Impact of interdisciplinary learning on the development of engineering students' skills

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ABSTRACT

This paper intends to present an interdisciplinary project carried out in a School of Engineering, and to refer to its effects in the development of students' skills. This project's main goal was to present students with an intellectually demanding challenge which implied overcoming the disciplinary barriers thus integrating knowledge to solve the problems they were challenged with. After the project had been concluded, a study was carried out using a qualitative methodology by conducting two focus groups ($n = 16$). The main goal of this procedure was to get a better perception of (1) how students understood the project; (2) what kind of skills students considered to have developed throughout the project, and (3) the importance they have attributed to this kind of project. The results demonstrate that students are aware of the relevance of the project not only for their education process but also for the development of their skills. The results of the study also reveal that the students involved in the project have been capable of identifying the specific skills that the project work had intended to address and develop.

KEYWORDS
Interdisciplinary teaching; higher education; engineering education; soft skills

Introduction

Interdisciplinary initiatives have increasingly emerged in different fields of knowledge and interven- tion. In fact, societal, environmental, economic, and philosophical challenges are often so complex that it is impossible to fully understand and solve them using a single perspective or knowledge fra- mework (Jacob 2015).

Arguments against and in favour of interdisciplinarity have been used. Critics view interdisciplin- ary approaches as lacking in novelty, scholarly depth, and methodological rigour. On the other hand, it is argued that to eliminate boundaries and use an interdisciplinary approach it is essential to solve real-world complex problems (Bernini and Woods 2014).

By presenting an interdisciplinary project carried out in the Electrical Engineering – Power Systems degree, we aim at contributing for this discussion as well as to demonstrate the relevance of inter- disciplinary teaching. With this project we aimed at creating the opportunity for students to develop skills, in an integrated way, within the range of the subjects involved. Students were chal- lenged to perform a set of tasks by applying concepts and skills they were introduced to and improved within the subjects involved in the project.

In this paper, we reflect on the gains of this kind of projects for the learning process, and on the benefits of interdisciplinary projects. Furthermore, we explore the main objectives of this interdisci- plinary work, as well as the methodology and its main results.

This paper concludes with a reflection on the main lessons learned followed by a set of sugges- tions for future interdisciplinary works.

What is interdisciplinarity all about?

Klein (2000, 3) notes that 'for most of the twentieth century, the question of knowledge has been framed by disciplinarity'. The author argues that: 'Over the course of this century, metaphors of knowledge have shifted from the static logic of a foundation and a structure to the dynamic prop- erties of a network, a web, a system, and a field' (Klein 2000, 21). This has led some authors to consider that the notion of disciplines is artificial and is now breaking down into a postdisciplinary world (Turner 2006; Chettiparamb 2011).

Interdisciplinarity is a complex concept to define. Recently, Callard and Fitzgerald (2015, 4) have declared that 'interdisciplinary is a term that everyone invokes, and none understands'. On the other hand, Klein (2010b, 4) notes that interdisciplinarity faces many 'administrative, funding, and cul- tural barriers', and that sometimes the word is used merely as a label without fostering structural change.

Nevertheless, in recent times the theme of interdisciplinarity has gained popularity in different circles. Regardless of the scepticism in some educational environments, the number of supporters of its use in school contexts have been increasing, especially following its introduction in university curricula and research agenda (Chettiparamb 2011; Bernini and Woods 2014; Spelt et al. 2014; Jacob 2015). Frodeman (2014) suggests that the most adequate way to deal with complex challenges and problems is to combine already existing bodies of knowledge, instead of producing new knowledge. In order to clarify concepts, and distinguish *interdisciplinary* from other terms frequently used as synonyms, Klein has developed a taxonomy, clarifying the barriers of concepts such as *multi- inter-* and *trans-disciplinary*, which are highlighted below: *Multidisciplinary* is formed by juxtaposing knowl- edge, methodologies or information from different subjects, even though the knowledge structure, and the identity of the original subjects remain unquestionable. On the other hand, *interdisciplinary* approaches emphasise integration and interaction, which promote the disciplinary transformation at methodological and theoretical levels. Finally, in *transdisciplinary* methods, research questions and practices are framed by problems arising from the life-world and studied in different perspectives (Klein 2010a; Jacob 2015).

The Subcommittee on Interdisciplinary Teaching at Emory University, cited by Chettiparamb (2011, 31), provides the following definition of interdisciplinarity: '(1) the enrichment of one discipline by use of the language, methods, or canons of one or more other disciplines; or (2) the common inquiry into universal themes, such as health, justice, or violence, using the language, methods, and canons of two or more disciplines.'

Interdisciplinary teaching

If interdisciplinarity is not a consensual concept nor practice, it is even more complex when we aim to apply interdisciplinarity to the teaching-learning process, in which each subject is usually associated to a pedagogical unit, implying the use of specific methodologies sometimes difficult to adapt to other contexts (Chettiparamb 2011).

Interdisciplinarity teaching can take many different forms and can occur at several places in the curricula (Chettiparamb 2011). According to Haynes (2002, Xvi),

> Interdisciplinary pedagogy is not synonymous with a single process, set of skills, method, or technique. Instead, it is concerned primarily with fostering in students a sense of self-authorship and a situated, partial and perspectival notion of knowledge that they can use to respond to complex questions, issues or problems. While it necessarily entails the cultivation of the many cognitive skills such as differentiating, reconciling, and synthesizing […] it also involves much more, including the promotion of student's interpersonal and intrapersonal learning.

From Gero’s perspective (2013, 2017), interdisciplinary learning will not only contribute to the development of the learner’s cognitive skills, including high-order thinking, but also increase learner’s motivation to learn due to the interest it unleashes.

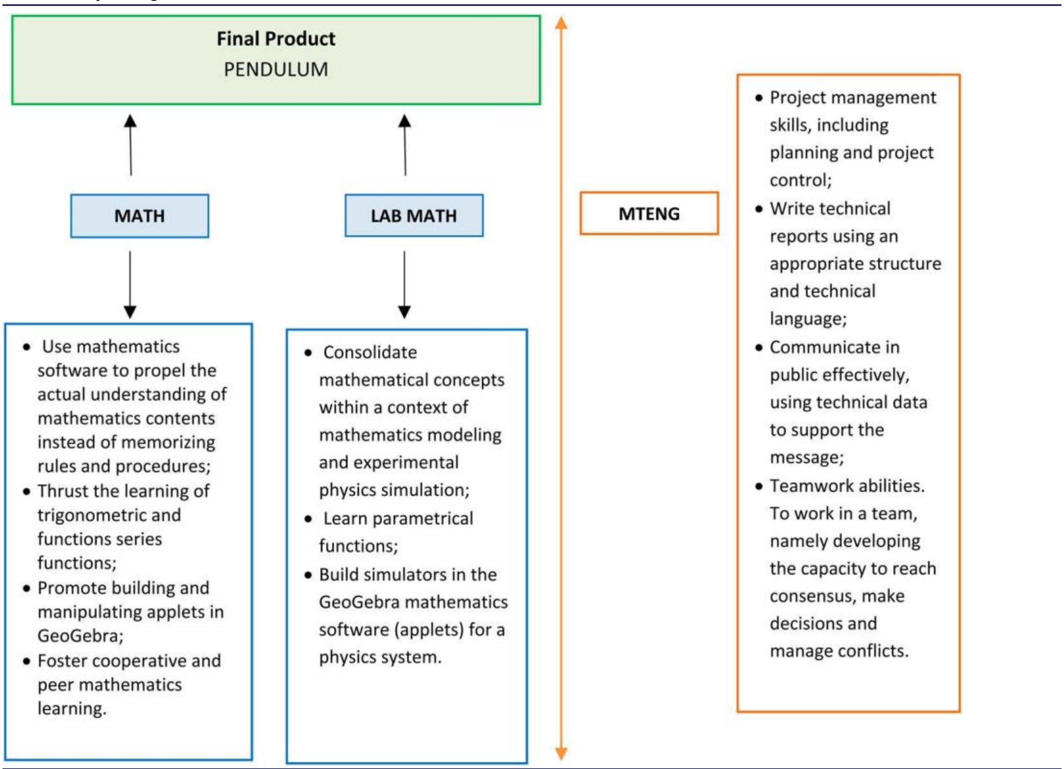
Crossing disciplinary boundaries is particularly important for a future engineer, who will be expected to solve complex problems that will require the ability to cross boundaries both horizontally (across subjects) and vertically (across experts, policymakers, practitioners, and the public) (Lélé and Norgaard 2005; Clark and Wallace 2015; Păvăloiu, Petrescu, and Dragomirescu 2015).

The advantages of interdisciplinary studies are widely accepted by teachers and researchers. Some authors suggest that interdisciplinary works comprise knowledge that comes from different curricu- lum areas, thus providing different perspectives on a particular problem, making the curriculum more compact and more consistent. Additionally, interdisciplinary works provide students with relevant, challenging and enjoyable learning experiences (Borrego and Cutler 2010; Jacob 2015).

In alignment with these ideas, some universities have been developing some interdisciplinary design courses so as to improve students’ abilities to operate across disciplines, and therefore con- tribute to them being better prepared for the job market (Harrison, Ewen Macpherson, and Williams 2007). This tendency may also be observed in engineering teaching, which is not actually surprising since the success of future engineers is also linked to their capability of solving complex problems to which overcoming existing disciplinarity barriers is often essential (Lima et al. 2007; Borrego and Newswander 2008; Lima et al. 2009; Borrego and Newswander 2010; Bernini and Woods 2014).

Nevertheless, implementing an interdisciplinary programme involves profound challenges for tea- chers as well as for students. Spelt et al., cited by Gero (2013, 1048), refer to a set of premises con- sidered to be essential for an interdisciplinary programme to succeed: ‘patience, curiosity and openness on the part of the student; a syllabus that balances the interdisciplinary and disciplinary components; and teaching staff and methods that encourage learners to cooperate with their peers from other disciplines’.

Table 1. Project organisation.



Project description

This project was carried out within the scope of the degree in Electrical Engineering, involving three different course units, two in Mathematics, namely ‘Mathematics I’ (MATE1), and ‘Laboratory Mathematics’ (LABMAT) and the course unit ‘Working Methods in Engineering’ (MTENG) (see Table 1).

The project was developed throughout 11 weeks in the first semester of the first year of the under- graduate degree in Electrical Engineering, involving all the students enrolled in the degree. Students were assessed considering three outcomes: the final product, a report, and an oral presentation fol- lowed by discussion.

Using a unique project work, students were given the opportunity to develop their personal skills – their underlying individual characteristics directly related to criteria of effectiveness and/or pro- fessional achievement (Boyatzis 1982, *cit in* Boyatzis 2008) –, in an integrated way, in the diverse fields of the subjects involved. Students were challenged to perform a set of tasks by applying con- cepts and skills developed within the three aforementioned subjects.

With those tasks, we aimed to achieve a set of global objectives, such as enabling students to develop:

- the ability to integrate knowledge, and to be open to integrating knowledge coming from various scientific areas;
- research, analysis and validation skills, as well as information handling skills;
- scientific curiosity;
- creativity and innovation skills;
- communication and listening skills;
- the ability to bridge the gap between theory and practice;
- strategies for working in teams, namely to develop the capacity to build consensus, take decisions, and solve conflicts.

In addition, a set of specific objectives was defined for each of the scientific areas, Mathematics and Working Methods.

As far as the course unit Working Methods in Engineering is concerned, the project aimed at devel- oping skills in the areas of:

- Project management, including planning and project control;
- Writing technical reports by using adequate structures and technical language;
- Public communications, using technical data effectively to support the message;
- Teamwork, namely to develop the ability to reach consensus, make decisions, and manage conflicts.

On the other hand, concerning Mathematics, the objectives were:

- To use mathematics software to propel the present understanding of mathematics contents instead of memorising rules and procedures;
- To thrust the learning of trigonometric functions and functions series;
- To promote building and manipulating applets in GeoGebra;
- To foster cooperative and peer mathematics learning.

For a better understanding of the project, its main tasks are described in the following paragraphs, and summarised in Table 2.

Table 2: Project life cycle framework and task scheduling (weekly).

Activities	October	November (weeks)				December (weeks)				January (weeks)	
	5th week	1st	2nd	3rd	4rd	1st	2nd	3rd	4rd	1st	2nd
Task 1 Project planning (MTENG)											
Task 2 GeoGebra (MATH)											
Task 3 Building the Pendulum (MATH+MTENG)											
Task 4 Preparing report and oral presentation (MTENG)											
Delivering product and presentation (MATH+MTENG)											
Delivering report (MATH+MTENG)											

Task 1

Students were divided into groups of four elements. A written statement was delivered to each group, containing all the instructions as well as the deadlines, and criteria for each evaluation moment.

Each group was asked to plan, design, simulate and construct a simple pendulum using GeoGebra software as modelling software. In addition to building the pendulum, following the modeling carried out in GeoGebra, students also had to write a report, and do an oral presentation about their work. To facilitate project planning, a schedule of activities, like the one presented in Table 2, was given to each group.

With the aim of developing planning skills, each group was asked to start by planning the whole project. For that, students were advised to use a planning instrument such as the Gantt chart, which had to be delivered to the teachers, and used by all the students throughout the project to monitor the project development.

Task 2

Task 2 related to Mathematics and aimed at learning trigonometric functions. Students were required to build a simulator using GeoGebra software, based on a model of a physical system constituted by a simple pendulum as the one represented in Figure 1, and taking into account no air resistance.

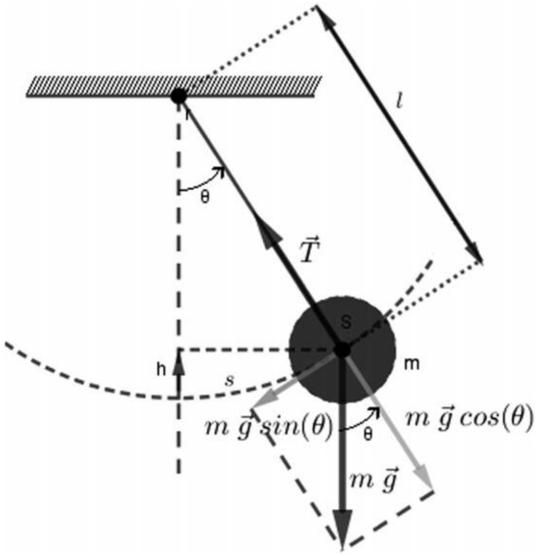


Figure 1. Physical model of the simple pendulum.

When developing the simulator, it was necessary to bear in mind that the user should be able to vary the length of the pendulum, the starting angle of the mass release (m) and digitise the value of the gravity acceleration. Building the simulator should enable supporting students' answers to a set of mathematical questions in the physical context of the pendulum, such as: visualising the pendu- lum's movement; determining the gravity acceleration when the pendulum is in different locations as well as determining the specifications for building a classical pendulum watch.

Students were also supposed to develop their learning on Taylor's series in a context where the model of the simple pendulum was applied. Therefore, students were led to build a simulator using the GeoGebra software which would allow the user to find an approximation polynomial to a function. Elaborating the Taylor's series simulator would permit supporting the students in understanding the outset of the series of functions, and to help them answer questions in the physical context of the pen- dulum, such as: (i) to analyse the behaviour of the function approximation to a polynomial when the considered points might, or not, belong to the series convergence interval; (ii) to find a solution based on the Taylor's serie s that might answer problems regarding the number value determination of a real

constant such as $\sqrt{e}$ or cos(π/5), when a calculator is not used, and estimating the resulting error; (iii)

find solutions that maytransform complex expressions of engineering models into approximations based on Taylor's polynomials, in this case, the pendulum movement.

Task 3

Task 3 aimed at building a physical structure that would include the pendulum (pendula). This had to be done partially or totally computer simulated. The computer simulation of the physical prototype model built in the project would allow comparing the real situation to the mathematical model used in the simulator.

Task 4

Finally, task 4 implied each group to write a report and to present their results in a formal oral pres- entation, both being assessed by the teachers involved in the project. The presentations were deliv- ered to the group of teachers of both fields of knowledge involved.

From an interdisciplinary perspective, the teachers of the different course units closely followed the development of the project throughout the whole process. This coordination required teachers to schedule regular meetings. The project was assessed in the three involved course units, having specific assessment criteria been defined in each of the course units. In addition to the project product, the pendulum and the corresponding mathematical calculations, students were also assessed for the oral presentation and for the final report concerning their project.

At the end of the project an evaluation of the students' perception about the project, its gains and benefits, the skills developed, and the importance of these skills for students' future was conducted. For this purpose, two focus groups were formed with a sample of the students involved in the project (n = 16). The Focus Group moderator was a teacher with experience in qualitative methodologies.

Goals and methodology

In total, 66 students participated in the project, mostly male (*n* = 64), aged between 17 and 46, attending day classes (*n* = 42), and evening classes (*n* = 14), the average age being 23.47 (SD= 6.53). Evening students usually enrol in higher education through the 'elder than 23' programme stated in the Portuguese law, hence this group is mainly consisted of working individuals who at a certain time in their career have decided to take a degree while pursuing their professional activity. Apart from presenting the interdisciplinary project, this paper also intends to disseminate the results of the study carried out at the end of the project. The main objectives of this study were the following:

- To understand students' perception about the project, namely its gains and benefits;
- To get to know which skills students considered to have developed during the project, as well as the impact they perceive those aptitudes would have for their future professional life;
- To identify possible improvement areas to be implemented in future interdisciplinary projects.

In order to meet these goals, we used a qualitative methodology, applied to two focus groups con- ducted within a sample of students (*n* = 16). Each focus group was made up with eight students from both evening and day classes, following the perspective of most experts in this field (Silva, Veloso, and Keating 2014).

Recent literature recognises the importance that qualitative methodologies may take in research processes, specifically as for the relevance of the focus group. A focus group, as well as any other type of research of a qualitative nature, has the purpose of searching for meaning and understanding phenomena, using an inductive strategy and giving rise to a qualitative result (Galego and Gomes 2009). This qualitative technique can then be used in educational investigation to evaluate the impact of programmes or projects (Galego and Gomes 2009), which was the use within the scope of the present study. In fact, several authors emphasise this to be a swift procedure, considering its scope and the amount of generated information (Silva, Veloso, and Keating 2014), as long as the diverse assumptions associated to planning, moderation and data handling are assured.

Findings

After having conducted both focus groups with students that had participated in the project, a content analysis procedure was run (Bardin 2011).

To optimise the content analysis, the focus groups discussions/opinions were fully transcribed, thus making the Corpus. Afterwards, the units of record were selected. At this stage, we started by categorising information in terms of the themes from the *à priori* defined categories, and then the analysis was completed with *post-hoc* categories.

In the results analysis, following the methodological proposal advocated by Bardin (2011) and reinforced by several other authors (Silva, Veloso, and Keating 2014), the first step was the complete

Table 3. Concept of skill.

Category	Unit of meaning	Frequency

Concept of skill	Acquisition	'It is acquired by practice'; 'May be improved by practice' 'Demandstraining'	3
	Fulfilment	'a person that performs the tasks' 'fulfilling deadlines' 'organization'	3
	Meaning	'Knowing by doing' 'It is associated with performance'	4

transcription of the content, followed by the elaboration of categories and sub-categories of analysis. Subsequently, information was attached to each of the categories – Units of meaning – to allow a better understanding of the categorised contents.

When identifying the categories as well as when selecting the units, we took care to satisfy the criteria defined by Bardin (2011) and Esteves (2006), which imply mutual exclusion, consistence, com- pleteness, pertinence, productivity, and objectivity.

Firstly, students were inquired about the meaning of the term 'skill' ('Can you please, tell me what does Skill mean for you?'). In a first approach, participants had difficulties in defining the concept. The main resulting ideas are presented in Table 3. It is to be highlight that this concept is often confused with the acquisition and development of the skill itself (3 in 16). This confusion may be inferred in expressions such as: 'it is acquired with practice,' 'it may be valued by practice,' or 'it requires training.' It is to be underlined that some participants define 'skill' by referring to specific abilities such as 'complying with deadlines,' or 'organization.' Also to be highlighted is the frequent association of 'skill' to 'knowing by doing,' or with 'performance.'

Afterwards, students were inquired about the skills they consider to be more important to master after graduating ('What skills do you consider most relevant for a professional who wishes to succeed in your study area?'). Regarding those that are perceived as being more relevant by the end of the first cycle, students highlighted the 'knowledge' ('Being well-informed', 'Knowledge of the context') (4 in 16) and the 'know by doing' ('Applying combined theory and practice') dimensions (4 in16), together with other transversal skills such as 'Organizational Skills', 'Planning', 'Working Methods', and 'Inno- vation' (5 in 16) (see Table 4).

Students were also questioned about the Education Institution's responsibility in the skills devel- opment process ('In your opinion, what should be the role of ISEP in the development of these skills?'). Until this stage, the answers were completely unanimous in both focus groups. Students clearly consider the Education Institution to be totally responsible for developing the essential skills to allow students to succeed professionally. It is to be underlined that school's prestige as well as its impact in students' professional integration, is fully recognised (see Table 5).

On the other hand, students were requested to express their point of view about their own responsibility in their skills development process ('What is your own role in the development of these skills?'). Results showed that, while there is a unanimous perspective regarding the Education Institution's responsibility in the skills development process, statements differ when individual responsibility in that same process is assessed, evidencing that there are students who seem to dis- regard their personal role in developing their own individual skills (4 in 16).

Table 4. Professional skills acquired during the undergraduate degree

	Category	Unit of meaning	Frequency
Skills	Knowledge	'Being well-informed' 'Knowledge of the context'	4
	Know by doing	'Applying theory and practice combined'	4
	Transversal skills	'Organization' 'Planning' 'Working Methods' 'Innovation'	5

Table 5. Individual responsibility in skills development.

	Category	Unit of meaning	Frequency
Skills	Involvement	'Dedication is a must' 'Effort is decisive' 'The undergraduate degree has to be seen as a job'	8
	Individual role relevance	'Each one has to invest'; 'Students have to dedicate themselves'	4

Those that consider their personal role to be relevant also value each student's role and involve- ment in determining their path, as presented in Table 5.

Furthermore, students were required to globally evaluate the project they had been involved in. All participants stated the added value of the project for their educational process, having identified the development of skills that favour the smooth adaptation to the job market, and the possibility of facing highly challenging situations as its main advantages.

It may be inferred by the students' comments gathered in the questionnaires that they perceived the project quite positively, nevertheless they have also identified some weaknesses, mostly referring to the project topic, which was considered to have been minimally related to the central study area (Electrical Engineering), and to the fact that the Physics course unit had not been involved. The latter aspect was pointed out by all the students involved in the focus groups.

As for the skills the students have acknowledged to have been developed within the project, all the students involved were able to identify skills, highlighting the following: applying knowledge to real situations ('Moving from abstract knowledge to a real setting', 'Moving from theory into practical application') (9 in 16), teamwork ('Team work organization was fundamental', 'Learning to work as a team') (8 in 16), skills within the working methods field ('Working with project management method- ology', 'I learned how to manage projects') (8 in 16), project management ('Organizing information was fundamental', 'I believe that I have developed a lot in this area') (4 in 16), personal organisation ('Organizing information was fundamental', 'I believe that I have developed a lot in this area') (4 in 16), time management ('When we have deadlines, we have to define priorities', 'Time management was fundamental and I felt that I have developed this competence') (4 in 16), and presentation techniques ('Speaking in public', 'Presenting our ideas to an audience', 'Having to present ideas clearly and attrac- tively') (7 in 16) (see Table 6).

Finally, the focus groups participants were still asked to contribute with suggestions for future improvements. Referring to this item, students have reinforced the need for teachers' constant

Table 6. Skills developed.

Category		Unit of meaning	Frequency
Skills	Knowledge application to actual situations	'Moving from abstract knowledge to a real setting' 'Apply knowledge to a real project' 'Moving from theory into practical application'	9
	Team work	'Team work organization was fundamental' 'Learning to work as a team' 'How to work as a team'	8
	Working methods	'We develop key competences in terms of work methodologies' 'The work method was very developed'	8
	Project management	'Working with project management methodology' 'I learned how to manage project works' 'Project management skills were very developed'	4
	Personal organization	'Organizing information was fundamental' 'I believe that I have developed a lot in this area'	4
	Time management	'When we have deadlines, we have to define priorities' 'Time management was fundamental and I felt that I developed this competence'	4
	Presentation techniques	'Speak in public' 'Presenting our ideas to an audience' 'Having to present ideas clearly and attractively'	7

support, which indicates that lecture time should be assigned to the supervision of projects. They have also suggested that the project topic should be in more related to their study area, Electrical Engineering in this specific case, and that Physics should also be involved.

Discussion and conclusion

Education professionals face complex problems every day, which cannot be efficiently addressed by single and disconnected approaches. Nonetheless, overcoming barriers and building bridges between the diverse knowledge areas are considered to be effective approaches to intervene in complex problems (Bernini and Woods 2014).

Interdisciplinary approaches call on the use of transversal skills such as communications skills, teamwork and conflict management skills, leadership, work organisation, planning, cognitive flexibility, among others; however, they also require practice in combining knowledge bodies of different scientific fields, which is often more relevant than producing new knowledge (Frodeman 2014). Nevertheless, to include interdisciplinary programmes in academic contexts is not a simple procedure, namely owing to each course unit's pedagogical specificity, which implies specific methodologies sometimes difficult to be adapted to other contexts (Chettiparamb 2011). Moreover, interdisciplinarity teaching can take many different forms, and may occur at several moments in the curriculum (Chettiparamb 2011).

In a nutshell, this paper presents the results of a qualitative study performed with the purpose of evaluating students' perception about an interdisciplinary project conducted within the undergraduate degree in Electrical Engineering. We particularly aimed at understanding whether students had acknowledged the project as an important learning tool, and whether they had identified the skills to be developed and challenged throughout the project.

The focus groups revealed that, regardless of the difficulty in conceptualising 'skill', the participants associate this concept to the act of knowing by doing, and to something that requires practice, and which has an impact on their performance. In addition, it is clear which is students' understanding about the role that Higher Education Institutions play in propelling the development of the fundamental skills future professionals are required to master once in the job market, even though the individual role is also perceived to be quite important.

When required to assess the interdisciplinary project they had been involved in, students recognise its added valued for their education, having successfully identified it as an opportunity to develop their skills, namely those that may contribute for a smoother adaptation to the job market, as well as help them handle challenging situations. This awareness about the acquired gains while working in the project is positive for students' motivation, as Gero and Zach state in the study 'High school programme in electo-optics: A case study on interdisciplinary learning and system thinking', published in 2014 (Gero and Zach 2014).

As for the tangible skills developed within the project, the inquired students have highlighted the acquired skills and knowledge usefulness in real life situations, the improvement of their ability to work in a team, the integrated skills within working methods, project management, organisation, and time management as well as the techniques for presenting in public. These results are similar to other studies performed in the same field, which tend to highlight the relevance of interdisciplinary projects in the development of transversal skills (Lima et al. 2007; Lima et al. 2009; Bernini and Woods 2014; Gero and Zach 2014).

Considering the objectives the teachers had outlined for the project to be worked by the students, it is possible to infer that students' opinion sustains the accomplishment of those objectives. Moreover, even though weaknesses have been identified, students' perspective strengthens the relevance of this kind of academic activities, with emphasis on the importance students give to the involvement of different knowledge areas in the project. It is to be noted that students have pointed out including another course unit in the project, as an improving measure, as this might be an added value to their education.

All in all, based on these results, we may state that interdisciplinary projects in an academic context add value to Higher Education students' education, and favour the development of their skills. However, interdisciplinary work is a demanding challenge not only for students, but also for the involved teaching staff, who must interconnect knowledge and educational practices (Lima et al. 2007). Therefore, real time coordination is essential when managing interdisciplinary projects as Lima et al. point out (2007), and within it, it is fundamental to clarify the individual role of each member of the teaching staff involved. Notwithstanding this demand, all the participants believe that this experience should be repeated, and that it should be applied to other contexts and to other course units.

Considering the enormous challenge implied in implementing projects such as this, and inferring from teachers' experience and both focus groups' results, we present a set of suggestions to facilitate that transferability:

(1) Core of the project – the criteria to select the project focus (its topic) should take into account students' study field;
(2) Communication between the teachers – communication between the involved teachers is essential for this kind of projects to succeed. Team meetings must take place regularly, before, during the project development, and at the end of the project, so that its planning, monitoring and evaluation may be effectively performed.
(3) Introducing the project to the students – students should be given a written assignment which includes: (i) description of project's general objectives, and of each course unit's specific objectives, (ii) tasks to be performed by the students, (iii) assessment moments and tools, and the respective criteria, (iv) deadlines, and, lastly, (v) project's monitoring/control planning;
(4) Supervising and guiding the students – students' supervision is a critical success factor in a project of this sort. In addition to the supervision taking place in class time, communication channels with the students must be created, namely regular meetings, e-mail exchanging, or even a discussion forum. Keeping a document for group monitoring and weekly activity register will facilitate supervision;
(5) Communication platform for teachers/students – using a communication platform – in this case *moodle* – is essential for the project to succeed as it simplifies delivering information to every student simultaneously, and enables students' submitting their written assignments and their respective assessment;
(6) Presentation of the projects with the presence of every involved teacher – the interdisciplinary message is also connected to the interest and commitment teachers show when working in a network.

Concluding, although this project has been extremely productive for the students, we are aware of the aspects that need improvement, which inform the limitations of this present study, namely in the planning and implementation. To start, select a topic more closely related to students' study field, and assure closer and more regular supervision of the several teams in class as well as outside the classroom context. Furthermore, the study could be improved with having more students participating in the focus groups as well as with the involvement of other subjects. These are essential aspects to be considered in future studies, together with the possibility of collecting quantitative data, which may provide relevant information to be added to the qualitative data gathered within the focus group approach.

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