- O4: Feedback and results on larger scale use of training packages and possible use of guidelines,
- O5: Assessment methodology for project-based learning in Engineering studies,
- O6: Development of toolboxes/toolkits (for measurable competencies) for assessment of skills and knowledge with reference to the environment you are working in.

In this work-in-progress, we will especially focus on O1, O2 and O5. Results from these sections will allow us to launch thereafter the other three intellectual outputs.

A. O1: Model of facilitator roles and skills in project-based learning

As a starting point for developing training packages and tools for facilitation, a model was required that relates the desired learning outcomes of a given student project to the roles that the facilitators need to take on and that points them towards helpful tools. A comparable model was already developed by KU Leuven [2] and was taken as a starting point. This model uses the learning outcomes as defined by the ACQA framework [3]. Based upon an analysis of different types of student projects in science and engineering at KU Leuven, nine different facilitator roles were defined: advisor, authority, problem solver, inspector, model, motivator, feedback provider, educator and group specialist. Depending on the desired learning outcomes for a given project, the model suggests in how far the facilitator(s) should take on each different role. Facilitators can use a web application to

[b] The PLACIS project is managed by the French National Agency for Research under "Investments for the future" program with the reference ANR-11-IDFI-0029.

use this model, see section B on O2. The context of projects in the EPICES framework differs somehow from the context of the projects this model is based upon:

- EPICES projects are typically master projects, whereas the model developed at KU Leuven started from the analysis of projects in bachelor programs;
- There was no distant-learning component in the KU Leuven projects;
- There was no industrial partner involved in the KU Leuven projects;
- The KU Leuven projects only involved Belgian students.

These differences raise the question wether the model needs extension and optimisation to be used in EPICES-like projects. To find this out, a number of actions have been proposed: first of all, discussions were organised with 6 facilitators and students of 8 existing EPICES-like projects. The main goals were to find out

(i) how projects were set up and organised and whether the learning outcomes were considered while setting up the project and defining the role of the facilitators and

(ii) what the facilitators and the students considered to be the most important learning outcomes and facilitator roles.

Some main conclusions were the following:

- There is a lot of difference in the way projects were set up, especially in how the different sub-teams, the facilitators and the industrial partner collaborate. Moreover, the learning outcomes were not really taken into account in the way the projects and the collaboration were set up. In some cases this worked out very well, but in others, it was mentioned that in retrospect, a different approach would have been more appropriate. This shows the need for a tool or a manual that helps the facilitators in setting up the collaboration in new projects describing, depending on, amongst others, the learning outcomes and the locations of all involved partners, which approaches can be taken and which pitfalls should better be avoided. As a consequence, the model should be extended with information on different ways of collaboration.
- Cooperation and communication between all involved partners were often seen as a complicating boundary condition, rather than a learning outcome, especially by the students. Both students and facilitators should be aware of the fact that these are indeed desired learning outcomes and hence they should also be provided with necessary tools to set up good cooperation and communication between all person involved.

Next to these discussions, the learning outcomes from the ACQA framework are currently being analysed in the framework of EPICES-like projects to check where they need to be extended or reformulated.

Finally, the original surveys that were used to set up the KU Leuven model were translated, extended and optimised to be used for surveying the current EPICES projects. The first results from these surveys are discussed in the next section on O2. In a next step, all this information will be used to extend and optimise the model in the Fall of 2015.

B. O2: Studying teacher facilitation in preparation for training of teachers

Student projects were studied in order to link teacher views on their facilitation with the students view and reaching of the learning goals for their projects. These student projects were part of courses that were already part of the curriculum in, or newly started in conjunction with EPICES. There were 11 projects, which covered topics from mechanical engineering, automation, robotics and health technology. The role of teachers as facilitators was studied during February 2015 - May 2015 in project-based courses by using three web-based questionnaires for teachers and one for students.

The aim was to use the model previously developed by KU Leuven[c] for teacher facilitator roles to elucidate how well teacher facilitator roles, as perceived by teachers themselves, correlate with the learning experiences of the students. The aim was to assess how well the learning goals, including both scientific disciplinary knowledge as well as development of other skills, were achieved from the viewpoint of the students and the teachers. The aim was also to test how well the model would apply across teachers and students from different countries and institutions. Accordingly, the respondents were from all academic partners involved in EPICES. Teachers answered the 1st questionnaire at the beginning of their course, and the 2nd at the middle or end of their course. The 3rd questionnaire could be answered anytime, as the focus was on the overall role of the teacher, and not tied to their present course. The teachers were sent a link to the questionnaires and also asked to send one link to their students with the student questionnaire, which they were asked to answer at the end. A total of 11 teachers and 54 students of these teachers completed all the questionnaires.

After completion of the forms the answers were automatically recorded and analyzed by separating the replies to two main thematic areas, namely 1) Facilitator roles and 2) Learning goals. The preliminary data are grouped into percentages of teachers and students who agreed with the statements presented in the questionnaire. Only statements, where all or 80% of respondents agreed are presented below, in addition to those for whom there was less than 50 %, or no agreement.

1. Facilitator roles

Preliminary analysis of the perceptions of the teachers as facilitators suggest that teachers set certain goals for their facilitation, but during the ongoing projects their own view on facilitation changed. The data are still under analysis, and only most marked differences are presented. At the beginning, most teachers emphasize a rather teacher-centered view (table 1). Comparison to the model that we tested suggests that the

[c] https://www.biw.kuleuven.be/projectbegeleiding_en/Information.aspx

present data do not fit entirely with the roles proposed in the model. Rather it is evident that the roles of the teachers fall into many groups as has also been discussed by other [4,5] with teachers emphasizing the importance of being supportive, but allowing students to take a lead, whilst at the same time the more authoritative role of the teacher is also evident. Interestingly, students experience of the facilitation by the teacher, suggests that only 70% of the students in the present study felt that the teachers emphasized their own experience, and even though all teachers felt at the beginning that this was very important, only 15% felt that they had done so during the projects (table 1). There was also a clear difference in the way that the students felt teachers actually managed to support the groups, as this was rated very important by all teachers, but only 60% of students felt that they experienced this during their projects and, at the end only 40% of the teachers felt that they had actually done so.

Very marked changes were also evident in the teachers view on how regularly they gave feedback, how highly they ranged the importance of supporting the groups and made available their own experience. It is remarkable that 85 % of teacher replies stated that it is very important to give continuous feedback to students, but only 45 % of students felt that their teachers had actually done so during the projects and only 15% of the teachers felt that they had done so. Therefore, it appears, that teachers should be given more detailed insights into how feedback should be given and group work can be supported, and perhaps more formal documentation would be important to students.

TABLE I. FACILITATION: VIEWS OF TEACHERS, CHANGES DURING THE PROJECTS AND EXPERIENCES OF THE STUDENTS

Teachers feel it is important to:	***% of teachers agreeing at start or middle of course***	***% of teachers agreeing at the end of course***	***% of students agreeing at the end of the course***
to give students examples of the teachers' own experience and make sure that students understand how the teacher thinks that the possible problem(s) in the project should be solved	100 %	15 %	70 %
to support the student groups and make sure that the groups function well and students understand the process of project	100%	40 %	60 %
insist that goals should be met and the teacher should interfere when this is not happening exactly according to plan	80 %	40 %	75 %
give insights into their own (=teachers) trains of thought and reasoning	80 %	40 %	70 %
give regular feedback	85 %	15 %	45 %
find solutions to problems together with the students	80 %	45 %	85 %
give unconditional support to create a safe and activating learning environment to generate an active learning environment	80 %	30 %	60 %
make expertise available only if students specifically request	50 % or less	15 %	55 %
give students direct advice and instructions so that they can compete the project successfully	50 % or less	50 % or less	40 %

A comparison of the present data to the model previously was also carried out. The present data suggest that students' views on the facilitator roles are not in agreement with the model. It is evident, therefore that different cultural and institutional factors greatly affect the roles of the teachers. Of the eight possible roles for the teachers stated in the model, our data would confirm that student views only supported the role of Motivator, and demonstrates the difficulty of categorizing teachers into specific roles.

2. Learning goals

a. Teachers' view on the learning goals

Thematically the learning goals are grouped into seven areas. In table 2 the views have been stated only at a general level, giving the range of the agreement and more detailed analysis is ongoing. Development of basic intellectual skills was most uniformly though to be very important, whereas surprisingly the ability to conduct research was not as uniformly considered as very important. Designing skills and understanding the temporal and social context of the projects were not as uniformly regarded as very important from the teachers' point of view. Most variation is evident in views on the importance of learning to co-operate and communicate. Teachers did agree that it is important that students learn to communicate verbally and in writing, however, these were not graded as very important. Moreover, the ability to take part in a scientific debate and discuss issues with peers was not considered important. This suggests that for further development of possible training packages for teachers, it is important to develop more concrete tools for teachers to adopt and to be able to make these issues more visible to students.

TABLE II. THE IMPORTANCE OF LEARNING GOALS FROM TEACHERS POINT OF VIEW AND COURSE OUTCOME FROM STUDENT LEARNING POINT OF VIEW.

Thematic areas of learning goals	***Teachers in agreement***	***Students in agreement***
Competence in scientific discipline	60-90 %	60-75%
Understanding scientific approach	70-90 %	30-70 %

Thematic areas of learning goals	***Teachers in agreement***	***Students in agreement***
Development of basic intellectual skills	90-100 %	55-70%
Learning to co-operate and communicate	10-100 %	35 -60 %
Ability to carry out research	40-70 %	50 -60%
Designing	40-70 %	40-70%
Understanding temporal and social context of projects	40-70 %	40-50%

b. Students' view on achieving learning goals: course outcome

Students were asked about the course outcome, as a measure of what they have learned. Most students agreed that they felt that they had learned competence in their scientific discipline and following a scientific approach. Interestingly, student replies suggest that the scientific theory has been more prominent in the projects, and not as much emphasis had been on the practical aspects. This contradiction is probably due to the different goals of the individual projects, as some projects did not involve e.g. building prototypes or similar. Students did not feel that the temporal and social context of their projects had been clear to them. This may be due also to the difficulty in interpreting the meaning of such terms, and suggests that this is also an aspect that should be included in development of teacher training packages. Further development of instructions for teachers also needs to take into account the nature of the projects and the level of the students. These data strongly support the importance for development of more implicit tools for assessment of student skills as is presented below in O5.

C. O5: Assessment methodology for project-based learning in Engineering studies,

Project-based learning in groups is getting common in universities providing engineering education. The proper assessment is one of the challenges associated with project-based learning, especially if students from different universities and countries are in one project group. Project-based engineering education not only requires changing the teaching methods and learning environment, but also adopting new assessment methods, such as student portfolio assessment, assessment of group project results and peer-assessment by other students in the group. The crucial factor for success of such education is close cooperation with the industry. All student group projects are based on authentic issues recommend by industry and industry experts take part in evaluation of results. The study defines 29 main skills for engineering students that could be acquired in engineering study courses. Skills are clustered in three groups: methodological and technical skills, management and communication skills, behavioral and cultural skills. Faculty members (course leaders) evaluate how the study course contributes to acquiring each of the 29 skills and set up skills based assessment system. The EPICES project promotes the further development of the assessment methods in engineering education.

IV. CURRENT OR ANTICIPATED OUTCOMES

There are several current or anticipated outcomes:

- Develop models for teacher roles, which will allow teachers to adjust their teaching style, contents and approach to be optimally aligned with the expectations of the student for promotion of deep learning,
- Generate robust methods for the assessment of students' skills in project-based learning. Provide teachers with such assessment toolkits/methods in order to achieve more objective, accurate and quantitative assessment of development of skills during project work,
- Develop joint platforms for teachers to share good practices for professional development in multidisciplinary, multicultural and often also pan-European settings.

V. CONCLUSIONS

During 2014-2015 the role of the teachers in 10-12 different engineering student projects have been studied and the views of the teachers and students have been collected. Assessment of skills has been developed and dissemination of results is continuously updated via SEFI (www.sefi.be).

EPICES has another year of funding by Erasmus plus. One of our priorities is to sustain the results of this project and continue to test the achievements in different kinds of project in different kinds of activities. For these reasons, and particularly in order to continue to meet the challenge of teachers' involvement in problem- and project-based learning (and in the use of new tools), we are planning to propose a new project as a continuum of EPICES under Knowledge Alliances with Erasmus plus. This project, if it is funded, could begin in September 2016 and would focus mainly on involvement of industrial partners as part of implementation and development problem- and project-based learning training for engineering students.

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