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Technical and Professional Communication in the European Project Semester (EPS)

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ABSTRACT

In the European Project Semester (EPS), communication is key. It is through continuous communication that project teams can plan and develop their projects, involving supervisors and companies in internationalized contexts. Furthermore, project outcomes are defined in the form of communication artifacts, typically a written report and an oral presentation, both of which are assessed in terms of their contents and communicative value. Set in the context of the EPS programme at UPC, this chapter situates TPC in engineering education and identifies communication practices as part of the professional practices of engineers. After presenting the main approaches to TPC in engineering, the chapter discusses how TPC is approached from a problem-solving perspective. The rationale and organization of the TPC course are presented, together with examples of tasks based on a practical methodology that promotes familiarization, practice, reflection and dialogue. From the principles discussed, a specific proposal is made for integrating TPC in EPS and similar capstone programmes. From an interdisciplinary perspective, this chapter reflects on the importance of TPC in engineering education, the requirements of globalized professional settings and the pervasiveness of digitalization, to discuss how engineering students can effectively engage in international engineering communication.

Keywords: Technical communication, professional communication, engineering communication, English for Specific Purposes, English as a lingua franca, genre, process, intercultural communication, collaborative writing, problem-solving, technical report writing.

INTRODUCTION: THE ROLE OF TPC IN EPS AT UPC-VILANOVA

In the European Project Semester (EPS), which replicates a real-life engineering project and places emphasis on transversal (or soft) skills, communication is key. It is through continuous communication that project teams can plan and develop their projects, involving a number of stakeholders, such as collaborators, supervisors, companies and clients, in an internationalized context. Furthermore, project outcomes are defined in the form of communication artifacts, typically a written report and an oral presentation, both of which are assessed for contents and for their communicative value. As engineering students experiencing a real-world project for the first time, they also become aware of the importance of Technical and Professional Communication (TPC), as engineering practice requires multiliterate engineers, who can grapple with the complexities of international professional communication. The role of TPC in engineering has attracted the attention of education and researchers, with a growing body of literature devoted to it over the years (e.g. Ford and Paretti, 2013; Cleary et al., 2017; Eggleston and Rabb, 2018; Yong and Ashman, 2019). Parallel to this interest among academics, TPC has also attracted the attention of corporate and professional sectors, where there is growing awareness of the importance of TPC in professional practice. Examples of this greater focus on TPC are found in the resources for learning technical writing created by Google (2021), preceded by the explicit motto "Every engineer is also a writer" or the resources provided by IEEE (2021), which stress the importance of technical communication in English for engineers on a global scale.

Adopting a problem-based learning approach, focusing on the development of a real project, the EPS curriculum includes some "key elements" (European Project Semester, 2021), common to all EPS programs, which basically involve project-supportive courses that train students in a variety of transversal skills for professional practice. Among them, language courses are included (specifically, an English course and a course in the local language) as well as project management and teambuilding. Given the focus of EPS on project development, the English course is, in fact, a course in technical and professional communication, which has a direct impact on the outcomes, both in terms of communication with partners and supervisors during the development of the project and of presentation and dissemination of project results (project report and presentation as well as other dissemination materials). Because of the pivotal role of TPC in engineering projects, in the EPS program offered by the Universitat Politècnica de Catalunya (UPC) at Vilanova i la Geltrú, the communication course is, together with project management (PM), one of the main project supportive courses. Looking at the configuration of other EPS courses, one can find that, unsurprisingly, they are approached from the perspective of project-based learning and focused on practice and improvement for the project. The course listings that appear on the websites of EPS providers vary in their degree of explicitness. From the titles, such as English and communication skills and explicit descriptions of some of the courses, it can be seen that they focus on academic and report writing as well as oral presentation skills so as to prepare students for their successful reporting and presentation of the project, with continuous assessment of students' progress and attention to midterm as well as final reports and presentations.¹

The EPS at UPC started in 2008 (Segalàs, 2012) and since then, it has been offered once a year (in the spring semester), featuring different types of real projects (in collaboration with companies, research groups or public institutions) that involve multidisciplinary work. The program is offered at the campus of Vilanova i la Geltrú (a coastal town located 45 km south of Barcelona) and is integrated in the school of engineering's offer to final-year undergraduate students. As a full-time capstone program that runs over one semester, it is worth 30 ECTS credits, 20 of which are devoted to the project and 10 to the courses. Following the founding principles of the EPS (e.g. Andersen, 2004), the focus is not only on project outcomes, but especially on the process. That is to say, students are encouraged to reflect on their learning and to collaborate with others. Therefore, assessment takes into account progress, interim reports and also self- and peer-assessment, reflecting a view of engineering education, based on cooperative teams, that enforces positive interdependence as well as individual and group accountability (Smith, 1995).

One of the characteristics of the School of Engineering of Vilanova i la Geltrú is that it offers a variety of bachelor's degrees in the field of general engineering (mechanical engineering, industrial design and product development, electrical engineering, industrial electronics and automation) and Information Technology (Computer Science). This variety of degrees leads lecturers and students to embark on multidisciplinary projects, which resonates with the nature of EPS projects.

Although the focus of EPS projects at UPC is on engineering, most of them (reflecting real-life engineering) involve social, business and ethical issues, adopting sustainable and eco-design approaches (Duarte et al. 2020). Following general EPS guidelines, the teams comprise four to six students from at least three different nationalities and, in addition, one of the team members is a local student, as EPS is offered to local students who want to engage in an Internationalization at Home (IaH) experience (Crowther et al. 2000; Beelen and Jones, 2015). The EPS student cohort at UPC usually consists of 40 students, who are divided into international, multidisciplinary teams and are assigned a real project, proposed by a company (or research group) and co-supervised by two tutors, one assigned by the company and the other by the university. Such projects are presented as real-life professional challenges so that students have to collaborate with other team members, take on different roles and

solve real problems. Effective communication, thus, becomes essential to solving these problems. On the one hand, project development requires students to communicate with each other and with their supervisors. On the other hand, they will have to report on their progress and results, so they will need to communicate with a variety of audiences, similar to what happens in authentic professional communication. The texts that students submit have to conform to the requirements of the types of texts (or genres) that are common in professional engineering practice. The technical reports that accompany the projects have to include the technical, economic, administrative and environmental aspects that are expected in professional engineering projects, which students will have to deal with once they have graduated. The TPC course is crucial towards these objectives and the challenge faced by the TPC instructors is to guide students towards producing documents that draw heavily on engineering knowledge and practices and that have to be accepted in professional contexts. Complementary to the TPC course, lecturers from the same department teach the intercultural communication course, offered as an intensive seminar, and which is complemented by the "study buddy" program in which local students are paired up with EPS students for cultural and linguistic exchange.

The organization of the EPS program at UPC Vilanova is as follows. The first four weeks of the program are devoted to intensive short seminars on a range of subjects on project-oriented transversal skills, such as teambuilding, innovation, intercultural communication and eco-design among others, offered by a combination of local and guest lecturers, which gives the program a true international atmosphere. Two semester-long courses, technical and professional communication (TPC) and project management (PM) are offered in an integrated manner to accompany students in the different stages of the project, especially in relation to the two project milestones, the midterm report and oral presentation, in which students present their interim results and receive constructive feedback from an international, multidisciplinary panel of lecturers, and the final report and presentation, at the end of the term. TPC training is designed to be conducive to help students succeed at such crucial stages. The TPC course is approached from a meaningful and situated perspective, not only in relation to students' projects, but also interacting with the subjects of other seminars, such as intercultural communication, sustainability, teambuilding, similarly to what could be expected in a real engineering project.

The remainder of this chapter will discuss the approach to TPC in EPS at UPC. After drawing on theoretical backgrounds that inform appropriate pedagogies TPC in engineering education, special emphasis will be placed on the interdisciplinary nature of TPC, drawing on the perspectives of both communication and engineering faculty. The rationale for the design of the TPC course will be discussed, with a detailed presentation of its contents and methodology. Taking into account the position of the TPC course in the EPS program, the last section of this chapter will present the impact of TPC on the program over the years, the challenges encountered in the evolution of EPS at UPC as well as lessons learned and implications for the integration of TPC in EPS and other capstone programs.

BACKGROUND

Engineering curricula increasingly include a broad range of competences that go beyond specialized technical skills and knowledge, reflecting a view of engineering that incorporates social and ethical dimensions. Since the turn of the century, guidelines for designing engineering curricula, such as the 'Dublin' descriptors (Joint Quality Initiative Informal Group, 2004), in the European university reform, and the ABET Engineering Accreditation Commission (ABET, 2021), in the U.S., have established that current curricula should develop awareness of the social impact of engineering, communication skills, critical thinking, ethical communication (TPC) plays a key role, considering that engineers spend much of their work time communicating (Gopsill et al., 2015). Even if engineering students do not think that learning communication is part of their job (Maylath et al., 2013), they need to become aware of the role of communication to different audiences, which will be assessed by different stakeholders. This section will situate TPC in engineering education, by identifying communication practices as part of the professional engineering practices, and will lay out the theoretical frameworks that support the proposed approach to TPC in capstone programs in general and the EPS program in particular.

TPC in Engineering Education

The fact that communication forms part of professional engineering practices may not be so apparent to engineering students, who, when starting college are generally attracted to mathematics and physics and, as they progress through their studies, they become more interested in technological matters and may prefer doing calculations or manipulating objects rather than writing reports. In addition, and unlike engineering curricula in other universities, in which TPC is a compulsory component, at UPC Vilanova, TPC courses are elective, which means that not all students take them. In such situations in which TPC courses may be perceived as an add-on, it is not uncommon to find the paradox that while students are interested in learning disciplinary communication in English, they sometimes hold stereotypical views of TPC (in our context, known as English for Specific Purposes) as "traditional" English language courses (Arnó-Macià & Mancho-Barés, 2015). However, despite this lack of knowledge of what TPC in engineering education involves, engineering students who have taken such courses generally perceive the value of TPC training at university, as a form of induction in specialized communication in English and as a gateway to international academic and professional practice (Arnó et al., 2020). One of the proposals made in this chapter is that TPC should be a compulsory course in all engineering curricula, which would help students develop the different types of written and spoken texts that they are required to produce throughout their studies, especially their final thesis. In fact, it is in their final thesis (a requisite for graduation) that students have to incorporate what they have learnt during their studies, with an oral presentation and a long report that are assessed by a panel of examiners, usually composed of engineering lecturers, that assess not only the technical contents, but also the communication skills that students demonstrate in the report and the presentation.

While students give great importance to designing, calculating, programming or building a device, they tend to neglect the importance of explaining how it works or how it was developed. For example, the design of a prototype must be accompanied by a user manual that covers a number of aspects ranging from its composition to its operation and must be understandable to multiple audiences (not only engineers) that need to know about, use or operate the machine or system.

As a result, one of the main challenges faced by TPC lecturers (usually with a background in linguistics) is not only to train students in language and communication, but also to make engineering students aware of the importance of TPC for their professional future. A key issue that emerges in TPC pedagogy in engineering is interdisciplinary collaboration, so that communication and engineering faculty (like the authors of this chapter) find common ground to improve students' communication skills. In the well-established fields of Writing Across the Curriculum (WAC), Writing/Communication in the Disciplines (WID/CID) and Integrating Content and Language (ICL), a considerable body of research has been developed to align communication instruction with disciplinary contents, not only to improve students' much needed communication skills, but also to "support engineering learning through assignments that prompt students to select information in ways that are consistent with disciplinary values and stakeholders' needs, and make and justify decisions about approaches and solutions in ways that demonstrate sound engineering judgment" (Paretti et al., 2019: 28). In other words, TPC instruction in engineering not only helps students become better communicators, but also helps them become better engineers.

A key issue in effective TPC pedagogy is student engagement, that is, attracting engineering students to TPC and making them aware of its importance in engineering practice. Apart from interdisciplinary collaboration, it is also useful to approach TPC from an engineering perspective, designing TPC programs that draw on engineering contents and design thinking (Shalamova, 2016; Lane, 2021). Such approaches can facilitate dialogue in interdisciplinary faculty collaboration as well as help students draw on their own skill sets and knowledge, integrating engineering knowledge and communication so as to produce written and spoken texts that can fulfil the expectations from both engineering and communication lecturers (apart from other audiences to which they may be addressed). In addition, as part of this interdisciplinary faculty dialogue, having shared engineering frameworks to approach technical communication (e.g. design thinking, usability and user experience, problem-based approaches, etc.) can help both engineering and TPC faculty find common ground to integrate TPC in engineering education.

This integration of TPC and engineering education becomes even more apparent in engineering capstone courses (Paretti et al., 2007), like EPS, which take a holistic, project-based approach to training

students by familiarizing them with the professional skills needed in international contexts. In the EPS, based on international project-based collaboration, TPC is a crucial component. Accordingly, the EPS program at UPC features the TPC course as an essential component to assist students in the production of the main deliverable and evaluated artifacts of the program, namely the Written Report and the Final Oral Defense presentation. These deliverables are assessed both in terms of their professional content and communication value by multidisciplinary expert audiences. As a capstone course that involves the collaboration between university and companies, students are guided through the stages of developing a real project, the TPC in EPS can help bridge the gap between university and workplace situations, as capstone courses involving real companies can contribute to creating situations and contexts that university TPC classes cannot fully simulate (Ford et al. 2021).

Theoretical Background

The main approaches to teaching TPC in engineering draw on well-established disciplines for which there is a considerable body of literature. On the one hand, there is a long tradition in the field of English for Specific Purposes (ESP), which started in the second half of the 20th century with an increased interest in the language of science and technology, partly due to the growing economic and technological power of the US after the Second World War. Thus, the first work on ESP was in fact English for Science and Technology (EST) (Swales, 1985). Key distinguishing features of ESP are that it approaches the teaching of language and communication from the perspective of the needs of the students to whom it is addressed and that its pedagogical practices draw on the activities of the disciplines (Dudley-Evans & St. John, 1998). On the other hand, in the United States, a tradition that has gained momentum has been termed technical communication, professional communication or technical and professional communication (TPC), with such established journals and associations as the IEEE Transactions on Professional Communication or the Society for Technical Communication (STC). Precisely, the definition of technical communication posited by the Society for Technical Communication (2021) stresses that "The value that technical communicators deliver is twofold: They make information more useable and accessible to those who need that information, and in doing so, they advance the goals of the companies or organizations that employ them."

Both frameworks stress the importance of situated learning-gearing the teaching of technical communication towards disciplinary contents- promoting those skills and literacies that are part of the academic and professional practices that future professionals will engage in (Zhang & Chang, 2017; Wingate, 2018), and using the types of written and spoken texts (i.e. genres) of those disciplines (Kedrowicz & Taylor, 2013). Following this trend, Lockwood (2019) proposes a framework for designing workplace English courses, which can be placed on a continuum of situatedness, from more general (educational settings) to more specific (workplace settings), and suggests that the design of such courses should incorporate the perspectives of professionals while taking into account real workplace practices, especially as more and more communicative situations are based on the use of ICT (information and communication technology). Thus, the teaching of TPC goes beyond linguistic skills to embrace professional activities and the development of broader competencies, related to the ethical and social dimensions of the technology professions. Along these lines, TPC is defined by Lannon & Gurak (2021: 23) as "a humanistic endeavor, not just a set of job-related transcription tasks, with broad societal implications." This trend towards approaching communication from a situated, disciplinaryspecific perspective has developed, over the past years, as opposed to an approach to communication based on teaching general communication skills and types of texts common to different disciplines (Hyland, 2016).

In addition, as engineering communication contexts become increasingly globalized, greater emphasis is placed on intercultural aspects--which become essential in the EPS program, with projects developed by international teams. Batova (2018) argues for the integration of intercultural communication in technical communication from an experiential approach that incorporates students' experience and perspectives. A global perspective on TPC goes hand in hand with the adoption of an English as a *Lingua Franca* (ELF) model, accommodating both native and non-native speakers of English (Cogo & Jenkins, 2010).

APPROACH TO TPC IN EPS

Based on the principles of TPC presented above, what follows is the approach to TPC in the EPS at UPC, based on the integration of TPC in engineering and the adoption of a problem-solving approach to technical communication, an approach that suits students' engineering mindset (Woolever, 2005). This section presents the rationale and organization of the TPC course in the EPS at UPC. At this point, it should be mentioned that the TPC course has been designed and is being taught by lecturers of English for Specific Purposes (ESP), who, in addition to the TPC course in the EPS, also teach ESP courses that form part of the engineering curricula in the different bachelor's degrees offered, as part of a set of elective courses focusing on technical writing, academic and professional speaking skills and project communication, each of which is worth six European Credit Transfer System (ECTS) credits, which amount to four weekly hours. The design of the TPC course for the EPS is similar to the regular project communication course in the sense that both share the same goals, prepare students to write a report on their projects and present them orally. The main difference between both courses is that the TPC course in the EPS is attached to a real project and helps students develop the communication artifacts that will be evaluated by an external audience, following the conventions set for project texts, while in the regular project communication course students can choose the project they want to communicate about and the texts that they want to develop (targeted to their chosen audience and purpose). The EPS course is shorter in weight, 2 ECTS, and currently it only has a weekly session of 1.5 hours (in past editions it used to be a longer course, with the opportunity to have small group coaching sessions). In spite of these differences, the TPC course in the EPS is based on the same rationale and approach as other technical communication courses taught by the same department.

Specifically, the TPC course in the EPS at UPC has been designed with the aim of raising students' awareness of the importance of technical communication in an engineering project, which, in the case of EPS, has a dual focus: (*i*) professional, as the EPS involves developing a real project in collaboration with industry, (*ii*) and academic, as students have to submit written assignments and, especially, work on their final thesis, which will be assessed by a panel of examiners. The course has been designed to give students exposure to and practice in the aspects required to communicate their projects professionally and effectively, which in the context of EPS involves helping students transfer their technical communication skills from university to the workplace. Below is a detailed account of the organization of the course in terms of the contents, the methodology and the types of activities used, followed by the challenges encountered and the evolution of the EPS over the years.

The TPC Course

Before describing the course objectives, contents and methodology, it is worth highlighting a couple of issues in relation to the EPS students' profiles, their initial expectations of what a technical professional communication course in English is, and why they are required to take it over the whole semester.

EPS student profiles and expectations

As detailed earlier in the chapter, participants on the EPS are final year undergraduate students from a wide range of cultures, nationalities, and academic backgrounds. 'Native' English speakers from the USA, UK and Ireland are regular participants on the course alongside those whose first language is not English. Students who wish to take part in the EPS should already possess advanced skills in spoken and written communication. The TPC course is defined in the EPS coursebook as a course *in English* rather than an 'English' course.

Despite the description of the TPC course in the EPS coursebook, it is perhaps inevitable that some students' initial expectations for the TPC course may be of a language course focusing on linguistic competence rather than the TPC driven communicative competences the course attempts to foster. This can cause students, for whom English is not their first language, to initially feel they may be at a disadvantage compared to those whose first language is English. However, perceptions change quickly and over the duration of the course. Students begin to realize that those 'native' English-speaking engineering students, like themselves, have generally had little training in TPC skills and what is more, unlike themselves, lack training in using English as a *lingua franca*. On the EPS, the language playing field is, in fact, more level than some students may initially believe.

TPC course – aims and organization

The milestones of the EPS mean that students are continuously shaping, reshaping, adding, adapting and ultimately finalizing the evaluated deliverables; i.e. the midterm and final written reports and the midterm and final defense presentations. Along with the course content, the TPC course offers not only a regular time and space for EPS students to meet with their teams at the school, but also an established feedback loop that allows support and guidance from the TPC tutor from project beginning to end.

As stated previously in the chapter, engineering communication contexts have become increasingly globalized. The nature of the EPS in replicating such a context – a collaborative international team project - makes it clear to students from the beginning that communication, with teammates, project supervisors, tutors and other stakeholders in their projects, is vital. Students attend seminars in teambuilding and intercultural communication, among others, during the first four weeks of the semester to incubate and encourage said communication.

The overarching objective of the TPC course therefore is to further cultivate and indeed champion the need for successful communication in the development and delivery of the projects. Nevertheless, the communicative skills needed to explain the particular technical details of a project in writing for an expert audience are not the same as those needed to engage a tribunal in an oral defense situation. The TPC course attempts to encourage students to reflect on how these and other types of communicative situations are different, which communication strategies need to be adopted in these situations and to develop these strategies to be able to manage the situations successfully.

Overall, and through a practical methodology that involves familiarization, practice, dialogue with and assessment from the course instructor and external audiences, the TPC course intends to provide students with support in order to achieve the following aims:

- to develop strategies for effective technical and professional communication in English, both in speech and writing;
- to carry out a collaborative project;
- to develop critical thinking skills;
- to integrate TPC into engineering content/projects.

TPC course contents

The TPC course consists of six modules that cover the principles, planning, process and product of both the written and oral texts, as well as an overall post-project reflection and self-evaluation. Recognition of and practice in written and oral communication with different audiences and for different purposes is emphasized from the beginning of the course and constantly returned to as students make progress in the confection of the written report and oral defense. Following a process-genre approach, the course combines the formal models of genre with the communicative process carried out through "dialogical modeling" (Dressen-Hammouda, 2008), that is, dialogically constructed by the teacher and the students through interaction and discussion. A process-genre approach is also that espoused in the textbook that serves as the main reference (Bombardó et al., 2007). On the one hand, the notion of genre (Swales, 1990) is essential, as students need to become familiar with the conventions and structure of the typical written and spoken texts used in their field. On the other hand, process, as an essential part of the EPS, also becomes essential in the TPC course, both referring to the stages of producing the document and to the reflective and interactive processes that facilitate effective communication and project development. In turn, reflective and process-oriented skills can help students become aware of the strategies and resources they can use to succeed in future professional scenarios. For this reason, in the module contents presented below, process and reflection appear as key words.

The course not only focuses on the formal deliverables that are communicated to external audiences, but also focuses on team communication and project development, so that students can develop effective communication skills such as *participating in meetings, time and conflict management* and *cross-cultural communication*.

Although the contents of the modules (detailed below) are covered during the course, depending on the immediate needs of the students, the order in which themes are introduced is flexible. For example, the midterm defense comes around quickly and students are given support in delivering a team presentation and responding to questions and comments from the midterm tribunal despite this content appearing in module 5.

A detailed explanation of the contents of the course modules is given below.

Module 1: Principles and characteristics of Technical Communication

During an initial introductory session in which the course is presented, students are asked to reflect on their own experience of different types of written and spoken texts, both in English and their own languages. They reflect on the wide variety of genres they already have experience with, from message chats on online gaming platforms to formal academic writing. This is done to raise awareness of the skills they already possess in recognizing the different requirements needed for such different types of communication and to reflect on how these skills can be transferred to the requirements of the type of technical communication they will need to produce during the EPS. The first module then covers the following themes:

- a. What is technical communication? Characteristics and a problem-solving approach;
- b. Audience;
- c. Purpose;
- d. Tone and style;
- e. Organizing a team and participating in meetings.

Class activities seek to relate the concepts involved in the themes of the module to their own projects. They are encouraged to adopt a problem-solving approach to their own projects not only in relation to the intricacies of the project itself, but also as they consider questions of defining the scope of their project (*Why are they doing it? Where? Who is the project for? Who will be affected and how? What limitations do they have? etc.*), deciding which team member(s) is/are responsible for which tasks, keeping a record of progress, decisions made, next steps etc.

The importance of audience and purpose and their influence on communicative choices is central to the module. A variety of sample texts are analyzed for intended audience, including analysis of the use of language as well as tone and style. Students also practice producing short texts for different audiences and for different purposes.

The final component of the module focuses on organizing the team and participating in meetings. In terms of organization of the team, concepts from the teambuilding seminars are reinforced. Regarding meetings, students are encouraged to hold regular team meetings both in person and virtually and to prepare agendas for them, take minutes and keep a record of when they were held and who attended. It should be taken into account that virtual meetings and online collaboration became more of a fixture of our lives during the pandemic and are a permanent feature of the professional world. Students on two EPS courses affected by the COVID-19 pandemic have needed to adapt to collaborating virtually and the TPC course content has attempted to reflect this reality.

Class time is given over to meeting role plays with each team member taking turns to be responsible for chairing a meeting (or at least one of the topics on the agenda for the meeting), preparing the agenda and taking minutes. This often leads to the intended outcome of disagreements arising between the participants in the meeting. Reflection on strategies for dealing with disagreements, resolving conflicts, cultivating cooperation and positive working relationships results from these practice meetings with the intention of them being put into practice in the project team meetings.

Module 2: Planning and organizing a collaborative project

The second module continues with reflection on the differences between written and oral communication and scenarios are presented in which students decide how best to react – via written or oral communication – and again gain practice in producing written and oral texts for different communicative situations.

Again in this module, as the teams begin to make some progress with their projects, it is valuable for them to reflect on not only what they are being asked to do in their projects, but also to consider how they are going to explain what they are doing, why, and for whom. They look at sample situations that generate communicative tasks which allow them to consider technical communication as solving interrelated problems. Thus, following the problem-solving approach proposed by Lannon (2000), students are encouraged to consider which information needs to be communicated, how this information can be presented to persuade the reader to take the action needed, how potentially conflicting

stakeholder interests also need to be considered as well as deciding how the team collaborates to make sure the information is communicated. In other words, students gain insight into applying their engineering problem-solving skills to technical communication. This module addresses:

- a. Oral and written communication;
- b. Definition of a communicative task: analyzing the communicative situation.

Module 3: The process – researching and gathering information, citation, outlining and drafting.

This module focuses on the process of confection of both the report and the oral defense. Students have access to a template for the written report which details compulsory components such as a title page, an abstract, team members, bibliography, appendices, etc. However, the number and focus of the sections of the report vary depending on the project and teams need to make decisions about what to include and what to leave out.

As can be seen from the main components of this module, the focus is on gathering and organizing information from a variety of sources and how to use them appropriately in both the written report and oral defense. Emphasis is placed on the importance of avoiding plagiarism and the referencing system used - all reports are required to use the IEEE referencing format.

Importantly, explicit focus is given to patterns of organization for the project texts. Choosing the most appropriate pattern of organization is an important factor that contributes to clarity and readability. Patterns such as problem-solution or cause-effect seem appropriate for the content of many of the project reports and students are encouraged to consider alternative patterns for different sections of their reports. Thus, the module works on:

- a. Main stages in the communication process;
- b. Gathering information from written and oral sources;
- c. Taking notes and expressing one's ideas (avoiding plagiarism);
- d. Organizing ideas and developing an outline.

Module 4: Written communication: Preparing and reviewing a written project.

It is worth noting that the written report makes up 50 % of the students' final evaluation. It is evaluated both for its professional content and its communication value. It is therefore essential to devote time to its confection. The elements covered in module 4 give students this support when reviewing and editing their written reports, both at the midterm and final delivery stage. Again, the concepts of audience and purpose are returned to as students consider the primary and secondary readers of their reports. Among other aspects, students need to think about the appropriateness of their reports' format, structure, content, visual information, and layout. Consequently, the module focuses on:

- a. Academic documents in engineering;
- b. Drafting and revising a document (content, register, appropriateness);
- c. Elements of language and style in academic writing.

Module 5: Oral communication. Preparing and delivering a team oral presentation

As mentioned previously, although the material that focuses on oral presentations appears in module 5, focus on oral presentations comes before and after both the midterm and final defenses. Along with the components outlined below, explicit focus is given to engaging an audience, dealing with questions 'tactfully' as well as advice on aspects of the delivery of the presentations such as intonation, pausing, signposting, handovers and body language. As a result, the list of topics addressed are:

- a. The process of preparing and delivering oral presentations in English;
- b. Strategies and techniques for preparing an oral presentation;
- c. Structure of an oral presentation;
- d. Elements of language (introducing the presentation, signposting, dealing with questions, levels of formality, etc.);

e. Team presentations.

Module 6: Evaluating and reflecting on the project, both the written document and the oral presentation and developing tools for lifelong learning.

Another component of the EPS assessment is self and peer evaluation. It is therefore useful for students to have some time to think about how they should evaluate themselves and their teammates. In a perfect world equal credit would be given to each member of the team, nevertheless, in practice this is not always the case. This module therefore promotes concepts of critical reflection. Specifically, it explores:

- a. Analysis of the written document and oral presentation;
- b. Critical reflection on one's production, the overall project and other projects;
- c. Peer review;
- d. Strategies and resources for learner autonomy, including internet resources (language skills, technical communication, teamwork, etc.

Methodology and Types of Activities

In this section, the aims, presented above, together with examples of tasks and an account of challenges encountered will be presented and discussed. In addition, and as a reflection of the growing digitalization of society in general, and workplaces in particular, a reflection will be included on the more informal modes of communication that have also been incorporated into EPS in the past years (promotional texts, graphics and videos), alongside videoconferencing and chat communication which are currently becoming part of newer generations' repertoires (Janssen & Carradini, 2021).

The TPC course adopts a highly student-centered approach in attempting to achieve its aims. It is taskbased with a constructive feedback loop that includes tutors, project supervisors as well as the students themselves. The clear milestones of delivering the midterm and final oral defenses and written reports provide students with deadlines which promote the use of the tools, strategies and skills offered to the students in the seminars taken in the early weeks of the course.

The midterm milestone provides students with the opportunity not only to explain what the scope and objectives of their project are, but also to explain how they have managed its organization up to that point, what they plan to accomplish by the final milestone and how. Details of their project management skills and strategies are presented at midterm; their use of tools such as Gantt charts for timeline monitoring, as well as other PM apps for idea management, milestone tracking and collaboration are explained to the midterm panel. The TPC course devotes class time to practicing for the midterm defense in collaboration with the PM course. The TPC and PM tutors offer feedback as do the other teams who are encouraged to learn from, comment on and offer constructive feedback to their peers. The midterm defense itself is a valuable opportunity for students to again put the skills and strategies for oral presentations focused on in the TPC classes into practice. We are hugely fortunate to be able to count on panels of international and local experts to hear the midterm presentations and read the midterm reports. The comments and questions from the midterm panel never fail to provide valuable feedback and focus for the students and are immensely helpful.

For the written reports, especially the final report, a well written introduction is vital. Apart from the abstract, the introductory section will usually be the part of the report that is read by the most people. A series of tasks in the TPC classes challenge students to consider what a 'good' introduction is, what it should include and exclude and in what order. We are fortunate to have a bank of previous EPS project reports and, having obtained permission from the authors of those reports, their contents are sometimes exploited in the TPC class. In considering how to write the introduction for the written report, first, students read several introduction samples from previous years' projects, discuss their content and identify any common functions within the organization of the content and questions that the content answers. They then perform a 'reverse outlining' task to extract a plan for the introductory samples to further focus on organization and function. Students then agree on a list of functions that an EPS written report introduction should contain and the questions that should be answered in the introductory section. The following list is that agreed upon by students on the EPS in the Spring of 2021.

The introduction of the written report should include:

- 1. General context of the problem that the project hopes to solve. *Why is the project necessary? What are we doing? What is the gap in existing / previous projects that this project fulfils?*
- 2. Background of the company / research group / other and context of the project, i.e. previous EPS projects with the same company, etc. *Who wants the project done? Where is it being carried out? Who is doing it? How is it being done?*
- 3. Identification of objectives of this project. *What are we doing? Why are we doing it? Who will benefit? How? Who will be affected? How?*
- 4. A road map for the rest of the report. *How is the project being carried out / has it been carried out? How is the rest of the report organized?*

Following the identification of the functions and questions, students are then asked to write an introduction for their own project. They do this in their teams, collaboratively. They then read other teams' introductions, provide some comments and feedback and then tweak their own introductions to produce a version that is submitted for tutor evaluation. By focusing on the process, patterns of organization and thinking of questions that need to be answered, students gain insight into the writing process and develop writing strategies in the context of their own project that they can then apply to other sections of the written report.

Evolution and Challenges

Although the general structure of the EPS program has been fairly stable since it started to be offered at UPC Vilanova around 15 years ago, the projects developed have evolved over the years, reflecting recent societal changes and new concerns. EPS program coordinators are sensitive to these changes and select projects that involve social responsibility, sustainability and that foster ethical, collaborative and interpersonal values, in accordance with the principles of the EPS creators, of familiarizing students with "integrated engineering contexts" (e.g. Andersen, 2004, 2012).

Proposing meaningful and socially responsible projects is essential to engage and motivate students. The words expressed by a former EPS student at the end of the team's final project presentation reflect not only the values that we try to instill in our students, but also the very origin of the EPS program, to foster collaboration and mutual understanding:

Our job as engineers is not only to help companies earn money, but especially to improve people's lives.

Therefore, projects are rooted in current societal concerns and seek solutions that are interesting to companies, respect the environment and facilitate people's lives. We have witnessed an evolution from projects focusing on technical and economic aspects to projects that focus on the UN's Sustainable Development Goals (SDG). There is greater awareness of the need to find solutions for cooperation and the eradication of poverty, to protect our planet and guarantee peace and prosperity. The focus on sustainability, inclusive design and accessibility have characterized our EPS projects over the years. However, an evolution has been observed in terms of technological changes, like the internet of things, smart cities, wearable and embedded technologies as well an eco-design. Other changes that we have witnessed have to do with the digitalization of teaching, accelerated as a result of the COVID-19 situation, but which has had a profound impact on the way we teach, communicate and collaborate and which will stay in the future. For example, the visiting lecturers who taught some of the seminars or participated in examination panels had to switch to videoconferencing during the pandemic, thus leading to hybrid project presentations (students presenting onsite and the tribunal attending online). Instant messaging or collaborative writing tools, which have been useful for teams for some years, will be used even more in the future. Hybrid meetings or classes will probably become a possibility for those visiting lecturers for whom it is not feasible to travel physically, and videoconferencing will probably be kept as a convenient option for more frequent and focused meetings or to seek the occasional collaboration of external experts. The possibilities are endless, but important lessons have been learnt about flexibility and adaptability, applicable to globalized professional contexts.

INTEGRATING TPC IN EPS AND OTHER CAPSTONE COURSES

Throughout this chapter, it has been made apparent that as an integral part of engineering practice, TPC should also be stressed in engineering education programs. Specifically, in the case of the EPS and other project-based capstone programs that immerse students in real professional practices, TPC needs to be integrated in such a way that students can become familiar with those situations that are common in the professional practice of engineering. With its dual focus on academic and professional communication, the TPC course in the EPS aims to help students cope with the multiple communication demands posed in the program (communication within teams, problem-solving, producing technical documentation and manuals to accompany the design of the prototype, and producing reports and presentations to be defended before a panel). In addition, another key objective of this course is to go beyond the specific EPS demands and prepare students for effective and efficient professional communication as part of their future professional lives. This is probably the most pressing challenge, making the TPC course project-related enough so that students see its immediate applicability and at the same time, making it open enough so that learning outcomes can be transferred to future professional situations. With this dual view in mind, this section makes a specific proposal for integrating TPC in EPS and other capstone programs, especially in relation to other program components, namely related courses such as project management and intercultural communication as well as project-based work.

Based on what has been discussed in this chapter, the first point that should be mentioned is that TPC should be one of the core courses or modules in EPS and presented in a clearly identifiable way. Taking into account the golden rules of EPS that establish that an English course has to be offered alongside a local language course, our first recommendation would be not to label this course as "English", which could lead students to think it is a remedial language course, or even those students who are native speakers of English or have a high level of proficiency in the language may feel that this course is not necessary or relevant to their needs. Quite on the contrary, we follow Cogo and Jenkins (2010) in that English as a *Lingua Franca* is also necessary for native speakers of English to interact in globalized settings. Even more so, both native and non-native speakers alike need to develop their technical and professional communication skills and produce documents that are effectively received by different audiences.

Another recommendation that derives from the approach to TPC presented above is that it should be configured as a semester-long course, accompanying students throughout the project, as they state, develop, and refine their ideas, which build up throughout the different project development phases. Similarly, regarding the dialogical modelling type of instruction, it is advisable to organize classes in teams (with reduced numbers of students), so that class sessions resemble a seminar or workshop rather than a lecture type of class.

Perhaps one of the main challenges that the TPC course designer and teacher has to face is how to combine the specificity of the course, helping students verbalize and construct their project deliverables, and its transferability, so that the TPC instruction received as part of the EPS can help students improve their communication skills and be able to adapt to other projects and audiences, especially in the present time, with an increasing number of international student networks, contests and competitions (e.g. Formula Student), which require effective international communication.

Related to the point above, two interrelated principles on which the TPC course should be based are modularity and reflectiveness. Modularity refers to the structure of the course, in the form of modules that form a coherent structure but that can also be approached independently. This way, the course can be made more flexible depending on student needs or project development. The fact that each module deals with one aspect of TPC can help students focus on it (e.g. planning the text, reviewing or citing sources, for example) when needed. Reflectiveness, related to raising awareness of TPC processes, helps develop students' ability to critically evaluate one's own work as well as that produced by others. Such an approach allows students to gradually develop a set of skills and strategies that they can apply in future projects.

An important part of the TPC course is the integration of digital and hybrid forms of communication as well as the use of a variety of ICT tools to assist in the communication, teaching and collaboration processes (e.g. language tools, collaborative writing platforms or learning management systems). These are found not only during project development, but especially in the international workplace. For some time now, and accentuated after the COVID-19 pandemic, videoconference and hybrid meetings as well

as all types of online communication and the creation of digital artifacts (videos, posters and other graphic material) are acquiring more and more importance in the presentation and display of projects, both in the EPS and in a wide range of academic and professional contexts.

From the lessons learned through our experience in designing and implementing the TPC course in EPS at UPC Vilanova, we can also derive lessons for designing or reappraising the EPS program, from the perspective of communication. Because of its central role in project development, the TPC course should be coordinated with the project management (PM) course. A twofold benefit would derive from this approach. First, project management and communication are strongly linked in international project management (e.g., Mikhieieva & Waidmann, (2017)

) so that good communication contributes to better project management and more satisfactory results. Apart from better results, the second benefit is that the alignment of tools and methods used in both TPC and PM provide students with a disciplined and integrative vision of how projects can be effectively managed and developed, providing appropriate documentation for different milestones, a learning outcome directly applicable to the workplace. In the EPS at UPC, both TPC and PM are the only semester-long courses that accompany students throughout the semester.

The TPC course should also be integrated with other short seminars given in the first weeks of the EPS. The most apparent connection is with intercultural communication, taught by the same lecturer, and devoted specifically to raising students' awareness of the notion of culture, cultural diversity and about those skills and attitudes that can facilitate effective interactions on a global scale. Teambuilding is also connected to TPC. Similar to intercultural communication, the intensive seminar provides students with immersion in concepts and principles related to forming teams and effective teamwork, while they apply and develop teamwork skills during the process of project development, with the TPC class helping them towards more effective meetings, the presentation of shared ideas, and conflict resolution. Innovation and sustainability are also related to TPC and to the project, as students should be able to identify and present, in a convincing way, both the innovations that their projects bring and the sustainability issues that any engineering project must take into account nowadays. These issues are discussed in the TPC class, as students work on how they should present them in their reports.

Whether it is the EPS or another capstone program, the integration of different skills, methodologies and concepts that need to be applied globally for effective project development is paramount in preparing students for globalized engineering environments. The challenge remains, as presented in the literature review, as to what extent we can replicate the challenges of authentic professional environments at university. There will be an inevitable transition from study to work contexts in which students will have to demonstrate their ability to transfer their communication, collaboration and professional skills. However, an EPS program rooted in real projects proposed by industry can help students experience some of the scenarios, types of communication and challenges that they are likely to encounter in international engineering practice.

CONCLUSION

This chapter has adopted a broad interdisciplinary perspective on the importance of TPC in engineering education and, especially, in capstone programs like the EPS, which can help students transition between university and the workplace. Designed to help students cooperate and communicate to solve a problem posed by industry, the EPS constitutes a real scenario in which students can apply their engineering knowledge while they put into practice the transversal skills needed in international settings. In this context, TPC skills are crucial for project development and effective interaction with numerous stakeholders, as teams go through the milestones of their projects. This chapter proposes that a specific TPC course is included in the EPS, which draws on engineering skills and practices (for example, using a problem-solving approach). The principles of EPS program design establish that EPS programs should include an English course and work on communication skills, so it can be assumed that the kind of English course that is appropriate in EPS is, in fact, a TPC course in English (also known as English for Specific Purposes). Using this nomenclature is important for two main reasons, for students, to avoid misinterpretations about the nature of the course (not an ordinary English course), and for course designers, to have access to a long tradition of research and practice in a well-established field in applied linguistics, known as English for Specific Purposes or Technical and Professional Communication (the latter term commonly found in the United States). The international atmosphere

of the EPS, with cohorts of students and lecturers from different countries, makes it an ideal setting for a focus on English as a Lingua Franca, which is appropriate for both native and non-native speakers to become effective participants in international professional communication. As an important part of engineering education, a focus on TPC can help students in their studies (to produce academic assignments) and in the workplace. The combination of both an academic and a professional orientation makes the EPS an ideal scenario for helping students transfer skills between university and the workplace.

In a central position because of its relationship with project-work and other transversal courses, the TPC course can help students integrate different skills (project management, teambuilding, etc.), progress smoothly throughout the project and produce appropriate texts. To this end, the course presented in this chapter, TPC in the EPS at UPC, has been designed with different principles in mind: based on a problem-solving approach, promoting collaboration, structured in a modular sequence, taking a process-genre approach to communication (so that students can produce appropriate types of texts), encouraging reflection, and integrating digital tools for communication and learning. An appropriate TPC course designed to prepare students for effective international communication with the multiple stakeholders addressed in the EPS (in the university, company, and internationally) can help towards the global EPS goals envisioned by its founder: "It is important that engineering students acquire an international dimension and it is important to strengthen links with the world outside the university i.e. the industry and the international society" (Andersen, 2012: 27).

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ENDNOTES

¹ See individual descriptions of EPS course listings by the different providers: <u>http://www.europeanprojectsemester.eu/providers</u>. From this page one can access the links to the different providers' EPS websites, some of which include more detailed course descriptions.