Designing Student Centered Learning Methodologies in Applied Sciences Engineering Education

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Abstract

The literature generally acknowledges that, teaching and learning approaches (both empirical and theoretical) need to be more active, namely problem-based learning (PBL), project-based learning (PJBL), work-based learning (WBL), self-directed learning (SDL). These approaches help students to develop key cognitive skills such as knowledge transfer, critical thinking, and metacognitive strategies. On another hand, motivation studies conclude that students who undertake targeted intrinsic learning are more likely to find value in learning, to adopt cognitive strategies, rather than to focus on extrinsic rewards or achievement goals.

A typical cross-cutting issue of High Educational Institutions of Applied Sciences (HEIAS) is that the traditional learning approaches used in engineering education do not prepare graduates to face and contribute to solving real problems in a demanding, complex work environment. A set of limiting factors can be identified at different levels. In order to solve or minimize the lack of skills development of future engineers, and to be prepared for new challenges, an open approach is needed, which includes the creation of project-based courses, the integration of engineering and humanities perspectives, the integration of different, active, learning appoaches, and networked learning experiences, in order to reflect the nature of the modern world. These experiences will allow students to personally relate to the social contexts of technology which can increase the student motivation and the development of lifelong learning skills.

Inspired by the Olin College of Engineering (http://www.olin.edu) this paper aims at presenting a methodological approach to "designing study-centered learning experiences to be implemented at HEIAS, in Engineering Courses. Based on ongoing research, it is expected it will to contribute to reduce or minimize the mismatch between real life situations and student preparation, fostering knowledge and discovery, creating an integrative culture of belonging and global institutional engagement, creating effective and far-reaching partnerships.

Keywords: *Innovative Teaching; Student Centered Learning Methodologies;*

1. Introduction

It is widely acknowledged in the literature that methods of teaching and learning applied to engineering, are increasingly more active, from Problem-Based Learning (PBL) [1-11], Project-Based Learning (PjBL) [1, 10-16], Work-Based Learning [17] or Self-Directed Learning [1, 4, 7, 18]. Overall these approaches are considered to help students to construct important cognitive skills [6, 15, 20], such as knowledge transfer, critical thinking and metacognitive strategies. However, although cognitive abilities are one of the greatest benefits of active learning, student achievement in active classes requires more than thought and reasoning, cognitive behavior and self-regulated activities associated with PBL and PjBL. It is a process that involves strong interactions between cognitive impairment and motivational strategies and is beneficial to various tasks related to the problem / project, such as goal orientation, value creation, self-efficacy. Motivation studies [15, 20] also conclude that students who use goal-oriented and intrinsic learning approaches are more likely to value learning, adopt cognitive strategies, and perform better than students who follow extrinsic rewards or performance goals. In the last decades, the Olin College of Engineering[3] successfully adopted a set of student-centered active teaching methodologies in most courses. Although methods used are essentially PjBL, a wider set of cognitive and motivational strategies are also used involving the academic environment, teachers from various areas of knowledge as well as companies from outside the university, where students develop multidisciplinary projects adding value to society.

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Fig 1. – Global reach “Student Centered Learning Experiences” model [2, 12].

Figure 1 illustrates the coverage domains of the methodological approach for “Designing Student-Centered Learning Experiences” (DSCLE) (http://www.olin.edu/academics/curriculum/) degree courses and below a set of guidelines concerning its implementation in HEIAS, in engineering courses to eliminate or minimize the current lag problem between the existing training offer and the labor market needs and expectations. This is an ongoing research process and its expected results are a student-centered learning approach, which will redefine engineering education, fostering learning and discovery, creating transformational work environments, an inclusive culture of belonging and global institutional engagement, as well as creating effective and far-reaching partnerships.

2. Model Approach and implementation process

The aims and objectives of the DSCLE Methodology to be implemented in Applied Sciences Engineering are:

I) **Redefine Engineering Education** – establish and maintain active learning classes and instructional laboratories, as well as interdisciplinary alliances that enrich the core strengths and helps to prepare graduates for global leadership roles; prepare students for success in Higher Institutions and beyond; engage students with substantive co-curricular and internship opportunities; offer flexible pathways to and through the university;

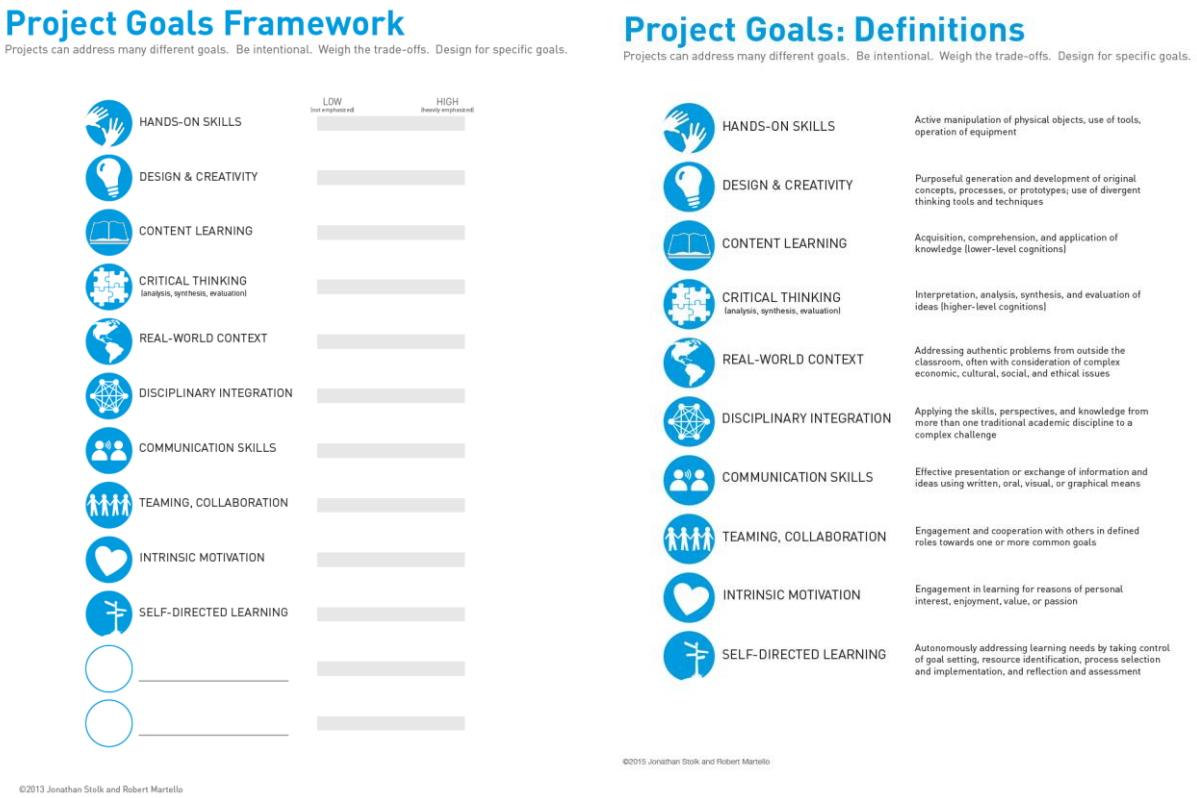
II) **Transformational Work Environment** - ensure vitality and sustainability by building a forward-looking, efficient, and caring culture that stimulates, recognizes, and rewards creativity, entrepreneurial thinking and exemplary performance; built upon continuous improvement and evaluation;

III) **Create Inclusive Culture of Belonging and Global Engagement** - Promote a diverse culture of inclusion, integrity, and collaboration that deepens understanding and embraces intercultural and global experiences; create an environment where people live, learn, and work cooperatively; expand, virtually and physically, HEIAS global involvement;

IV) Create Effective and Far-reaching Partnerships - Cultivate mutually beneficial partnerships, applied to service-oriented projects that strengthen the local/region/national, and world communities; partner with educational and other public and private sector institutions to co-design academic and outreach programs that enhance access to and support of quality higher education; increase lifelong learning opportunities.

Following the information in the previous sections, motivation studies [15, 20] conclude that students who adopt goal-oriented intrinsic learning approaches are more inclined to find value in learning, adopt cognitive strategies, and perform better than students focused on extrinsic rewards or performance goals.

Fig 2. – Definitions of Project/Curricular units dimensions based on the student identity.



The model can be applied to a wide-range of areas (and in particular Olin's Methodology offer courses accredited by ABET, http://www.abet.org/accreditation/) as Computer Engineering and Electricity, Mechanical Engineering and Engineering, with flexible undergraduate programs that allow students to choose an area of specialization based on Engineering, Mathematics and Science, Design, Arts, Humanities and Social (AHS) Sciences, Entrepreneurship, Communication, Engineering Final Project. The distribution requirements specify the minimum total number of credits to be filled in each of the five broad areas: Engineering (46 ECTS), Mathematics and Science (30; of which at least 10 must be in Mathematics), AHS and Entrepreneurship (28; of which at least 12 must be in the AHS area).

In terms of **pedagogy** the educational perspective is based on Practical learning, Open-based project learning, inter and multidisciplinary learning. The **assessment or competency evaluation** is made by: Qualitative Analysis, Quantitative analysis, Teamwork, Communication, Lifelong Learning, Contextual Awareness, Design, Diagnosis and Evaluation and Opportunities Development. On another hand **Individualized study options** designed for the student: Self-Study, Concentrations and Final Projects, Cross-registration of curricular units with other institutions, Cross-registration of curricular units with other institutions, Distance Learning, Research, Independent Study and Research of Projects of Personal Interest. The **steps to create the curriculum's or projects** is initiated with the exploration of student's identity (Political Beliefs, Language Proficiency,

Socioeconomic class/background, religion or spiritual affiliation, national origin, educational background, organizational role and Political Beliefs), analyzing the alignment of the course and projects with the student's performances in the domains of goals, activities, assessments and products. Then it is created the project/curricular units goals in the different dimensions (figure 2). The **students' performance is constantly monitored** at different levels as learning goals, course context, learning strategies, products and deliverables, applications and context, grading evaluation, due dates and schedule, team roles and structure, resources and physical space. Also, the **creation of space conditions to implement the model** are also defined, as: a student self-determination continuum performance is measured in terms of motivational orientation (amotivation, external regulation, identified regulation and intrinsic motivation) in order to evaluate the student's autonomy, relatedness and competence.

3. Conclusions

In this paper we present a methodical approach to "Designing Student-Centered Learning Experiences (DSCLE) and a set of guidelines to be implemented in HEIAS in Engineering Courses. The methodical approach is based on project-based Learning Methodology and is in line with most relevant and updated guidelines, namely Modernization agenda for higher education (http://ec.europa.eu/dgs/education_culture/repository/education/library/policy/modernisation_en.pdf), in the way it aims at increasing the attainment levels by developing and implementing new learning and teaching methods; boosting innovation in higher education, business and in the broader socio-economic environment; jointly developing and implementing new learning and teaching methods (like multi and interdisciplinary curricula, learner-centered and real problem-based teaching and learning); make the knowledge triangle work, by establishing a strategy of close cooperation between universities and businesses; and in the delivery of students centered learning methodologies. This approach also contributes to sustainability of institutional-business cooperation through partnerships with companies, sharing resources and perform budget funds for research and development. The proposed methodologies will be based on a solid needs analyses (at the initial stage of the project a state of the art and needs research will be conducted, in order to identify the gaps of existing courses concerning student centered learning processes. Students, universities and businesses perspectives will be addressed. Identification of best practices across educational sectors and countries and scaling up of best practices and experimentation. The ongoing research intents to result in proposing a learning methodology to redefine engineering education, promotes learning and discovery, present guidelines to create transformational work environments, creates an inclusive culture of belonging and global institutional engagement, create effective and far-reaching partnerships.

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