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Students' Perceptions of Key Competencies Supporting Work-Integrated Learning*

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In this paper we explore the perception that industrial organization engineering students had after facing a compulsory, long-duration practicum oriented to develop key professional skills as management, analysis, diagnosis, resolution and organization of production and management and business administration in real professional environments. Specifically, we seek to explore the competencies and input provided to these students during their training stage as an Air Control and Defense Officer at the Spanish Air Force. In this case, the degree syllabus was designed so that the students could acquire the competencies related to industrial engineering, telecommunications, electronics or management linked to this profession. The study was based on the 141 students' feedback as well as the assessment by the professional mentors and the academic faculty. Results revealed that transversal competencies (also known as cross-curricular or soft competencies) are crucial. According to students' perceptions, competencies related to problem solving, team integration, communication and management play a major role for them to become successful in the practicum. In addition, 92% of these students held the view that the competencies acquired during the degree subjects helped them to finish the practicum satisfactorily. They valued the new knowledge and aptitudes they received during the process.

Keywords: practicum; perceptions; competencies; engineering students; industrial engineering; air force

Acronyms and Abbreviations

CUD-San Javier: *Centro Universitario de la Defensa en San Javier* – University Center of Defense of San Javier.
UIOE: Industrial Organization Engineering.
ACD: Air Control and Defense.
ACDO: Air Control and Defense Officer.
ANECA: Spanish National Agency of Evaluation of Educational Quality of University Studies.
UPCT: *Universidad Politécnica de Cartagena* – Technical University of Cartagena.
SAF: Spanish Air Force.
ECTS: European Credits Transfer System.
EHEA: European Higher Education Area.
EQF: European Qualification Framework.
BC: Basic Competency.
TC: Transversal or Cross-curricular Competency.
GC: Generic Competency.
SC: Specific Competency.
SO: Specific objective.
WIL: Work-integrated learning.

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1. Introduction

The terms "practicum" and "placements" can be used to encompass different types of work experience undertaken while the students are studying. This learning approach has shown good results at the tertiary, non-university level, for example, in Germany [1]. Practicums, placements and dual education at international university level are also a well-established learning approach in some degrees such as education, nursing or medicine. Accordingly, it is a common approach in Spain, USA, France, Italy, Japan, Argentina or Uruguay. In the last three decades, this type of methodology has been spread to science and engineering degrees in many countries worldwide as well. In this case, the non-compulsory practicum is the most frequent educational approach. Aleisa and Alabdulahfez [2] indicated that more than 97,000 enterprises and government agencies were, at that time, involved in co-operative education programs in USA. Moreover, according to UK Higher Education Statistics Agency [3], the students who performed this kind of internship improved their employability when this was compared to graduate students who did not do a work placement. In addition, it has been widely reported that this kind of experience provided important benefits to students acquiring disposi-

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tional knowledge and broadening their social and professional skills [4–6].

The European Higher Education Area is a common university system established in Europe from the Bologna Treatment [7]. The European Qualifications Frameworks in Higher Education Area (QF-EHEA) are frameworks describing the higher education qualifications of countries participating in the Bologna Treatment that currently relies on 48 countries. It consists of three cycles, approximately equivalent to a bachelor's degree, master's degree and PhD-equivalent degrees in the Anglophone world [8]. The system is supported by a common workload system: the European Credit Transfer System (ECTS). This system permits the student's workload to be assessed quantitatively. One credit of the ECTS is, on average, between 25 and 30 hours of current work by a student whereas an academic year holds 60 ECTS. In Spain, a bachelor's degree has an extension of 240 ECTS distributed over a minimum period of four years.

This study analyzes the results of a compulsory practicum by undergraduate students in the last year of an industrial engineering degree, specifically the Industrial Organization Engineering (UIOE) degree of the Technical University of Cartagena (UPCT), which is offered in CUD-San Javier, Spain. The UIOE is a bachelor's degree developed according to the standards and philosophy of the EHEA. The total number of credits is planned over five years in this case. The integration of a long-term practicum in the last year of the UIOE is a singular learning approach in engineering degrees in Spain. This study focuses on the air control specialization of the degree, which was designed from the very beginning to provide well-formed professionals to work as Air Control and Defense Officers (ACDO) at the SAF. The degree syllabus is based on a dual system, and this is oriented for the students to acquire the competencies related to industrial, telecommunications, electronics and management engineering that are needed to perform the professional tasks expected of an ACDO at the SAF. In the last year of the degree, the students have to aim for a practicum of eight months within the SAF. This practicum consists in a "learning by doing" methodology based on the constructivism principles [9-10], cooperative learning [11] and experiential learning [12], where students build up their knowledge out of their experiences and their interaction with other workmates.

The purpose of the study is to analyze the perceptions held on work-integrated learning (WIL) by engineering students at the Spanish Air Force. The specific objectives derived from this general objective are:

- SO1: To evaluate whether the competencies that they acquired from the subjects of the degree helped them to complete the practicum successfully.
- SO2: To identify the competencies that the students considered to be more useful so as to succeed in their practicum as ACDO.
- SO3: To explore the input provided by completing the practicum.

The analysis of the educational results of this practicum was carried out by means of the evaluation of the acquisition of competencies by the students based on their grading as well as on the students' perceptions. The paper is structured as follows: firstly, a review of different educational systems supported on WIL methodologies at university level and a brief account of the work related to competencies in WIL are presented. Secondly, the research context is described. Thirdly, the methodology and data analysis are shown. Fourthly, the results obtained are discussed. Finally, some key conclusions are drawn.

2. Review of Relevant Integrated Learning Programs

In general, it is accepted that engineering students need to be prepared for the use of advanced and appropriate technology in their future workplaces [13–17]. Dudman and Weame [18] indicated that most engineering careers demand skills and expertise for project management or leadership. Under these conditions WIL and dual education appear as key tools to reach the goals of both, graduate engineers and industry stakeholders [19].

Many countries have integrated dual education systems within the university engineering field with success. For example, in the 70s Germany established a dual education system for the fields of business and engineering at university level. In the case of the "Berufsakademie", the students carry out periods of courses at the university and WIL in enterprises [1]. For our students the practicum period was not optional. Each period of work usually takes 12 weeks and includes practical components and one theoretical component. The study performed by Göhringe [1] revealed that the cooperative education graduates showed rapid career advancement. The "Duale Hochschule Baden-Wuerttemberg" university studies are further examples of the success of this kind of education in Germany. They included the dual, practice-oriented degree at their School of Engineering with good results. In this case, it was a three-month phase with both, theoretical and practical sessions. The program promotes international mobility. Results showed that approximately 85% of the students signed employment contracts with the companies after graduation [20].

There are many engineering degrees worldwide that offer optional practicum to the students. However, there are not so many programs that include a long-term practicum as a compulsory component to obtain a university degree. One example of this kind of planning is located at India. All India Council for Technical Education (AICTE) is a public, national-level organization for technical education, headed by the Department of Higher Education, Ministry of Human Resource Development. This organization makes internships compulsory for engineering graduates. Nonetheless, it is currently a challenge to find companies for all the students. Aleisa and Alabdulahfez [2] analyzed the engineering and technology dual systems at the Riyadh College of Technology of Saudi Arabia from 1998 until 2001. The system comprises areas such as chemical, electrical or mechanical technologies with successful results. In this case the practicum is obligatory for the students and last for 12 weeks to be spent in the workplace. The authors suggest that the rapid growth in enrollments brought about several challenges, such as the difficulty in securing work-placements in private sector companies, along with a shortage of financial resources and personnel. They noted the importance of cooperation and coordination with the private sector to guarantee the success of the learning process.

Leandro Cruz et al. [21] reviewed 99 studies of competency measurement methods in engineering education published in the last 17 years. They identified several measurement methods based on questionnaires and rubrics and suggested a need for setting professional standards when measuring the mastery of competencies. They also put forward guidelines for the design of these measurement methods. According to the guideline, the students were asked about their learning.

Recently, Rouvrais et al. [22] conducted a study where they analyzed the French work-based learning models in engineering. They summarized the results of a program where several higher education institutions implemented an integrated curriculum following the international CDIO educational framework. In this work, they analyzed several cases after 30 years of work-based learning methodology implemented though compulsory placements in engineering. They highlighted that mandatory, integrated internships permitted to promote the inductive pedagogy (from experience to theory) which were considered to be more efficient than the classical deductive one. In addition, they found that this methodology provided a better understanding of academia and employers of their mutual constrains and objectives. They proposed to spread the CDIO framework [23] to systematically include work-based learning to better match industry requirements.

Computing engineering is an area where work placements have been found to provide good results as a learning strategy in the UK. This field of engineering consists of electronic engineering and computer science. Smith et al. [4] analyzed the experience of a target group of 99 students that performed non-compulsory placements. They observed that students who had undertaken a placement as undergraduates took advantage from work experience financially, earning more than those who had not completed placements. They also noticed that they found graduate positions more quickly and were more likely to find a job than those who had graduated without completing a placement. Khampirat et al [24] studied the case of a public university in Thailand. They explored a group of 584 co-op students of engineering, agricultural technology and information technology. The average age of the informants was 22.5 years. The authors showed notable changes in the student skills after entering the workplace.

Australia has a long tradition in WIL for engineers [25]. In most cases, the high education institutions account for mandatory WIL for the engineering students [26] as the engineering profession in this country is overseen by an accreditation body (Engineers Australia) that requires "exposure to professional engineering practice" for all the programs of study [25]. In fact, the accreditation body "Engineers Australia" provide feedback on the capacity of the institutions to facilitate the students' development in WIL across three domains: knowledge and skills, engineering applicability and professional and personal attributes [23,28]. In this context, Peach and Button [29] have demonstrated the effective use of blended learning environments for the development of professional competencies across the undergraduate engineering curriculum when a continuous evaluation and feedback on the students' progress is provided.

In Spain there are many engineering degrees with optional long-term or short-term practicums. Notwithstanding, according to all the sources consulted, currently, there are only three engineering degrees out of sixty-eight in Spain that comprise a practicum as a compulsory (i.e. not optional) subject in its program. In this work the UIOE degree includes one of them. This degree accounts for a practicum of 30 ECTS programmed in the fifth course of the degree which lasts from mid September to late May. In this case, the students must have passed the subjects of the previous four years in order to have access to the practicum. By doing so it is made sure that the students that undertake this last stage of the degree have acquired the contents and competencies required to succeed in the practicum.

Regarding the students' perceptions of specific workplace competencies, Coll and Zegwaard [25] analyzed the answers offered by the students who had finished a three-month industry placement in New Zealand. In that study they rated a list of 24 workplace competencies for graduated students joining the workforce using a 7-point Likert scale. The top five ranked competencies were the "ability and willingness to learn", "initiative", "achievement orientation", "personal planning as well as organizational skills", and "analytical thinking". The comparison with the business sector students showed some differences in what the students thought were the most important competencies. Specifically, business students considered "computer literacy", "teamwork as well as cooperation" and "self-confidence" to be more important than for the science and technology students. Concerning the perspective of recent graduates, Zegwaard and Hodges [30] suggested that the students' "inculturation" in the workforce was permitted by their workplace experience.

As for the industry perspective, Makhathini [19] identified the competencies expected by the industrial supervisors' in South Africa. The study demonstrated that chemical engineering students meet the standard expectation on cognitive and "hard" skills but seem to lack the behavioral or "soft" skills and indicated that cooperative education programs need to do more so as to develop the students' soft skills before they go out for WIL placement to guarantee its effectiveness.

3. Research Context

UIOE is an industrial engineering bachelor's degree, also known as "Industrial Organization Engineering" in some countries. This field of the engineering profession deals with the optimization of complex industrial processes, systems and organizations by means of developing, improving and implementing integrated systems. These systems involve people, money, knowledge, information, equipment, energy and materials [31].

In general, a typical curriculum of an industrial engineering degree incorporates a broad math and science foundation including chemistry, physics, mechanics, material science, computer science, electrical, electronics, statistics, manufacturing and engineering economics. The curriculum of the UIOE was designed under a dual perspective: providing students with general and specific competencies as a means for them to perform their future professional tasks successfully and, on the other hand, provide the graduate engineers with the skills to fulfill the professional duties of ACDO at the SAF. Thus, the UIOE curriculum comprised some specific subjects related to air control such as fluid mechanics, thermal engines, engineering design, circuits, telecommunications, electromagnetic exploration systems, logistics and human factors. The educational system consists of a competency-based learning approach. The OECD defines competency as the "ability to respond to demands and to perform tasks adequately". Each competency is developed through a combination of cognitive and practical skills, knowledge, motivation, values, attitudes, emotions and other social and behavioral components. Hence, the concept of competency is a term that combines knowledge, skills and attitudes and it allows the person who has acquired it to act adequately in the professional and/or social environment.

A total of 47 competencies are evaluated in the degree through the different subjects. The competencies of the UIOE degree are classified into basic (BC), transversal (TC) (also known as cross-curricular or soft competencies depending on the author), generic (GC) and specific competencies (SC). The list consists of 5 BCs, 7 TCs, 5 GCs and 30 SCs. The first group of competencies is referred to as basic competencies as they are linked to the national curriculum of a bachelor's degree. These are set by the government in order to fulfill the first cycle of the QF-EHEA and level 6 of the European Qualification Framework (EQF) [8]. These basic competencies are listed in the Appendix.

The TCs are common to different engineering degrees, and these are defined by the university whereas the GCs are related to the industrial organization engineering field, and these can be common to other degrees of the professional field. They are listed in the Results and Discussion section. Finally, SCs are professional competencies having to do with the UIOE degree and they deal with the capacity of the student to understand basic principles concerning the professional degree and to apply them in practical terms [32]. These competencies are shown in the Appendix. This engineering undergraduate program was accredited by the Spanish National Agency of Evaluation of Educational Quality of University Studies (ANECA) by 2010 [33] and it faces an external auditing performed by ANECA every two years.

In the last levels of the degree, the undergraduate students have to undertake a compulsory, long-term, practicum of eight months (30 ECTS) at SAF. During this period, students learn, for example, to communicate and operate current telecommunication satellites that orbit the Earth or operate with national air traffic data recorded from the previous day in order to acquire the professional capabilities needed to become a competent ACDO [34]. The activities and tasks that the students have to carry out during the practicum are fixed (i.e. not open) and specified in a "practicum project". This project was agreed between SAF and the university and was published in the Official State Bulletin via a Ministerial Resolution [35]. This practicum project links the activities and tasks in which the students must be engaged in the practicum with the professional and academic competencies and the subjects of the bachelor's degree. In the case of some specific procedures or contents of the practicum, the students must face a practical examination. The learning outcomes of the practicum are to develop and apply the basic, general, transversal and specific competencies initially acquired in the different subjects of the degree in a professional environment within the Spanish Air Force. Each student has a professional mentor in the placement and a professor at CUD-San Javier that coordinates and evaluates the student performance during the training.

4. Methodology and Data Analysis

The analysis of the educational results of the practicum was performed through the evaluation of the acquisition of competencies on the basis of the perceptions that professional mentors and the academic faculty as well as the students have. This research was reviewed by the institutional review board of CUD-San Javier and received their ethical approval.

Therefore, this study concerns 141 responses received from all the UIOE undergraduate students of three cohorts of three different years (hereafter Classes I, III & IV) that attended the practicum over three academic years: 2014/15, 2016/17 and 2017/18. The average age of the students was around 22.5 years and more than 75% of the students were male. All of them had chosen this degree as a first option in their university application priority list.

The data were collected by means of an ad hoc questionnaire delivered to the students. The questionnaire asked students about their experiences in the practicum and aimed to find out about whether they considered that the subjects studied in the UIOE degree helped them to implement their tasks in the practicum. In the case of the students of Classes III and IV, they were also asked to identify the academic competencies of the degree which were more useful to be able to succeed in the practicum. Likewise, the students were asked to identify within the degree one basic competency (i.e. one out of five), one generic competency (i.e. one out of five), one transversal competency (i.e. one out of seven) and seven or fewer specific competencies (i.e. seven or fewer out of thirty). The survey also included an open question where the students were able to comment on their practicum experience and gave their view about whether this practicum was useful for their future professional careers.

The professional mentors and academic faculty were asked to complete an assessment feedback sheet regarding the students' performance after the training completion. The mentors and academic tutors completed this assessment which evaluated the students' general and transversal work-related competencies using a 5-point Likert scale. The nature and needs of our research are best met by adopting a complementary or holistic design (a mixed methods research), which implies including aspects from both the quantitative or neopositivist and the qualitative or interpretative methodological approaches [36]. The quantitative analysis included the histograms (frequency) of the students' answers to closed questions. It was used to identify which competencies in the degree were considered to be more useful by the students in order to succeed in the practicum and develop their professional activity.

A purely qualitative analysis was also undertaken in the case of the spontaneous verbal information provided to the open question mentioned above. The analytical procedure of textual data followed was that proposed by Miles and Huberman [37]. A mixed (deductive-inductive) qualitative approach was employed for the extraction of categories. For the text segmentation the thematic criterium was used [38]. Direct quotes were included to support the findings, in particular, the participant's exact words which offer the reader the most faithful image of the phenomenon studied [39]. Likewise, the meanings behind the categories were shown in graphical representations, networks, which assembled and organised the information.

The incomplete or not fully complete survey questionnaires were considered to be invalid. After post-processing the surveys and filtering the invalid ones, a total of $N_{so1} = 141$ were considered for SO1. Regarding SO2, $N_{so2} = 66$ samples were taken into account. Specifically, the cohorts approached for SO2 were n = 35 for Class III and n = 31 for Class IV.

5. Results and Discussion

5.1 Results

The first step in the evaluation of the acquisition of professional competencies by the students in the practicum was performed by means of the analysis of the educational results achieved by the undergraduate students that passed the practicum. The qualifications provided by the professional mentors of SAF and the academic faculty at CUD-San Javier have revealed that, in general, the learning by doing methodology followed in the practicum was effective for the students to acquire the professional competencies required by an ACDO. Based on the grading by the professional mentors and the academic faculty, the students' final marks in the practicum ranged between 6 and 9.8 out of a maximum mark of 10, i.e. between C and A marks.

The results of the survey made it possible to get insights into the students' perceptions of the practicum and they also helped to analyze the results of this placement. The most important findings were that, according to the students, the competencies mastered during the first four years of the degree made it possible for them to succeed in the practicum. In fact, 92% of the students that completed the questionnaire claim this (which is related to SO1). Only 8% of the students considered that the learning of competencies acquired during the degree did not help them to succeed in the practicum. However, these students did not provide reasons to justify their view.

Regarding the most useful competencies that helped the students to pass the practicum (SO2), the students of both cohorts agree that the most useful basic competency was BC2 "Students know how to apply their knowledge to their work or vocation in a professional way and possess the skills that are usually demonstrated through the elaboration and defense of arguments and the resolution of problems within their area of study" and the most useful general competency was GC1 "Organizing and directing companies and institutions by evaluating aspects of organizational behavior and resource management" (Tables 1 & 2).

As for the transversal and specific competencies (Table 3 & Fig. 1), students clearly opt for the TC5 "Ability to seek solutions to a situation, implementing an appropriate action plan, by managing the knowledge acquired and the information available" (with 41% of the answers) and, to a lesser extent (22% of the answers) for teamwork integration (TC2) as well as communication (TC1) (with 16% of the answers).

As shown, with 10% of the answers the study underlines the specific competency SC27 "Communicate in a foreign language" as the most useful one. Also, although to a lesser extent (with 7% of the answers), students highlight "to use and program computers, operating systems, databases and software with engineering applications" (SC3), "to

Table 1. Basic competencies chosen by the student as the most useful ones. Distribution of the basic competencies chosen

COMPETENCY		Percentage
BC1	☐ BC1. Students have demonstrated knowledge and understanding in an area of study that is at the basis of the general secondary education. This area of study is usually at a level that, while supported by advanced textbooks, also includes some aspects involving knowledge from the forefront of their field of study	2%
BC2	☐ BC2. Students know how to apply their knowledge to their work or vocation in a professional way and possess the skills that are usually demonstrated through the elaboration and defense of arguments and the resolution of problems within their area of study.	59%
BC3	☐ BC3. Students have the ability to gather and interpret relevant data (usually within their area of study) to make judgments that include reflection on relevant social, scientific or ethical issues.	11%
BC4	☐ BC4. Students can convey information, ideas, problems and solutions to both specialized and non-specialized audiences.	20%
BC5	☐ BC5. Students have developed those learning skills necessary to undertake further studies with a high degree of autonomy.	9%

Table 2. Generic competencies chosen by the student as the most useful ones. Distribution of the generic competencies chosen

COMPETENCY		Percentage
GC1	☐ GC1. Organizing and directing companies and institutions by evaluating aspects of organizational behavior and resource management.	45%
GC2	☐ GC2. Applying general technologies and fundamental matters in the industrial field for the resolution of problems typical of engineering.	20%
GC3	☐ GC3. To identify and describe aeronautical technologies.	18%
GC4	☐ GC4. To work in a language environment specific to air navigation.	15%
GC5	☐ GC5. To describe the legislative and legal framework in institutional and business organizations.	2%

Table 3. Transversal competencies chosen by the student as the most useful ones. Distribution of the transversal competencies chosen

COMPETENCY		Percentage
TC1	☐ TC1. Ability to express and transmit ideas and knowledge of the professional and academic world, orally and in writing, clearly and effectively.	16%
TC2	☐ TC2. Ability to integrate into a work team with the aim of achieving a certain result. The integration must be as a member or performing management tasks and with a sense of individual and collective responsibility.	22%
TC3	☐ TC3. Ability of the student to plan and perform the non-attendance activity and build meaning with a deep focus, in both conventional and non-conventional teaching-learning modalities.	5%
TC4	☐ TC4. Ability to manage information in their field of expertise, organize it and use it effectively, ethically, and legally for a variety of purposes and as a basis for autonomous and lifelong learning.	8%
TC5	☐ TC5. Ability to seek solutions to a situation, implementing an appropriate action plan, by managing the knowledge acquired and the information available.	41%
TC6	☐ TC6. Ability to respond to society's economic, social and environmental challenges. Keep in mind the moral dimension in their professional actions in a responsible and committed way with the present and future generations.	2%
TC7	☐ TC7. Ability to propose and develop ideas and solutions that add value to processes, products or services.	8%

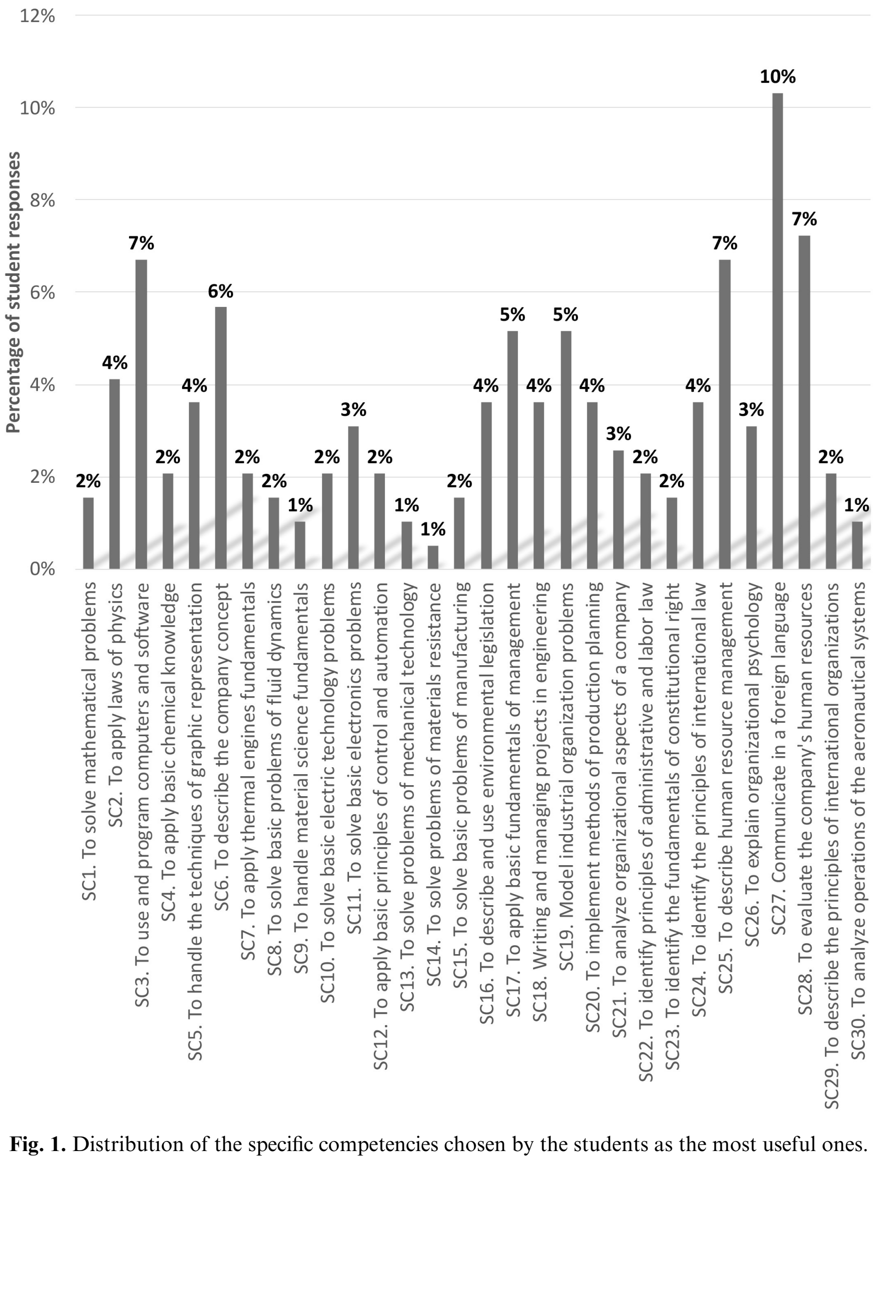

Fig. 1. Distribution of the specific competencies chosen by the students as the most useful ones.

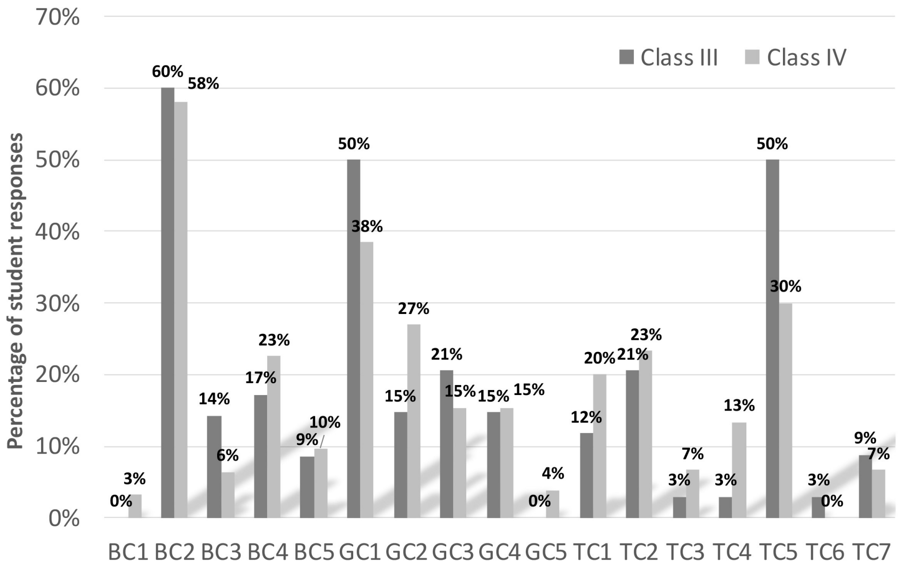

Fig. 2. Comparison of basic, generic and transversal competencies chosen by the student as the most useful ones among cohorts. Cohorts: Class III n = 35; Class IV n = 31.

Table 4. Input provided by completing the practicum

STUDENT INPUTS			
New aptitudes	**New knowledge**	**Practice of knowledge**	**New capacity**
70.7%	65.3%	34.7%	26.7%

describe human resource management processes" (SC25), "to analyze the importance of an adequate work organization and evaluate the opportunities, problems and limitations of the company's human resources" as well as "to propose policies to solve problems related to them" (SC28).

The comparison of the answers among cohorts shows, in general terms, similar results (Fig. 2). The differences among cohorts are more noticeable when analyzing the transversal competencies. While half of the students of Class III opted for the competency related to problem solving (TC5), in Class IV, only 30% of the students chose it and the competencies concerning communication TC1 and TC4 increased their specific weights in Class IV if compared to Class III by 8% and 10%, respectively.

As for the comments made by the students in the open question (SO3, Table 4), they gave great importance to novelty (the adjective new was present in the lexicon they used in their comments), especially when this novelty was related to their aptitudes or knowledge. Around 70% of the total number of students talked about having been enriched by the practice in terms of acquiring new aptitudes and new knowledge. Also present, although moderately, as an input to the practicum is the practice of those aptitudes or knowledge.

5.2 Discussion

The students' final marks in the practicum, between 6 and 9.8 out of 10, suggest that the learning methodology used in the previous degree courses was successful. It would seem that the small percentage, 8%, who considered that the learning of competencies acquired during the degree did not help them to succeed in the practicum was not satisfied with the way the Degree developed in terms of preparation for future work, but they did not offer any alternative for improvement either.

The fact that the most useful competencies that helped the students to pass the practicum are BC1 and GC1 seems to point out that competencies related to communication and management are key in the learning process within the engineering practicum studied. It is worth commenting that there is no variation in the students' preferences depending on their cohorts as in both cases they chose the same competencies as the most useful ones.

The perception of key competencies regarding transversal and specific competencies (T5 followed by TC2 and TC1) is in line with other studies carried out by Coll and Zegwaard [25] in the case of the science and technology field (including engineering students) in New Zealand. These students identified the "ability to learn", "initiative", "achievement orientation", "personal planning" and "organizational skills" among the top 5. These competencies are directly related to the top 2 competencies in the present study: TC5 and TC2. This highlights the concordance between the students' perception in the science and technology field even in different countries, placements and degrees. It also remarks that even with a lapse of time of 15 years between both studies, the perception that students have of key transversal competencies seems to remain similar, which suggests that these "soft skills" [29] are important for tasks undertaken in WIL even if the level of technological advances in the society and the workplace evolves. As in the case of the present study, Meda and Swart [40] also identified "innovation and problem solving" as one the most important competence required in a junior graduate in electrical engineering based the input of industry, academia and accreditation bodies of South Africa.

The results concerning differences among cohorts reflect an evolution of the perception of the competencies concerning information management and human resources, which were key for the engineering students in their WIL phase. Besides, specific engineering competencies linked to the technical field (i.e. aeronautics) of the workplace were identified as crucial.

Finally, the comments made by the students in the open question (SO3) in which they highlight novelty and later practice make sense since, before the practice, the new knowledge and aptitudes need to become assimilated. The following comment in the survey summarizes the general perspective that students adopt: "Personally, this practicum has offered a practical view of the subjects studied in our degree and it has given me the possibility of analyzing my abilities to assimilate and put into practice the necessary concepts to undertake a specific task or activity".

6. Conclusions

In this paper we analyze the students' results and their perspective of a compulsory practicum stage of 30 ECTS performed by the undergraduate engineering students of the UIOE degree at SAF in close relationship with ACD professionals. Students' perceptions together with academic qualifications from both professional mentors and the academic faculty have shown that this practicum is an effective mechanism for the students to acquire the professional competencies required by an ACDO.

The results were examined on the basis of both quantitative and qualitative methodologies to explore the view of students in relation to the basic, generic, transversal and specific competencies of this engineering degree by finding out about which of them were considered to be more useful to succeed in the practicum belonging to the last academic year. According to the students, the competencies acquired during the first four years of the degree helped them to succeed and to reach the learning outcomes of the practicum. In fact, more than 9 out of 10 students that participated in our survey claim this. The results also reveal that the students identify the competencies related to organizing institutions and managing resources (GC1), problem solving (BC2, TC5), work team integration (TC2), communication (TC1) and foreign language communication skills (SC27) as the most useful ones to succeed in the practicum amongst all of those developed within the engineering degree. Therefore, the competencies concerning communication, social relations and management are identified as key in the WIL within the engineering field studied. As already discussed, the results for the students' perceptions on transversal competencies are similar to the ones found in different placements and degrees 15 years ago. This suggests that these "soft skills" are key or important to tasks undertaken in WIL.

All in all, the results allow us to link the perception of engineering undergraduate students in the practicum with the competencies and subjects of the corresponding university degree. Therefore, it might be considered to be an indication of the correct attainment of the competencies set in the engineering university degree for the full professional integration of graduates into their future working field as an ACDO. Besides, the system presented in this study can be used as a model to follow for other universities in Spain and other countries in the engineering field and move towards compulsory placements. For future research it could be of interest, for example, to explore the cases of the remaining engineering degrees in the Spanish Armed Forces and other analogue international institutions (i.e. the different university centers) so as to find out about similarities and differences.

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Appendix

Degree in Industrial Organization Engineering (Cud-San Javier, Spain)

Basic competencies:

- BC1. Students have demonstrated knowledge and understanding in an area of study that is at the basis of the general secondary education. This area of study is usually at a level that, while supported by advanced textbooks, also includes some aspects involving knowledge from the forefront of their study area.
- BC2. Students know how to apply their knowledge to their work or vocation in a professional way and possess the skills that are usually demonstrated through the elaboration and defense of arguments and the resolution of problems within their area of study.
- BC3. Students have the ability to gather and interpret relevant data (usually within their area of expertise) to make judgments which imply reflection on relevant social, scientific or ethical issues.
- BC4. Students can convey information, ideas, problems and solutions to both specialized and non-specialized audiences.
- BC5. Students have developed those learning skills necessary to undertake further studies with a high degree of autonomy.

The specific competencies of the UIOE degree are:

- SC1. To solve mathematical problems related to the engineering field.
- SC2. To apply the general laws of mechanics, thermodynamics, fields and waves and electromagnetism to solve engineering problems.
- SC3. To use and program computers, operating systems, databases and software with engineering applications.
- SC4. To apply basic chemical knowledge in engineering problems.
- SC5. To demonstrate spatial vision and handle the techniques of graphic representation, both by traditional methods of metric geometry and descriptive geometry, as well as through computer-aided design applications.
- SC6. To describe the company concept based on a legal framework
- SC7. To apply thermodynamic, heat transfer and thermal engines fundamentals in the engineering field.
- SC8. To solve basic problems of fluid dynamics.
- SC9. To handle material science fundamentals.
- SC10. To solve basic electric technology design problems
- SC11. To solve basic electronics problems.
- SC12. To apply basic principles of control engineering and automation.
- SC13. To solve basic problems of mechanical technology.
- SC14. To solve basic problems of materials resistance.
- SC15. To solve basic problems of manufacturing technology.
- SC16. To describe and use management techniques and environmental legislation
- SC17. To apply basic fundamentals of management.
- SC18. Writing, organizing and managing projects and reports in the field of industrial organization engineering
- SC19. Model industrial organization problems and use resolution techniques and decision support.
- SC20. To select and implement methods of work study, production planning and management and projects.
- SC21. To analyze organizational and production aspects of a company.
- SC22. To identify and examine the fundamental principles of administrative and labor law.

- SC23. To identify the basic fundamentals of constitutional right.
- SC24. To identify and examine the fundamental principles of international law.
- SC25. To describe human resource management processes.
- SC26. To explain organizational psychology.
- SC27. Communicate in a foreign language.
- SC28. To analyze the importance of an adequate work organization and evaluate the opportunities, problems and limitations of the company's human resources, as well as propose policies to solve problems related to them.
- SC29. To describe the basic principles of the relations and structure of international organizations.
- SC30. To analyze and apply the subjects applied to engineering and operations of the aeronautical systems.

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