The Internship Subject in a CTeSP Course

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In any higher education degree, the internship subject is designed to provide students the opportunity to work as a company labourer, but is not considered an employee, however, he/she must respect the rules of his/her host institution, and to get more hands-on work experience. In engineering courses, an internship is an on-job training similar to an apprenticeship, more often taken up by students during one semester, usually the last of the course, to supplement their formal education and expose them to the professional world. Therefore, the relationship between educational institutions and public or private companies is considered as strategic to be possible to train students with practical skills, but also with some theoretical knowledge. In addition, the internships are also a form of interaction that students can use to guide them through the transition to a career. The goal of this study is to present a new kind of higher education program in Portugal, the Higher Technical Professional Course (CTeSP), but also to explore the perception and challenges faced by students in undertaking an internship in one of these courses.

Keywords: CTeSP, Engineering students, Internship

1. Introduction

The relationship between the higher education institutions and the public or private companies is an essential aspect in all the engineering courses. So, incorporating an internship subject in a course curriculum is an essential requirement towards ensuring a holistic education system.

According to [1], the internship, an integrative subject, provides an opportunity for the student to experience the challenges of professional life and can be used as a successful strategy to connect theoretical knowledge with practice. While there are many sources of connection between school and industry, the internship ensures also that job prospects are promoted, because is a strategy to safeguarding employability soon after the student's graduation.

Several recent studies [2] [3] [4] indicated that internship has positive effects in engineering courses, even during the confinement period due to COVID-19 (time during which students, for the most part, were compelled to attend a virtual internship) [5], and there are many others [6] [7] [8] that report about different methodologies for its implementation with success.

The objective of this contribution is to discuss about the internship subject taught in an Automation, Robotic, and Industrial Control (ARCI) course at *Instituto Superior de Engenharia do Porto* (ISEP), a public higher education institution located in the city of Porto, Portugal, which provides training in the different branches of engineering. This course is a post-secondary and technical training program, specifically a Higher Technical Professional Course (CTeSP), which purposes to confer a Technological Specialization Diploma, this is a level 5 accreditation at the European Qualifications Framework (EQF) [9].

From now on, this work is organized as follows: Section II, gives an overview of the Higher Technical Professional Course. In Section III some results about the internship subject are summarized and analyzed. Conclusions are derived in the last Section.

2. Higher Technical Professional Course (CTeSP)

The Bologna Declaration, which had its genesis with the Sorbonne declaration in 1998, established rules to create a European area of higher education with uniform criteria and formal principles of education. According to [10], the common name that summarizes this declaration, as well as the various subsequent amendments, is the Bologna Process, whose main objective is to promote mobility and citizenship through the conciliation of higher education in the various signatory states. In addition, it allows that a degree obtained at any university in a member state to be automatically recognized in other countries.

Many substantial changes have occurred in higher education with the Bologna Process, and it is worth noting that the participating states have adopted a structured

curricular organization to ensure solid scientific and cultural preparation, in addition with technical training that qualifies students for professional and cultural life, and split into [10]:

- Short cycle of higher education, within the 1st cycle or linked to the 1st cycle;
- 1st cycle, which in Portugal corresponds to an undergraduate degree (in Portuguese is called *licenciatura*);
- 2nd cycle, which in Portugal corresponds to a master's degree;
- 3rd cycle, which in Portugal corresponds to a doctorate.

Although the most visible alteration has been the change in the duration of the various study cycles, especially in undergraduate degrees, another of the most relevant in Portugal, and which came about with the entry into force of Decree-law Nº. 43/2014 of 18 March [11], was the introduction of CTeSP, planned in the Bologna Process and accommodated in the short cycle for high education linked to the 1st cycle. This type of training confers a level 5 qualification of the European Qualifications Framework (EQF), a common European reference framework, partitioned into eight reference levels defined in terms of learning outcomes, i.e., knowledge, skills and autonomy/responsibility, whose purpose to make qualifications more readable and understandable across different countries and systems. According to [9], essentially a level 5 qualification, is the one that gives students:

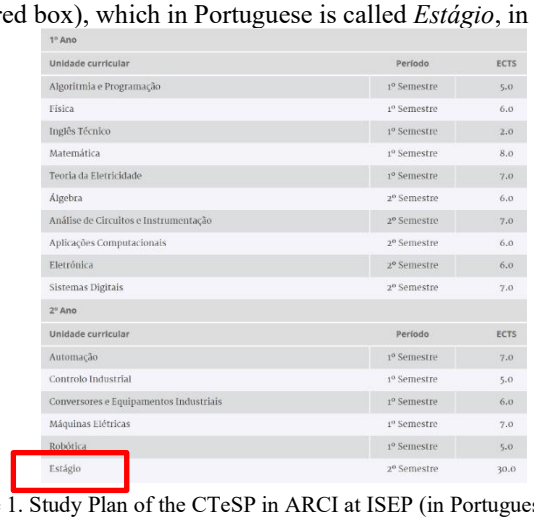
- A comprehensive, specialized, factual and theoretical expertise within a field of work or study and an awareness of the boundaries of that knowledge;
- A complete range of cognitive and practical skills required to develop creative solutions to abstract problems;
- A responsibility and autonomy in order to exercise management and supervision in contexts of work or study activities where there is unpredictable change, i.e., to review and develop performance of self and others.

A CTeSP, which is a type of higher education training that does not confer an academic degree, consists essentially of a technical study cycle, and corresponds to 120 European Credit Transfer and Accumulation System (ECTS) points. With a duration of four semesters, the last of which is in a work context, this type of course is composed of a set of Curricular Units (CU) structured in general and scientific training components (up to 30% of the time), technical training (minimum of 70% of the time) and a vocational work placement (is extremely important because it grants thirty of the 120 ECTS points), which is materialized through a mandatory internship in companies or public or private organizations, in the field for which the course prepares and that have the capacity of accompanying the student, this type of course is organized around four school semesters.

In Europe, there is a wide variety of training courses leading to a level 5 qualification, such as *Brevet de Technicien Supérieur* (BTS) in France or the *Ciclo Formativo de Grado Superior* (CFGS) inSpain, however, many of the studies specified in the EQF are not assigned to higher education short course programs, as is the case, for example, in Portugal with the Technological Specialization Course (CET), which is a non-higher post-secondary training.

Taught almost exclusively in polytechnic higher education institutions a graduate of an CTeSP can also apply to an undergraduate degree, through specific positions (they are limited in number and always less than the quantity of students enrolled in the course), but without taking the entrance exams and receiving partial accreditation for their training. Currently, the *Instituto Politécnico do Porto* (IPP) offers forty-nine courses (from diverse areas as metrology, instrumentation and quality, gerontology, sports and nature tourism, management informatics, laboratory practices in hearing aids, accounting for the management of SME, or modeling and prototyping in goldsmithing), seven of which are taught by ISEP, all related to engineering [12].

Of the CTeSP taught at ISEP, the one in Automation, Robotics, and Industrial Control (ARCI) stands out. It aims to train students in automated systems, robotic manufacturing cells, centralized and computer-assisted industrial process control systems, with a view to optimizing the quantity and quality of production. Having started its activity in the academic year 2018/19, with two classes of twenty students each, this course has a study plan (Figure 1) that includes the internship subject (marked in the red box), which in Portuguese is called *Estágio*, in the last semester.



1º Ano		
Unidade curricular	**Período**	**ECTS**
Algoritmia e Programação	1º Semestre	5.0
Física	1º Semestre	6.0
Inglês Técnico	1º Semestre	2.0
Matemática	1º Semestre	8.0
Teoria da Eletricidade	1º Semestre	7.0
Álgebra	2º Semestre	6.0
Análise de Circuitos e Instrumentação	2º Semestre	7.0
Aplicações Computacionais	2º Semestre	6.0
Eletrónica	2º Semestre	6.0
Sistemas Digitais	2º Semestre	7.0
2º Ano		
Unidade curricular	**Período**	**ECTS**
Automação	1º Semestre	7.0
Controlo Industrial	1º Semestre	5.0
Conversores e Equipamentos Industriais	1º Semestre	6.0
Máquinas Elétricas	1º Semestre	7.0
Robótica	1º Semestre	5.0
Estágio	2º Semestre	30.0

Figure 1. Study Plan of the CTeSP in ARCI at ISEP (in Portuguese) [12].

This internship course aims to consolidate the learning process by allowing students to integrate the knowledge acquired in previous phases (face-to-face classes, etc.). This process will be carried out through the development of practical work, usually in the form of one or more projects with relevance and applicability in the field of automation, robotics, and industrial control, during six hundred hours in a company, public or private, and fifty hours in the classroom (under the format of tutorial guidance), i.e., the students have three hours of weekly contact with the teacher who follows the internship. Thus, this course has a practical "how-to" character, and uses semi-directive and non-directive teaching methodologies, namely through the interrogative method in questioning and monitoring in the classroom, i.e., in the weekly tutorial guidance, and the active method, by encouraging group work and the autonomous search for solutions.

In an internship, which is always full-time (i.e., with eight hours a day and five days a week), which may be compensated (there are companies that carry the costs

of transport and food), non-compensated or sometime, to some extent, paid, there is always a protocol (based on a generic model) between the student, ISEP and the company that contemplates, among others, aspects related to normal working hours, daily and weekly breaks, holidays, absences, and safety and health in the workplace.

Therefore, the main objectives of the internship course are that the students are able, at the end of it, to:

- Mobilize the knowledge previously acquired to solve real problems.
- Develop the ability to design and carry out autonomously specific tasks in the field of automation, robotics, and industrial control;
- Acquire behaviors of research and handling of technical information;
- Have teamwork habits;
- Understand the functional and strategic structure of companies.

The final evaluation of the students is based on:

- An oral presentation, with a duration of twenty-five minutes, ten minutes for the student's work presentation followed by fifteen minutes for public discussion promoted by a jury of three teachers, one of them being the plaintiff of the work, another the teacher who supervised the student during the internship, and the teacher in charge of the CU;
- The analysis of a written report, where they describe in detail the solutions conceived and the work done, as well as argue and defend the decisions proposed.

It is emphasized that there is no intervention by the companies in the quantitative final evaluation of the students, providing only a qualitative assessment of the work developed during the internship.

3. Internship subject analysis

The current analysis is based on a qualitative approach, i.e., personal interviews with all students, and also on a quantitative approach. However, the values presented bellow were not obtained from structured questionnaire given to students enrolled in the CU, but they were collected from the ISEP platform designed for, among other tasks, aggregate and distribute administrative content about the subjects taught and the students.

This internship CU, which had its first students enrolled in the 2019/20 academic year, had nineteen students attending (this represents less than 50% of all those who accessed the course in the previous year), including two female's students and without any repeating student, occurred, in part, during the period of confinement due to the COVID-19 pandemic. Therefore, the sixteen institutions (one public and fifteen private) that hosted the students had to adapt the work objectives, the hours of stay at the organization's facilities (compensated by teleworking tasks, assigned by the companies and by ISEP's teachers), and the contents of the proposed projects,

fully maintaining the objectives of the CU and its method of evaluation. Thus, at the end there were projects that dealt with various themes such as the maintenance of industrial equipment, the development and production of solutions for the control of industrial processes, the design and assembly of electrical infrastructures, the programming of industrial robots, the retrofitting of machines, or the simulation of robotized cells for the automobile industry (Figure 2).

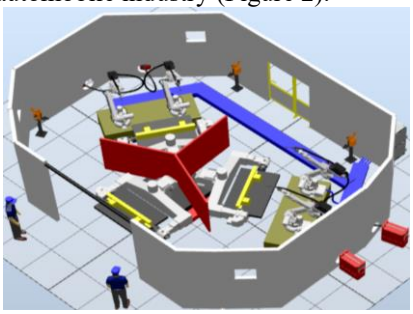


Figure 2. Simulation of robot cells for the automobile industry [13].

From the evaluation of the internships, according to the criteria mentioned above, it resulted that they were approved:

- Eleven students in the regular exam season, which in Portuguese is called *época normal* (EN).
- Five students in the exam appeal season, which in Portuguese is called *época de recurso* (ER);
- Three students in the special exam season, which in Portuguese is called *época especial* (EE), that is, in September. It should be noted that students who defend their internship work in the EE, will not be able to apply for one of ISEP's electrical engineering degrees, since the entrance selection process takes place in August.

The Table 1 shows the quantitative results (between 0 and 20 points) of the final assessment obtained by the students in each of the examination sessions held that academic year.

Table 1. Results of the final student evaluation (2019/20).

Evaluation	**Exam period**			**Total of students**
	EN	ER	EE	
10	1		1	2
11		1	1	2
12			1	1
13	2	2		4
14	1			1
15	1	1		2
16	4	1		5
17	1			1
18	1			1

From Table 1 it can be seen that all the students who attended the internship obtained a positive final grade, and that the average score was 14,72. It should also be noted that:

- Twelve of the students accessed one of the degrees in electrical engineering at ISEP to complement their academic training, getting enough equivalences to immediately enter the 2nd year of the course, but with subjects from the 1st year still to be attended, and of these students, and so far, only one has finished the degree, however there are five more who are finalists, so with the possibility of finishing the degree in the current academic year;
- Only three of the students (including one of those who enrolled in one of the electrical engineering courses at ISEP) remained working in the institutions where they did their internships, while the others chose, for economic reasons, to continue their activities in other institutions.

In the following academic year, 2020/21, there were fifteen students (without females but including two repeating students) who were enrolled in the internship subject of the ARCI course, but only eleven presented the project developed in a work context, in nine institutions (one public and eight private), five in EN, five in ER and one in EE. The proposed projects matched the subjects taught in the course, such as the implementation of a temperature control system, the design of a surplus energy manager, or the development of devices to control smart led advertising panels (Figure 3 shows some of the developed boards).

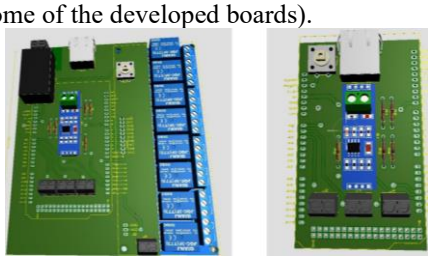


Figure 3. Developed boards for the control of smart led billboards [14].

The Table 2 presents the quantitative results of the final evaluation obtained by the students in each of the examination seasons that took place in the academic year 2020/21.

Table 2. Results of the final student evaluation (2020/21).

Evaluation	**Exam period**			**Total of students**
	EN	ER	EE	
10		1	1	2
11				0
12	1			1
13	2	1		3
14	1	2		3
15	1			1
16		1		1

From the data presented in Table 2, it is concluded that all the students who attended the internship obtained a positive final grade, and that the average evaluation was 13,09 values, that is, 8,89% lower than in the previous school year.

Five of the students who presented their internship work in 2020/21 accessed one of ISEP's electrical engineering degrees. In addition:

- Three students of those who had finished in the previous academic year also joined the undergraduate degree;
- One of the students who completed the internship in 2020/21 joined the mechanical engineering degree at ISEP through another type of access competition;
- Four students (including one of them part-time) kept working in the company where they had their internship.

In the current academic year, seventeen students are enrolled in the internship subject of the ARCI course. However, at the moment only fifteen students are actually integrated into institutions, and therefore carrying out projects, and there are currently no concrete results about their evaluation, because it will only take place in the last week of July (however, at the moment only ten students are able to present their internship work).

As there are currently no studies on the impact of the internships on the student's training in the CTeSP in ARCI of ISEP, now that almost three years have passed since their implementation and consolidation, in addition to the data exposed above, it was also proceeded to student's interviews, following questions defined on a prepared guide. The main purpose is to understand the student's perception and challenges faced by them in pursuing the internship. Therefore, for the students, the major challenges of the internship subject are:

- The definition of strict placement procedures, for example, by informing students in a timely manner (right after the beginning of the academic year) about companies that intend to take on interns and the projects proposed;
- The limitations in the choice of the academic mentorship (that is, the fear of having an inadequate guidance support);
- A lack of enough time to develop an ambitious project, but also to design and carry out autonomously specific tasks;
- How deal with the likely poor supervising practice generally observed in the companies;
- Being in a company that understands and respects the concept inherent to this type of activity, and not in one of those that use and abuse of unpaid internships and see the interns as free labor;
- The fact that the internship is mandatory for completing the course, which can delay effective entry into the world of work or even the possibility of losing real job opportunities.

Students reap many benefits from internships such as the job related, the career related, and the networking market. Generally, they also mention that an internship:

- Provide more realistic perceptions about the technologies, in contrast to what happens in classes, even those with laboratory components;

- Acquire behaviors of research and handling of technical information;
- Allows to obtain work experience;
- Improved skills and knowledge.

The students also mention that it was important to be accompanied by two mentors during the time of the internship, i.e., one from the educational institution that accompanies the academic side (for the writing of the report, etc.) and another, seconded from the company, which guides the professional side.

4. Conclusions

On CTeSP courses, taught always in higher education institutions, the internship subject is part of the academic qualifications provided, i.e., the on-the-job experience is used to develop competencies. Internships represent an approach for student's professional development of generic and specific skills, and allow them to gain relevant work experience.

From this study, about the perception and challenges faced by students in undertaking an internship in one of these courses, the ARCI course of ISEP, it was found that the students had a positive opinion. However, the students expressed that they had some doubts in terms of planning and implementation, and suggest improvements (for example, the early definition of the institutions where the internships will take place) in these aspects.

The overall positive effects of internships confirm that they are an advantageous situation for all the stakeholders, i.e., students, companies, and higher education institutions.

In a general way, from the results obtained in the student's evaluations, as well as from this study, it is possible to affirm that the CU defined objectives was accomplished.

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