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Article

Learning ethical, environmental and professional responsibility at Universitat Politècnica de València. Where are we?

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Abstract: This paper presents a study on the development of the cross-curricular learning outcome (CCLO) "Ethical, environmental and professional responsibility" by the students of different Bachelor'sDegrees taught at Universitat Politècnica de València. The work and development of this learning outcome entails great complexity, given the double dimension of responsibility that it involves. At the end of their training at the university, students are expected to show ethical, environmental, and professional responsibility towards themselves and others. Interviews have been conducted with lecturers who work and assess this outcome in their subjects, most/all of them related to science and engineering. The objective was to identify the learning approach used at the different subjects to guarantee the acquisition of this CCLO by the students. A focus group has also been carried out with students to determine the importance they give to this learning outcome, and to know their degree of satisfaction with the training received. The methodology used to obtain the data from lecturers and students and to process the information to get a precise diagnosis is fully described in the paper. Results are satisfactory to some extent: most of the lecturers carry out appropriate activities and most of students achieve the expected proficiency level. Finally, recommendations are given to improve the development of this cross-curricular learning outcome.

Keywords: cross-curricular learning outcome; ethical responsibility; environmental responsibility.

1. Introduction

The training and assessment of our students in Cross-Curricular Learning Outcomes (CCLO) is a complex problem, and although there is consensus on their importance, now there is no clear idea on how to implement these competences in the curricula and how to assess them [1].

When we talk about CCLO, we are referring to a series of learning outcomes that all students, regardless of their university studies, must acquire, but there is no specific subject in the educational program dedicated exclusively to them.

Some of these CCLOs, have been encompassed in terms such as sustainability learning outcomes, and it has been studied how they are achieved, what methodologies are used (case studies, lectures, project-based learning, service-learning, etc.) to ensure that future professionals practice their work with this knowledge [2], [3], [4].

Other studies highlight that teaching, and the educational program quality are not the only important determinants of students' learning outcomes [5]. It is very important and appropriate for universities to take these outcomes into account, but it should not be forgotten that other interactive, social and collaborative aspects are determinant and will

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influence the results that graduates will obtain. In this sense, it is interesting that universities begin to measure these cross-curricular contributions and integrate them into the educational programs.

In addition, accreditation agencies such as ABET [6] are also coming into play, introducing some of these CCLOs (i.e. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts) as essential elements that students must achieve at the end of their studies in order to obtain their quality seal. This, together with the growing importance and demand of society, has led to the study of the best way to incorporate these aspects into different fields of study related to business [7],[8], computer science [9],[10], and engineering [11],[12].

Examples of various methodologies can be found in the literature [13]-[15] or even how to integrate CCLOs across the curriculum [16]-[18], but we are still far from reaching a consensus on which is the best method, and we are not even sure of the results achieved by our students.

In this paper, we are going to analyze the degree of acquisition of the CCLO "Ethical, environmental and professional responsibility" by the students of different Bachelor's Degrees taught at Universitat Politècnica de València (UPV). Figure 1 shows the Gandia and Vera campuses and the schools participating in the project.

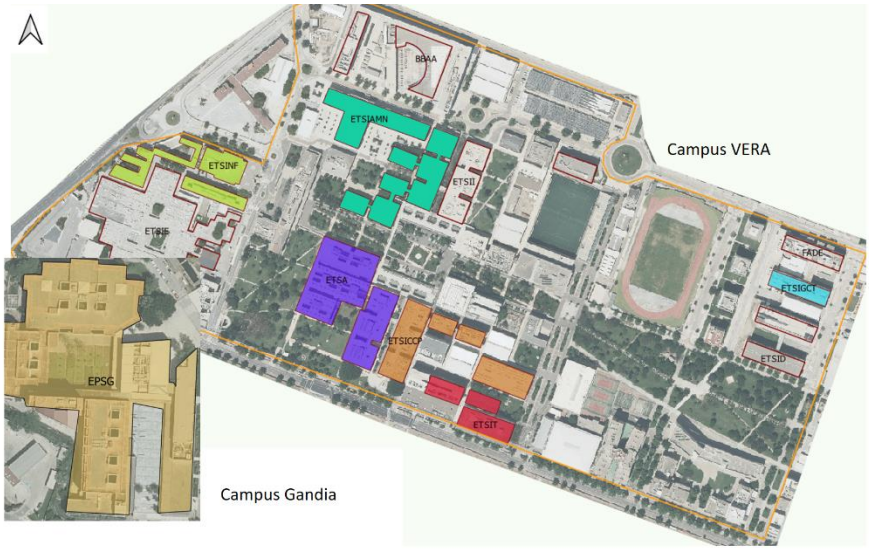

Figure 1. Schools participating in the project. Source: Prepared by the authors.

This CCLO is nowadays of utmost importance as it is the base to develop the social responsibility that future professionals will need to deal with the Sustainable Development Goals (SDGs) of the United Nations 2030 Agenda. But how is this ethical, environmental and professional responsibility developed at UPV? Are students acquiring this skill properly? How do lecturers feel about the way they teach and assess this CCLO? Before answering these questions let us review the way in which CCLOs were introduced in the UPV Bachelor´s degrees and Master's seven years ago, and the way we assess whether our students achieve them.

1.1 Development and assesment of CCLOs at UPV

In 2015, UPV launched an innovative institutional project with the aim of enabling students to acquire the CCLOs needed to become professionals adequately prepared to the demands of the labor market. Thirteen UPV CCLOs were then defined and the training of these CCLOs was considered from a wide perspective, connecting it with the full education cycle of each person, and addressing both undergraduate and postgraduate studies [19].

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Hence, the UPV CCLOs correspond to skills which are key and transferable in relation to the wide variety of personal, social, academic, and employment contexts that graduates may encounter throughout their lives. In this sense, UPV CCLOs constitute a fundamental part of the professional and formative profile of UPV's Bachelor's and Master's degrees. UPV CCLOs deal with issues that include a set of cognitive and metacognitive skills, and instrumental and attitudinal knowledge that are of great value to the knowledge society.

The main objective of the UPV's institutional project, which started in 2015, was to systematize and guarantee the acquisition of the UPV CCLOs in the training process of students using different complementary paths or strategies. Moreover, the project also addressed the design of systematic evaluation processes and strategies for the UPV CCLOs, that may consider both the individual results of each student and the aggregate information for the analysis and improvement of the training programs.

Association matrices were defined for each degree, in order to assign the training and evaluation of the different CCLOs to specific subjects of the training program. These association matrices are reviewed and updated every year. They can be considered a key factor in the system, as they allow the appropriate design of the curriculum, and constitute the basis for the evaluation process. Aggregate information of the degree of achievement of the CCLOs by students is generated every year for continuous improvement processes.

As explained before, in this work we are going to focus on the subjects that train and assess the CCLO "Ethical, environmental and professional responsibility" at different UPV Bachelor's Degrees. However, in future work we plan to address and analyze other UPV CCLOs following a similar approach.

2. Materials and Methods

Six out of thirteen schools (see **Table 1**) were selected to gather information about the number of subjects that train and assess students in the CCLO "Ethical, environmental and professional responsibility", and the appraisal of students and teachers about this outcome.

Table 1. List of schools, Bachelor's Degree and subjects considered. Source: Prepared by the authors on the basis of the subjects syllabi.

Name of school	Grade	Subject
School of Agricultural Engineering and Environment. (ETSEAMN)	Bachelor's Degree in Agricultural and Biological Engineering. (GIAMR)	Geology, Soil Science and Climatology. Chemistry - Extension Course. General agronomy.
		Crop protection.
		Soil mechanics, foundations, and rural roads and paths.
		Horticulture: Vegetable crops.
		Animal Nutrition.
		Sustainable Agriculture.
		Irrigation and fertilization needs and programming.
School of Architecture. (ETSA)	Bachelor's Degree in the Fundamentals of Architecture. (GFA)	Introduction to Architectural Construction. Physics for Environmental Conditioning.
		Electrical Installation Systems.
		Sustainable Development.
		Architectural, city and landscape project. Sustainable habitat.
		Projects 2.
		Projects 3.
		Projects 5.
		Bachelor's Thesis.

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School of Civil Engineering. (ETSECCP)	Bachelor's Degree in Civil Engineering. (GIC)	Topography. Science and Environmental Impact of Civil Engineering. Industrialized construction. Construction Management and Organization. Ethics in Civil Engineering.
Higher Polytechnic School of Gandia. (EPSG)	Bachelor's Degree in Environmental Sciences. (GCM)	Society and environment. Environmental Law and Public Administration. Environmental Assessment and Management. Oceanography and dynamics and coastal processes.
School of Engineering in Geodesy, Cartography and Surveying. (ETSEGCT)	Bachelor's Degree in Geomatics and Surveying Engineering. (GIGT)	Renewable energies. Cartography. Environmental Engineering. Business Organization and Management. Cadastre.
School of Telecommunications Engineering. (ETSET)	Bachelor's Degree in Telecommunication Technologies and Services Engineering. (GITST)	Processing and Energy Conversion. Acoustics. Computer Fundamentals. Instrumentation and quality. Mobile and Wireless Communications.

Data analyzed in this work come from four different sources: school administration, official syllabi of subjects, individual interviews to lecturers, and group meetings with students.

School administration: each school administration was requested for the list of subjects allocated to assess the CCLO "Ethical, environmental and professional responsibility (CC07)", and the global assessment results of the last academic year (18/19).

Official syllabi: All subjects taught at UPV publish its official syllabus in UPV's website. Members and not members of UPV can access to this information. The syllabus includes all the relevant information about the subject, like learning outcomes, assessment, plan, pedagogical methodologies, among others. The syllabus presents, with detail, the CCLO that will be assessed. This information comprises the activities the students will carry out and the way they will show their level of achievement. The syllabus of subjects involved in CC07 assessment were download and analyzed. Activities and assessment criteria were extracted and compiled. **Table 1** shows the subjects per Bachelor's Degree and school.

Interview with lecturers: A questionnaire was designed to know the point of view of the lecturers involved in training and assess this CCLO. The questionnaire includes 11 open questions (or open-ended) that collect their difficulties, aids and feelings . The questionnaire can be found in **Table 2**. First interviews were carried out face to face at the beginning of the academic year 2020 but the outbreak of COVID-19 pandemic in the second half of March suggested the authors to carry out the interviews by email and video call.

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Table 2. Questionnaires for lecturers. Source: Prepared by the authors

Questions
1. My subject assess CC07 because (I chose, it was imposed, I don't know, …).
2. Do you think CC07 is relevant for this Bachelor's degree?
3. Was it easy to include/work the CC07 in your subject?
4. Did you received help to develop this competence in the classroom? (staff training, guidance, examples, …).
5. What do you think is the perception of the students about this competence? Do they understand and think it is worth for their professional career?
6. What kind of activities the students carry out to train CC07?
7. How do you assess this competence?
8. What do you think about the influence of this competence over students? Do you think students improve their awareness about ethical, environmental and professional issues?
9. How do you feel working on CC07? Is it an overload, an inconvenience? Or do you feel involved, satisfied, comfortable? Did you make changes in the way you work this competence?
10. What are the main obstacles and troubles you faced?
11. Please, write any advice or proposal to improve the acquisition of this competence,

Group meeting with students: Short meetings (less than 90 minutes) with groups of no more than 20 students were performed. Most of the meetings were performed face-to-face during the beginning of the academic year 2020, but some of the meetings that were planned for the fall of 2020 were adapted to on-line, using on-line meeting and forms (Microsoft Teams Suite).The students formed groups of four members and the planning of the meeting was the following:

- Brief presentation (5 minutes) of the institutional project of CCLO and the acquisition levels.
- Questionnaire (

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- **Table 3**) with five open questions about their knowledge and global feelings on the institutional project. Students answered the questions on an individual way, then discussed their answers within the group and finally all the groups made an exchange of ideas.
- A second presentation with the list of subjects, the activities and assessment criteria than assess this CCLO in the educational program.
- Questionnaire (

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- **Table 3**) with seven open questions regarding the activities the students remember in each subject, and their appreciation about the success acquiring the competence. Like in the first questionnaire, students answered in an individual way, then discus within their group and finally with all other groups.
- The meeting finished with a general discussion where students are asked to propose improvements to the whole project as well as for CC07 competence.

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Table 3. Questionnaires for students. Source: Prepared by the authors

	Questions
Questionnaire 1	1. Do you know the institutional project? 2. Do you know the acquisition levels for each CCLO? 3. Do you remember which subjects were assessment point for this CCLO within the program curriculum? 4. Do you understand the meaning of the acquisition levels to be achieved? 5. Do you think you have reached the expected acquisition level?
Questionnaire 2	1. Are you aware that CC07 was evaluated in all these subjects? 2. Are you aware that CC07 was evaluated in some of these subjects? 3. Do you think that you reached the expected proficiency level with the developed activities related to CC07? 4. Considering all the information you got during the Bachelor's Degree, will you act ethically, environmentally and with professional responsibility in your professional life? 5. Do you know your grade regarding CC07? Do you agree? 6. Do you think that training related to CC07 must be increased in the program curriculum? 7. In each subject, did you worked the CC07 before being assessed? 8. The learning and assessment of CC07 supposed and overload?

3. Results

3.1. Data from school administration

At the end of academic year, schools generate a report with main statistical indicators about the development of each Bachelor's Degree grade, including student achievement in CCLO. The grades range from D to A, where D means not accomplished and A represents the maximum acquisition of the outcome. The values show that half of students achieve a mark B when finish their studies, and close to the half get a mark A. Less than a 15% percent of students fail in this outcome. The distribution of marks (in percentage) for the six Bachelor´s Degree were; mark D 2.8%; mark C 12.8%; mark B 45.3% and mark A 39.1%.

Distribution of marks for schools are shown in **Figure 2**. In all the Bachelor's Degree except GITST, the predominant grade is B, followed by A. It is remarkable that GITST has a wider distribution that other degrees, with a high percentage of D and C grades. It must be mentioned that in GITST, students who did not submit their activities, received a D mark, while in the other degrees they were qualified as absent, with no grade.

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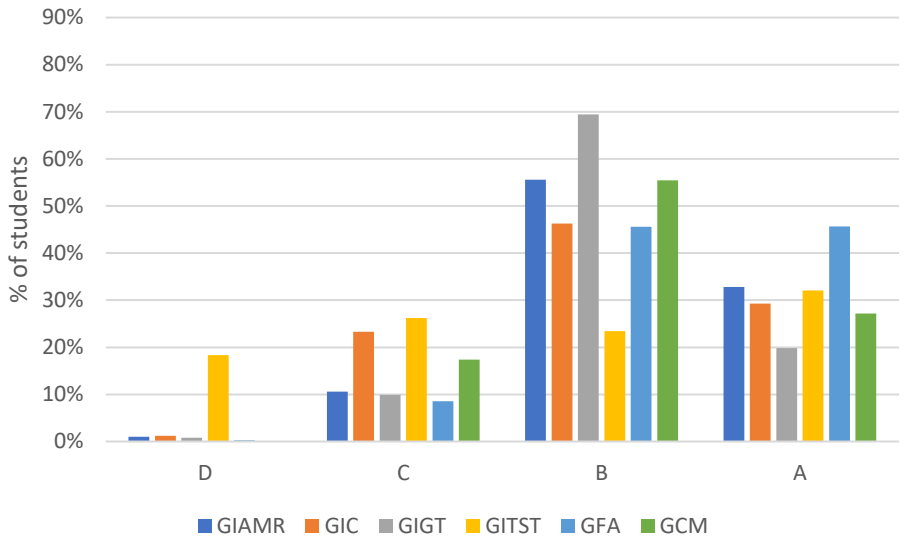

Figure 2. Distribution of grades in the different Bachelor´s Degrees. Grades range from D (non-acquired) to A (maximum) acquisition of the CCLO. Source: Prepared by the authors.

The CCLO Institutional project considers, for Bacherlor's Degree grades, two acquisition levels. Level 1 is assessed at the end of the second year, and level 2 is assessed at the end of the fourth (and last) year. **Figure 3** and **Figure 4** show the distribution of grades for Bacherlor's Degrees and levels. Although there are some differences, the trend in the distribution of grades is the same for both levels.

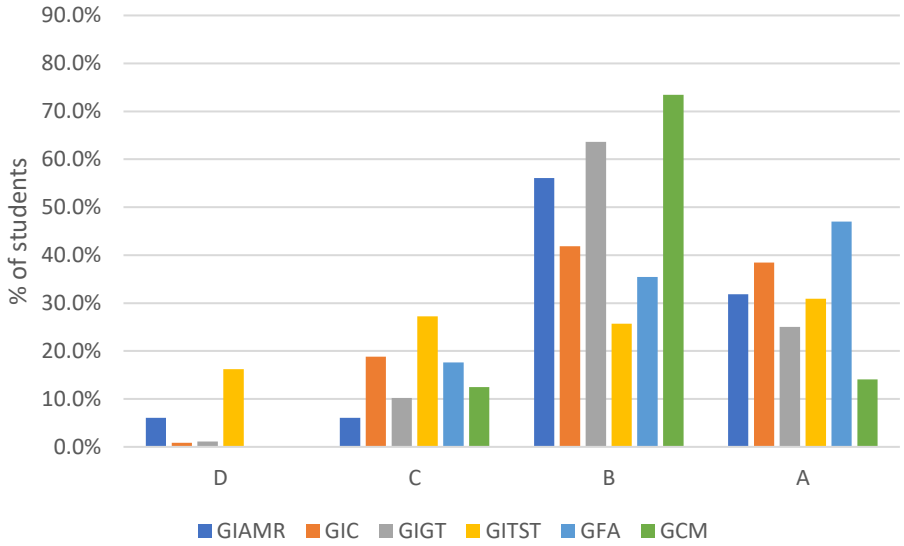

Figure 3. Distribution of grades in the different Bachelor´s Degrees (Level 1). Grades range from D (non-acquired) to A (maximum) acquisition of the CCLO. Source: Prepared by the authors.

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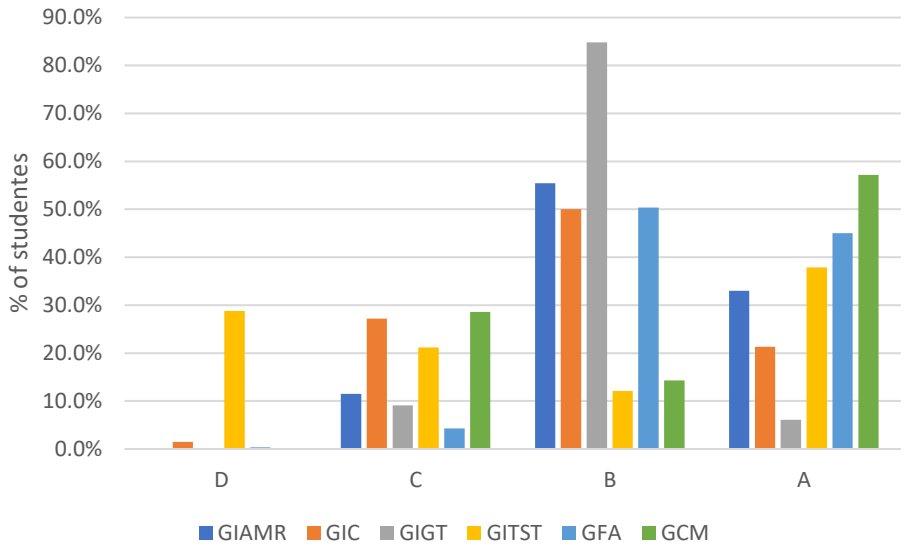

Figure 4. Distribution of grades in the different Bachelor´s Degrees (Level 2). Grades range from D (non-acquired) to A (maximum) acquisition of the CCLO. Source: Prepared by the authors.

3.1. Official syllabus

The scope of this work covers four Bachelor's degrees in engineering (GITST, GIAMR, GIC and GIGT); one in Architecture (GFA) and one in Sciences (GCM). The information described in this point has been extracted from the official syllabi of the different subjects and it has been contrasted through personal interviews with the lecturers responsible for the subjects. Table 4 lists the subjects that evaluate the CCLO "Ethical, environmental and professional responsibility" in each Bachelor's Degree, their number of credits and whether one or both of the aspects of this CCLO were developed.

Table 4. Subjects that develop and evaluate the CCLO "Ethical, environmental, and professional responsibility".

Degree	Number of subjects			Number of credits			Aspect		
	C	S/E	B	C	S/E	B	E	E/P	B
GIAMR	5	4	9	28.5	22.5	51.0	4	1	3
GIC	3	2	5	13.5	9.0	22.5	1	1	3
GIGT	4	0	4	20.5	0.0	20.5	3	0	1
GITST	3	2	5	13.5	12.0	25.5	0	3	2
GFA	6	2	8	61.5	9.0	70.5	3	0	5
GCM	3	2	5	24.0	9.0	33.0	4	0	1

C: Compulsory subjects; O: elective subjects; B: Both aspects. E: Environmental aspect; E/P: Ethical and professional aspect

There are several methods for developing and evaluating this outcome, including case study or project work. **Table 5** lists the methods used and the number of subjects where each method is applied. As it can be observed in the table, the use of rubrics for evaluation is not common, having no evidence of the use of institutional rubrics.

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Table 5. Methodology used for developing the UPV CCLO "Ethical, environmental, and professional responsibility".

Degree	Methodology										Evaluation	
	S	PBL	C	F	PS	R	G	E	W	U	N	RU
GIAMR	1	0	2	1	1	1	1	0	0	5	7	2
GIC	1	0	0	2	0	0	1	1	0	2	5	2
GIGT	1	0	2	1	0	0	1	1	0	1	3	1
GITST	0	0	4	0	0	0	3	0	0	1	5	?
GFA	0	5	0	0	1	0	0	0	0	3	3	1
GCM	0	1	2	1	1	0	0	0	1	2	3	0

S: seminar; PBL: project-based learning; C: case; F: forum and debate; PS: problem solving; R: readings; G: gamification and simulation; E: external visits and field trips; W: written report; U: undefined) and how it is evaluated (N: number of subjects where it is described; .RU: number of subjects where a rubric is used

All Bachelor's degrees develop this CCLO in a number of subjects, which is proportional to the total number of subjects in each educational program. However, if expressed in the number of credits (**Figure 5**), greater differences are observed. It is noteworthy the case of GFA, where the outcome is developed and evaluated on 20.5% of the compulsory credits of the degree, while in other Bachelor's degrees the outcome is treated in subjects that represent just over 5% of the credits of the Bachelor's degree.

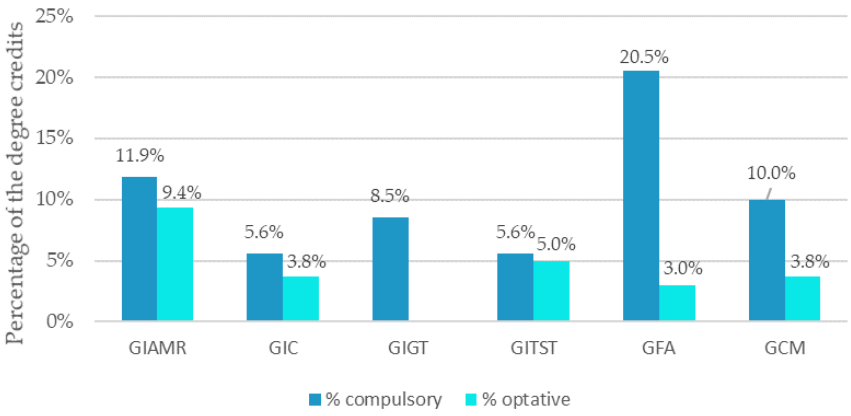

Figure 5. Proportion of credits (compulsory and elective) in which the UPV CCLO "Ethical, environmental, and professional responsibility" (CC07) is developed and evalutated in relation to the degree.

The specific description of the activities to be carried out for the acquisition of the CC07 is uneven, with a high number of subjects detected (27.45%) that do not describe them in detail. GitST stands out positively, where all subjects describe activities in a concrete way, while in GFA only half of them are described. Among the most common activities one can mention the case study, used in the 19.61% of subjects, followed by project-based learning and readings, both used in 11.76% of subjects (**Figure 6**). There is a very strong correlation between some methodologies and the particular Bachelor's degree. This is the case of project-based learning that is used in 5 out of the 8 courses that work this CC07 in GFA. However, this methodology is only used in 1 of the subjects of the other Bachelor's degrees.

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Figure 6. Methodology used for developing the UPV cross-curricular outcome "Ethical, environmental, and professional responsibility"(CC07).

Overall, just over 40% of subjects develop both aspects involved in the outcome: environmental resposnability and ethics, and professional responsability. Another 40% work exclusively in the environmental aspects and 14% work only in the ethical and professional aspects of the CCLO **(Figure 7).**

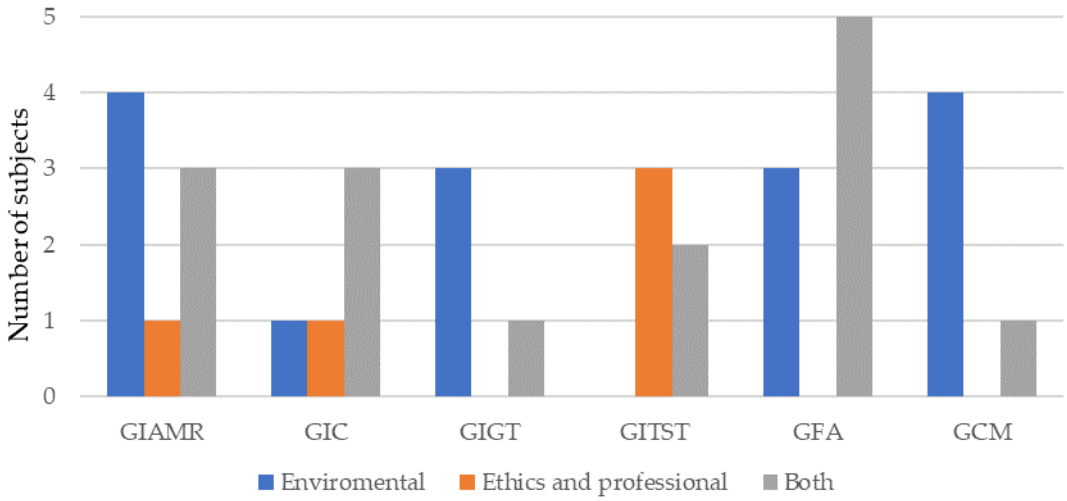

Figure 7. Number of subjects that develop and evalate each aspect of the the UPV CCLO "Ethical, environmental, and professional responsibility" (CC07).

There are two Bachelor's Degrees (GIGT and GCM) in which no course specifically works the ethical and professional aspects and only one subject works both aspects. Since the acquisition of the UPV CCLO is structured on two levels in the Bachelor's Degrees, it is clear that one of the two levels of the aforementioned aspects is not working on these Bachelor's.

3.2. Interviews with lecturers

Figure 8 presents the response of the lecturers to the interview. Overall it can be stated that virtually all lecturers (90%) considered the CCLO "Ethical, environmental, and professional responsibility" as being relevant in the students' curriculum, and their experience with this outcome can be considered as positive (76%). This correlates with the fact that a similar percentage (71 %) of lecturers indicated that they chose to develope and

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evaluate this this CCLO, or they were in agrement with the assigment made by the educational program manager. Less than 20% of the interviewed lectures had found any difficultty to work or evaluate this CCLO and around 33% have required specific training to work with the outcome. Despite this good predisposition to work with CC07 , less than 40% of the lecturers considered that the outcome was having a positive impact on the students' learning.

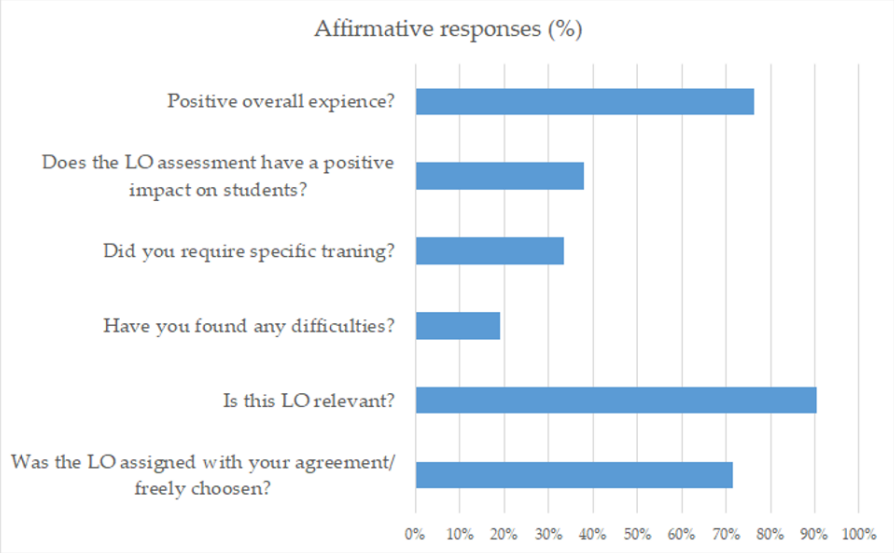

Figure 8. Lecturer responses (prensented as percentage of affirmative responses) to the interviews about the UPV CCLO "Ethical, environmental, and professional responsibility" (CC07)

3.3. Group meeting with students

Figure 9 presents the response given by the students, separeted by Bachelor's degree, to the first questionnaire. Most of the students know about the UPV CCLO Institutional Project, on average 79% indicated that they knew that the project exists, ranging from the 53% of the GIGT students to the 100% of the GITST ones. However, that knowledge drops when it is related to the acquisition levels, when only the 44% of the interviewed students indicated that they knew the differences between the levels to be reached. Once the adquisition levels were refreshed to the students, 91% of them stated that they understood them perfectly, with no remarkable differences between degrees.

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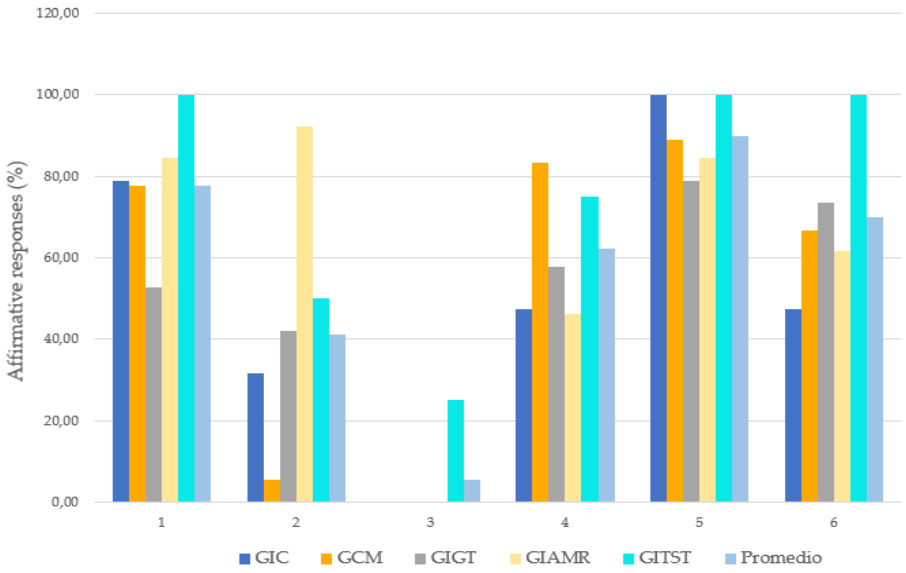

Figure 9. Students' response (presented as percentage of affirmative responses) to the UPV CCLO project questionnary: project knowledge (1); adquisition levels knowledge (3); remember the subject where the generic outcome Ethical, environmental, and professional responsibility has been evaluated, all of them (3) and any of them (4); understanding of the adquisition levels (5); reaching the adquisition levels (6).

Students did not remember all the subjects where they have been evaluated for this particular skill, but 62% of them remembered at least one subject where it had been evaluated. It is noteworthy that this percentage increases up to 83% in the GCM students, which could be motivated by the greater interest of these students for the environmental aspect of the outcome. Only 70% of the students considered that they had reached the expected adquisiton levels; particularly low is the percentage obtained for the GIC students, where this feeling only represents 47% of the group. Maybe this lower value could be related with the fact that the interview was carried out in the context of the "Ethics" subject.

The students received a summary of the information related to the development of the outcome within each Bachelor's degree, and afterwards they answered a second questionarry, which results are presented in figure 10. Globally, 33% of them indicated that they were aware of being evaluated in all those subjects. It is remarkable the difference between the evaluated Bachelor's degrees, while less than 10% of the GIC and GIGT students indicated that they were aware of this information, the percentage raised to values greater than 45% for GCM and GIAMR . When considering at least one subject, these percentages increased to 70% on average. Only 20% of the students knew their grades for this CCLO. Nearly 60% of the students indicated that they remembered to carry out different activities to develop the outcome before they were evaluated, but, once again, there were great differences between Bachelor's degrees, ranging from the the 28% in GCM to the 100% in GIC. Only the 21% of the GIGT students indicated that preparing this generic outcome supposed a work overload.

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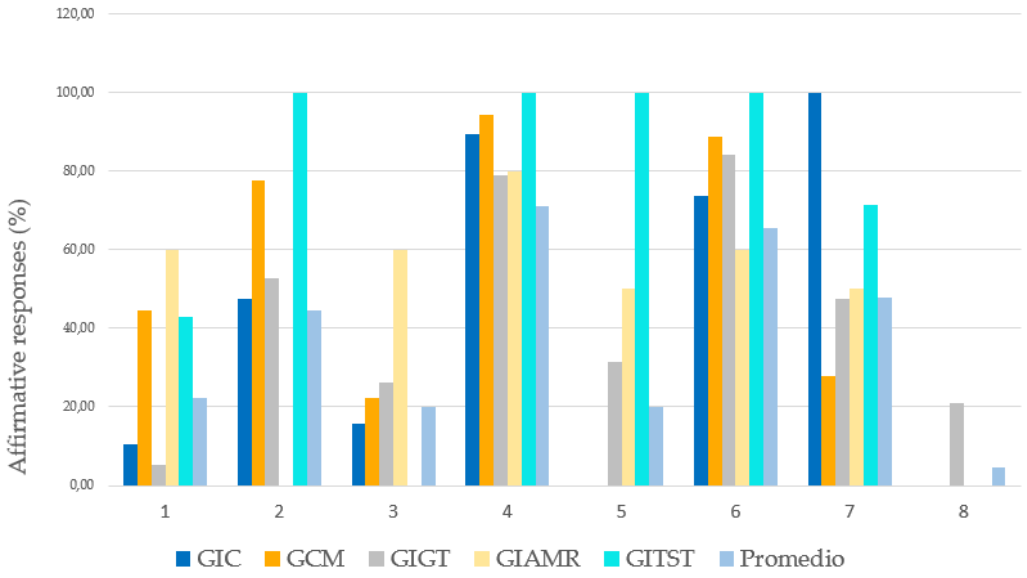

Figure 10. Students' responses (prensented as percentage of affirmative responses) to the devolopment of the outcome "Ethical, environmental, and professional responsibility" CC07 within each degree: awareness of being evaluated, in all the subjects (1) and in any subject (2), activities developed help to reach the adquisition level (3); application of this reponsability in the professional life (4); qualification knowledge (5), willingness ot increase the development of this outcome in the curriculum (6); activities to develop the outcome prior to be evaluated (7); the outcome developemnt supposed an extra work overload (8). Questions 7 and 8 were not answered by the GIAMR and GITST students.

Close to 90% of the students believed that they will be able to apply the ethic, environmental and professional responsibility in their future jobs, but only 25% of them considered that they had gained the skill thanks to the different activities developed along their subjects. Overall, the 81% of the interviewed students considered that training related to this CCLO should be furhter considered in their respective educatio0nal programs.

4. Discussion and conclusion

The work undergone within the 6 Bachelor's Degrees at UPV has led to diagnose the extent at which the institutional project on CCLO is performing after 6 years running, specifically regarding the CCLO "Ethical, environmental and professional responsibility" (CC07). Official subject syllabi analysis, interviews with lecturers and focus groups with students were developed in order to assess, first, objective information but further and even more relevant, the feelings and impressions of the two main actors of the teach-ing-learning process: lecturers and students.

UPV chose to integrate "Ethical, environmental and professional responsibility" learning in a transversal way into the educational program through a CCLO. Nevertheless, other universities include into their curricula compulsory subjects on the matter. There is no strong evidence on whether the way at UPV is better than the one chosen by other universities [20]. One way or another, the objective of this work is to assess if we are achieving the expected results or there are still some barriers and dif-ficulties hindering an effective deployment of the CCLO institutional project regarding CC07 learning at UPV.

The analysis of the different course syllabi involved in training the CCLO highlights a high heterogeneity between schools and Bachelor's degrees. First, the number of credits within the different educational programs that are devoted to CCLOis highly variable, but is also important to note that, in some cases, a high proportion of these credits are elective, thus is not assured that all students will follow the subject working "Ethical, environ-

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mental and professional responsibility". There is also a great variety on teaching-learning methodologies. This is somehow expectable as these methodologies are mainly oriented to the subject itself and to the development and assessment of the related technical competences. A paradigmatic example is the use of project-based learning methodologies in GFA.

Besides the above-mentioned heterogeneity, another point that arises when analyzing the different course syllabi is the double dimension of "Ethical, environmental and pro-fessional responsibility" CCLO. Less than half of the analyzed courses develop both as-pects of CC07 (either environmental or professional and ethical responsibility). As a result, there a risk to have students not achieving some dimension of the CCLO, especially if a high proportion of the subjects working it are elective.

The second target of the analysis was the interviews with lecturers. The main conclusion that arises is that a great majority recognizes that training in "Ethical, environmental and professional responsibility" is relevant and necessary within the students' curriculum. This result highlights that training our students to exercise their profession ethically and with environmental responsibility is a main priority along the educational programs.

A paradoxical result emerges when lecturers are asked if they found any difficulties to work with the CCLO (less than 20% acknowledge difficulties) and if they required some training before tackling it (only 33% recognize this need). It is surprising that staff training in ethics and professional and environmental responsibility is considered unnecessary by 2 out of 3 of the lecturers involved, although UPV offers every year, specific training for lecturers on CCLOs. But it is also remarkable that, in a university context, academic staff considers that is not necessary to be trained in ethics, which is a very specific body of knowledge, e that aims to guide human action in a rational sense: that is, it makes us act rationally [21]. As any other type of knowledge, ethics must be studied, learned, understood. It is not enough to know the deontological codes of the different professions to teach "Ethical, environmental and professional responsibility". The foundations of the body of knowledge must be understood so lecturers' training is absolutely necessary for a successful implementation of the CCLO into the educational programs.

The third and last part of the analysis consisted on focus groups with students. The main objective of these focus group was to assess the level of achievement of the CCLO along the Bachelor's Degree. Many of the students interviewed knew the institutional program, even the CCLO, but this level of knowledge falls when asked for the meaning of the different levels of achievement. Nevertheless, a short explanation on this issue reverts this situation. This point highlights that it is of paramount importance to explain at the beginning of each subject the CCLO that will be worked, and at which extent, to clearly state the objectives aimed at and, how it will be assessed. Students should be trained on "Ethical, environmental and professional responsibility", which remarks the importance that lec-turers had also received training.

A great majority of students have a high perception to be able to exercise their professions ethically and with environmental and professional responsibility. Nevertheless, they do not acknowledge to have achieved this competence through the activities developed within the context of subjects dealing with the CCLO. Students demand a more effec-tive and explicit training on "Ethical, environmental and professional responsibility" within their educational program.

Given this diagnosis, have we achieved the purposes of the institutional project regarding the "Ethical, environmental and professional responsibility" CCLO? Many authors highlighted the importance of providing engineering students with an effective ethics education, and most engineering lecturers agree that ethics is an important aspect of engineering education. However, there are still barriers hindering the effective integration of ethics into engineering and architecture educational programs: the curriculum is already full, and there is little room for ethics education; faculty lack adequate training for teaching ethics; there are too few incentives to incorporate ethics into the curriculum; policies about academic dishonesty are inconsistent; and institutional growth is taxing existing resources [22]. At least the first three above mentioned obstacles would exist at UPV.

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Best practices that allow for progressing towards a better integration of the CCLO into the ceducational programs are fully applicable at UPV, which must be inspired by other successful experiences to improve its model. The main actions needed in the short term to improve the teaching-learning process of the CC07 are:

a) Split the competence into two different ones, corresponding to the two present dimensions: environmental responsibility / ethical and professional responsibil-ity.

b) Emphasize the need to explain to students the institutional project, and, specifically, the scope of CC07 and how it will be worked and assessed.

c) Highlight the importance of training for lecturers on the body of knowledge of ethics.

d) Acknowledge the need of a cross-coordination throughout the curriculum for a better integration of the CCLOs. This task must be undergone by the schools boards and educational program managers.

e) Consider the introduction of a compulsory subject within the educational program to develop the foundations of ethics. This will allow students to better de-velop the outcome in a multidisciplinary context within other technical subjects.

The need of training in ethics and professional responsibility is, at present, essential for engineering and architecture Bachelor's degrees in a worldwide context. In this sense, the Accreditation Board for Engineering and Technology (ABET) of the United States include among outcomes to prepare graduates to enter the professional practice of engineering "an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts". Students should achieve this outcome for exercising successfully their profession in a more critical and demanding societal context. After 6 years of implementation of the institutional project in-troducing CCLO into the educational programs, UPV must acknowledge some disfunctions and overcome the identified difficulties for an effective introduction of "Ethical, environmental and professional responsibility" into the Bachelor's degrees.

Author Contributions: For research articles with several authors, a short paragraph specifying their individual contributions must be provided. The following statements should be used "Conceptualization, X.X. and Y.Y.; methodology, X.X.; software, X.X.; validation, X.X., Y.Y. and Z.Z.; formal analysis, X.X.; investigation, X.X.; resources, X.X.; data curation, X.X.; writing—original draft preparation, X.X.; writing—review and editing, X.X.; visualization, X.X.; supervision, X.X.; project administration, X.X.; funding acquisition, Y.Y. All authors have read and agreed to the published version of the manuscript." Please turn to the CRediT taxonomy for the term explanation. Authorship must be limited to those who have contributed substantially to the work reported.

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References

1. Martin L.; Mahat M. The Assessment of Learning Outcomes in Australia: Finding the Holy Grail. in AERA Open. 2017.
2. Bielefeldt, A.R. Pedagogies to Achieve Sustainability Learning Outcomes in Civil and Environmental Engineering Students. Sustainability. Special issue: Pedagogy for Education for Sustainability (EfS) in Higher Education (HE) 2013, Vol. 5 (10), pp. 4479-4501.
3. Svanström, M.; Lozano-García, F.J.; Rowe, D. Learning outcomes for sustainable development in higher education. International Journal of Sustainability in Higher Education 2008, Vol. 9 No. 3, pp. 339-351.

4. Jarchow, M.E.; Formisano, P.; Nordyke, S.; Sayre, M. Measuring longitudinal student performance on student learning outcomes in sustainability education. International Journal of Sustainability in Higher Education 2018, Vol. 19 No. 3, pp. 547-565.
5. Smith, C.; Bath, D. The Role of the Learning Community in the Development of Discipline Knowledge and Generic Graduate Outcomes. Higher Education 2006, Vol. 51, pp. 259–286.
6. ABET. Criteria for Accrediting Engineering Programs, 2019 – 2020. Available online: https://www.abet.org/accreditation/accreditation-criteria/criteria-for-accrediting-engineering-programs-2019-2020/ (accessed on 25/06/2021).
7. Fornes, G.; Monfort, A.; Ilie, C.; Koo, C.K.; Cardoza, G. Ethics, Responsibility, and Sustainability in MBAs. Understanding the Motivations for the Incorporation of ERS in Less Traditional Markets. Sustainability 2019, 11, 7060.
8. Setó Pàmies D.; Papaoikonomou E. A Multi-level Perspective for the Integration of Ethics, Corporate Social Responsibility and Sustainability (ECSRS) in Management Education. Journal of business ethics 2016, Vol. 136, n. 3, pp. 523-538.
9. Casañ, M.J.; Alier, M.; Llorens, A. Teaching Ethics and Sustainability to Informatics Engineering Students, An Almost 30 Years' Experience. Sustainability 2020, Vol. 12, pp. 5499.
10. Miñano Rubio, R.; Uribe, D.; Moreno-Romero, A.; Yáñez, S. Embedding Sustainability Competences into Engineering Education. The Case of Informatics Engineering and Industrial Engineering Degree Programs at Spanish Universities. Sustainability 2019, Vol. 11, 5832.
11. El-Zein, A.; Airey, D.; Bowden, P.; Clarkeburn, H. Sustainability and ethics as decision-making paradigms in engineering curricula. International Journal of Sustainability in Higher Education 2008, Vol. 9, No. 2, pp. 170-182.
12. Wang, G. C.; Buckeridge, J. S. Teaching Ethics for Construction Management Majored Students: Standalone Or Micro-Insert? - Globalization and Sustainability Considerations. Paper presented at 2016 ASEE Annual Conference & Exposition, New Orleans, Louisiana, 2016. American Society for Engineering Education-ASEE.
13. Miñano, R.; Uruburu, Á.; Moreno-Romero, A.; Pérez-López, D. Strategies for teaching professional ethics to IT engineering degree students and evaluating the result. Science and Engineering Ethics 2017, 23(1), 263–286.
14. Hsu, Y. C. An Action Research in Critical Thinking Concept Designed Curriculum Based on Collaborative Learning for Engineering Ethics Course. Sustainability 2021, Vol 13, 2621.
15. Berdanier C. G. P.; Tang X.; Cox M. F. Ethics and Sustainability in Global Contexts: Studying Engineering Student Perspectives Through Photoelicitation. Journal of Engineering Education 2018, Vol. 107, Is. 2, pp. 238-262.
16. Moore, C.; Hart, H.; Randall, D.; Nichols, S.P. PRiME: Integrating professional responsibility into the engineering curriculum. In Proceedings of the Science and Engineering Ethics 2006, Kluwer Academic Publishers: Dordrecht, vol. 12, pp. 273–289.
17. Glynn, E.; Falcone, F.; Doorley, M. Implementing ethics across engineering curricula. In Proceedings of the ASEE Annual Conference and Exposition, Conference Proceedings 2010, Atlanta, American Society for Engineering Education-ASEE.
18. Cruz, J.A.; Frey, W.J. An Effective Strategy for Integrating Ethics Across the Curriculum in Engineering: An ABET 2000 Challenge. Science and Engineering Ethics 2003, Vol 9, pp. 543–568.
19. UPV. Cross-curricular Learning Outcomes. Available online: http://www.upv.es/contenidos/COMPTRAN/info/957657normalc.html (accessed on 25/06/2021).
20. Barry, B; Ohland, M., Engineering ethics curriculum incorporation methods and results from a nationally administered standardized examination: Background, literature, & research methods., in Proceedings of the ASEE Annual Conference and Exposition, Conference Proceedings, 2009, Atlanta, American Society for Engineering Education-ASEE.
21. Cortina Orts, A. Ética de la empresa : claves para una nueva cultura empresarial; 1a, 5a edn, Trotta, Madrid, 1994.
22. Walczak, K.; Finelli, C.; Holsapple, M.; Sutkus, J.; Harding, T.; Carpenter, D., Institutional obstacles to integrating ethics into the curriculum and strategies for overcoming them. In Proceedings of the ASEE Annual Conference and Exposition, Conference Proceedings, Atlanta, 2010, American Society for Engineering Education-ASEE.