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PAPER

Analysis of the General Skills of Graduates in Environmental Sciences: The View of Students, Teachers and Employers

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ABSTRACT

General competencies are crucial for the personal and professional growth of university graduates. This paper provides a critical analysis of the significance and level of competence development within the environmental sciences degree (ESD) context. The research involved surveys conducted among final-year students, faculty members, and industry employers. The survey results reveal that employers perceive the level of competence achieved to be higher than what teachers and students reported. However, all three groups acknowledge a high level of competence development for most skills. Nonetheless, certain competences such as critical thinking (CT), problem-solving, organisation, and planning need to be strengthened to better align with their perceived importance. Students tend to undervalue essential competences such as digital literacy and environmental awareness, contrary to international organisations' recommendations. The study findings also underscore the necessity of enhancing "entrepreneurial skills" and emphasising the significance of the digital realm for students pursuing an environmental sciences degree.

KEYWORDS

troubleshooting, critical thinking (CT), skills, digital competences, entrepreneurial skills

1 INTRODUCTION

The challenges presented by globalisation, structural changes in the economy, and current technological developments require a re-evaluation of the preparation of students for the labour market [1], [2], and [3]. In this sense, it is necessary to prepare students for Industrial Revolution 4.0 [4]. Furthermore, it is necessary to develop the competencies of the younger generations to contribute to the well-being of both individuals and society as a whole [5]. In this context, higher education plays a pivotal role, and a comprehensive revision of the core competencies demanded in the contemporary world is imperative [6], [7], and [8]. In this sense, most

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international organisations have created and developed key skills using terms such as “21st century skills,” “employability skills,” “soft skills,” or “general skills” [1], [9], and [10]. Some of these competencies include adaptability, problem-solving, critical thinking (CT), leadership, and teamwork [11]. Current work focuses on defining these general skills as those that help workers find or keep a job [5].

A graduate’s profile is shaped by the competencies defined in their curriculum. Therefore, it is of the utmost importance to provide a clear and detailed explanation of the skills and outcomes that have been worked on during a degree program. The mobility of students between universities, of graduates in relation to the positions offered, of degrees between countries, as well as remuneration, career progression, authority, and security of expertise, also depend on the definition of competencies. In addition to being comprehensive, the definition of competencies must be expressed in a standardised manner. Many authors utilise the term “general competencies” as an “umbrella term”, encompassing a multitude of generic competencies, such as communication, group work, problem-solving, creativity, and time management [1]. Other authors provide a simplified definition of general competence as the ability to cope with complex situations. However, this definition is simplistic and does not fully capture the complexity and heterogeneity of the concept [5]. Despite this, there is much debate among different stakeholders (students, employers, and academics) about what general competences are and what their definition and focus on higher education should be [12]. The different general competences, and especially their relevance, depend on the profession or professional sector under analysis [5]. At an Australian university, it was found that arts, engineering, and science programs perceive general competences differently [13]. For arts students, CT and interpersonal relationships were key. For engineering students, problem-solving was the most important competence. In Spain, the definition of competences stems from the “Libro Blanco,” [14] which has its origins in the Tuning Project. However, there has been a lack of study of the general competences developed in higher education, especially in analysing the point of view of the three main stakeholders in the teaching process: teachers, learners, and employers.

The development of general competencies requires enthusiasm from both educators and students. Many teachers are sceptical about their role in the development of general competence in undergraduate students, as they assume that their responsibility is focused on the transmission of discipline-specific knowledge [15], [16] and many others knowledge. Additionally, some educators are resistant to adopting new perspectives to enhance these general competencies [17]. On the contrary, research suggests that students recognise the significance of general competencies and their impact on employability and personal growth. Nevertheless, students often feel that these competencies have not been adequately cultivated during their academic journey [18]. Furthermore, some students perceive the development of these competencies as a futile endeavour that does not contribute to their professional development [19].

It is clear that higher education should focus on competencies that help students cope with their professional and personal lives. However, the authors emphasize the importance of developing not only skills but also knowledge and abilities [20]. Unfortunately, studies show that many recent graduates lack essential skills or the most basic competencies needed for their jobs [7], [21], [22]. Given these circumstances, it is crucial to conduct a comprehensive assessment of the evolution of general competencies within the higher education sector. This study presents the opinions of three primary stakeholder groups (students, educators, and employers)

regarding the development and significance of competencies associated with the ESD at the University of La Laguna.

2 RESEARCH THEORY AND HYPOTHESES

The work is based on the premise that surveys are the quickest way to assess the development of competencies. However, other mechanisms exist, such as career development, but they are time-consuming and difficult to quantify. Some authors propose that competence development is related to improved academic performance, but the relationship is not direct and clear [23]. Therefore, surveys are the quickest and most widely used way. In addition, the questions are considered on the assumption that the work done is not sufficiently evident, which implies a partial recognition of the competence acquired. On the other hand, the survey may be biassed in terms of the perception of the work carried out since it is quite possible that pragmatic or sociolinguistic aspects of linguistic communication are worked on without identifying them as such. It is also possible that digital security issues are being addressed without a label that would make them more perceptible. It may be that we are promoting graphic expression and creativity within the framework of mathematical literacy without appreciating that this is an important enhancement of science, technology, engineering, and mathematics (STEM) competence.

Employer surveys enable an analysis of the level of competence achieved during studies because this stakeholder group is not directly engaged in the learning process. The manuscript's findings presume that educators comprehend the definition of each competency and can evaluate student progress indirectly without introducing substantial bias.

Considering the previous discussion, the aim of this study is to critically analyse the level of development of the general competences of the ESD at the University of La Laguna. The goal is to assess whether there is a need to strengthen certain competences or if, conversely, competences with low relevance are being overemphasized. To achieve this, we tested the following hypotheses: (1) Students and teachers agree on the level of competence development; (2) Employers perceive the same level of competence development as those involved in the training process (students and teachers); and (3) Higher education is in alignment with the competencies required by employers.

3 METHODOLOGY

The analysis of the general competencies of the ESD at the University of La Laguna was conducted through a survey involving three key stakeholders in educating graduates: students, educators, and employers. Participants were selected from a final-year subject of the degree programme, which includes a mandatory practical work placement in companies related to the field. All students enrolled in this subject, as well as participating companies, were invited to take part in the optional survey. Students and employers received an email containing a Google survey, which they could complete if they wished to participate in the research. Additionally, the survey was distributed to all teaching staff involved in the ESD program. Teachers, like other participants, were asked to complete a Google survey if they were interested in taking part. A total of 16 students, 18 educators, and 12 employers participated in

the surveys. The surveys were conducted using Google Forms, with a set of questions enabling an individual analysis of each skill. An open-ended question was included for respondents to mention any other competencies they deemed important but were not listed. It is worth noting that very few respondents answered this question. The questionnaire captured the responses of the surveyed groups on two types of questions: one focused on the work done to acquire competences, and the other on the significance of competences in education and professional growth. The competencies were categorised as general and assigned alphanumeric codes to accompany the descriptors in the reports. These codes were included in the questionnaire along with the descriptors to aid in identification and further analysis. Three separate questionnaires were used: one for students, one for educators, and one for employers. However, the questions in each questionnaire were identical.

The first question allowed for a response using a 5-point Likert scale, where one meant very underdeveloped and five meant very overdeveloped. The second question asked about the importance given; the answer selected the five considered most important from the full list of general competencies of the degree. Both questions were compulsory, and the wording was as follows:

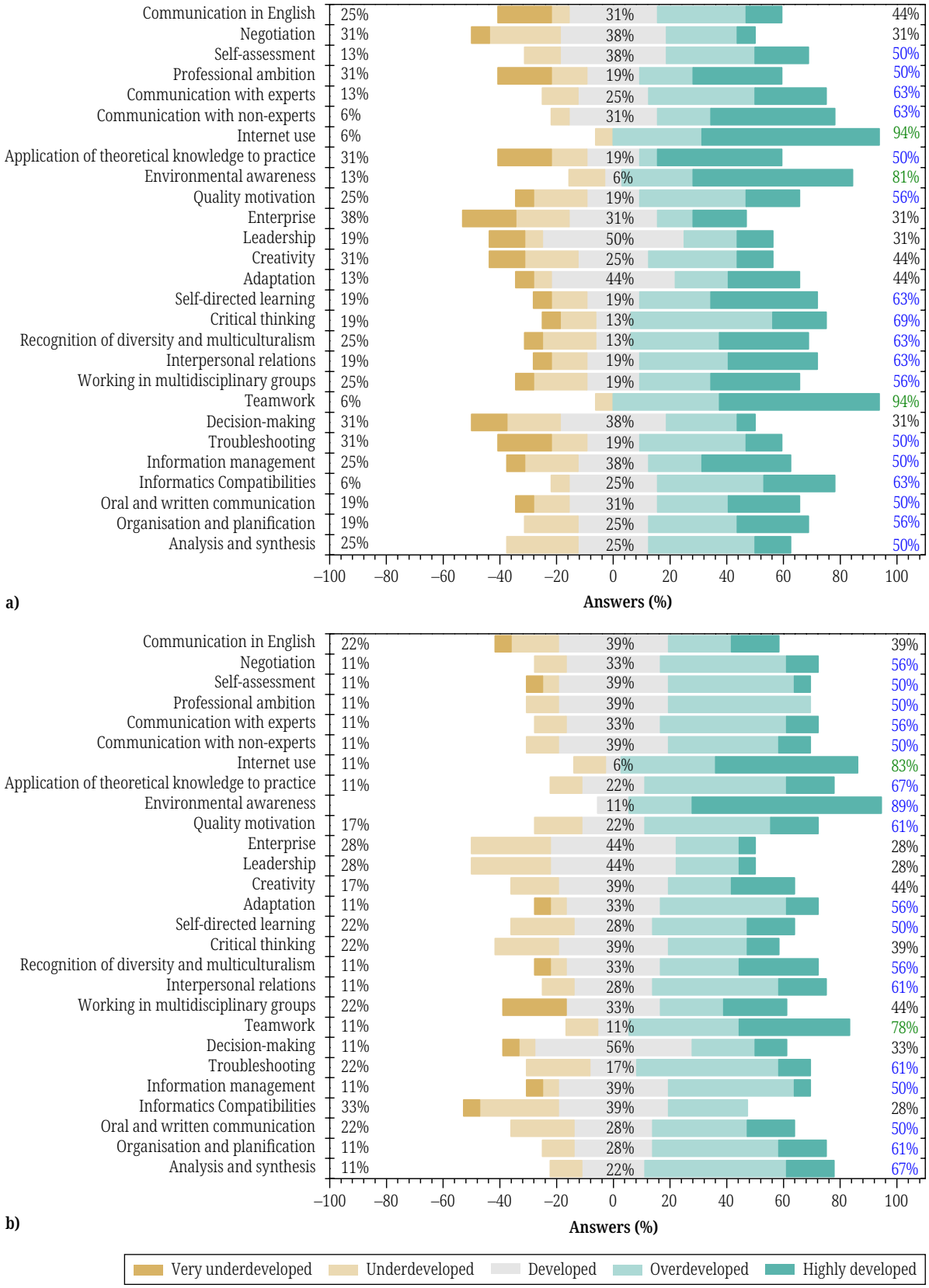
- Perception of the work carried out to acquire general competences in the environmental sciences degree.
- What are the five most important factors for professional development?

Once the collection of responses was completed, the questionnaires were downloaded as a comma-separated text file (CSV) and opened in a spreadsheet with UTF-8 encoding. The actual processing began with summing up the scores given by each respondent for each competency in the question related to the work done by hand and for the question on the importance attached to the competency.

The processing of the information continued with the calculation of percentages and the relative weights of the scores given. Using the data from the work done on each competence, the percentage of each value, ranging from one to five, was calculated as a proportion of the total mark for the competence. Additionally, based on the data regarding the importance assigned, the total number of mentions received by each competence was aggregated. Subsequently, the percentage of this aggregate, representing a single value, was calculated as a proportion of the total number of mentions received by all 27 competences collectively. After transferring the percentages to the value scales of one to five, the work-relevance discrepancy was computed.

4 RESULTS

The first question of the survey inquires about the level of work done to develop students' general skills in the ESD. Most authors evaluate the acquisition of competencies through surveys, while others consider that this approach views students as the analysis of competence development [23]. As a result, the SERVQUAL model, which gauges dissatisfaction levels among various stakeholders in higher education (students, educators, and employers), has been introduced and utilised by multiple authors [24]. Figure 1 displays the survey results from three stakeholder groups regarding the extent of work done in developing general competencies.



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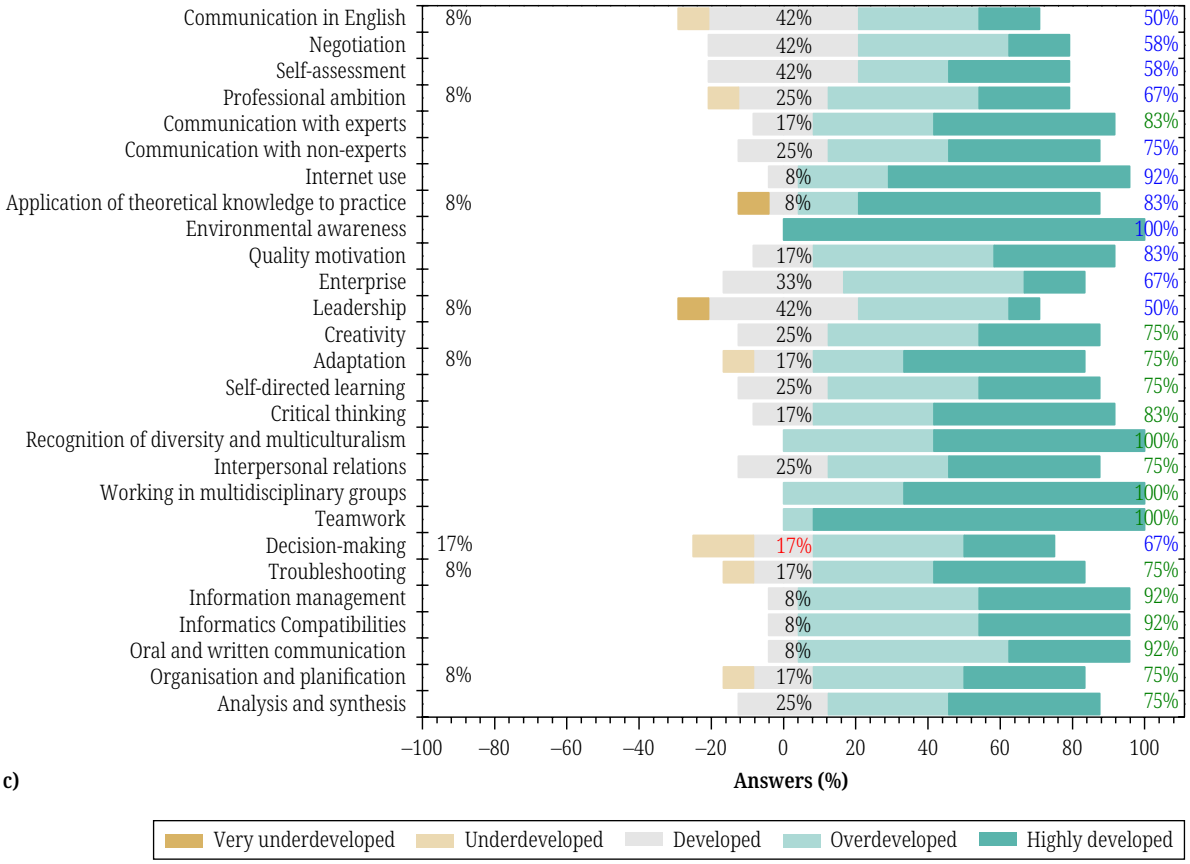


Fig. 1. Perception of the work done by the three groups of stakeholders for each general skill analysed (a, students; b, educators; c, employers)

The results reveal that the various stakeholder groups perceive a moderate-to-high level of work done for the development of most general competencies. Nevertheless, there are some discrepancies among the different stakeholder groups (see Figure 1).

Employers consider that there is a high degree of work involved in developing most general competences, with the majority of responses (>50%) indicating that the work done is overdeveloped or very overdeveloped compared to the results for the other two stakeholder groups. These results contrast with those of other major studies, where students generally rate their skills more positively than employers [25]. Employers observe a moderate or low level of development in competences such as English communication (50%), leadership (50%), negotiation (42%), self-assessment (42%), professional ambition (33%), entrepreneurship (33%), and decision-making (34%). All these competencies can be categorised under “entrepreneurship education” [26]. The other stakeholder groups (students and educators) exhibit similar results for the same competencies. For instance, in decision-making, 67% of educators and 69% of students consider this competence to be moderately or poorly developed. It is also noteworthy that there is a moderate or low level of work being done to develop entrepreneurship and leadership competences according to the other two stakeholder groups (72% for educators and 69% for students).

The second question analyses the relevance of each of the general competencies for each stakeholder group. Table 1 represents, for each group (students,

educators, and employers), the percentage of the population analysed who consider each competence as one of the top five most important for Environmental Science graduates.

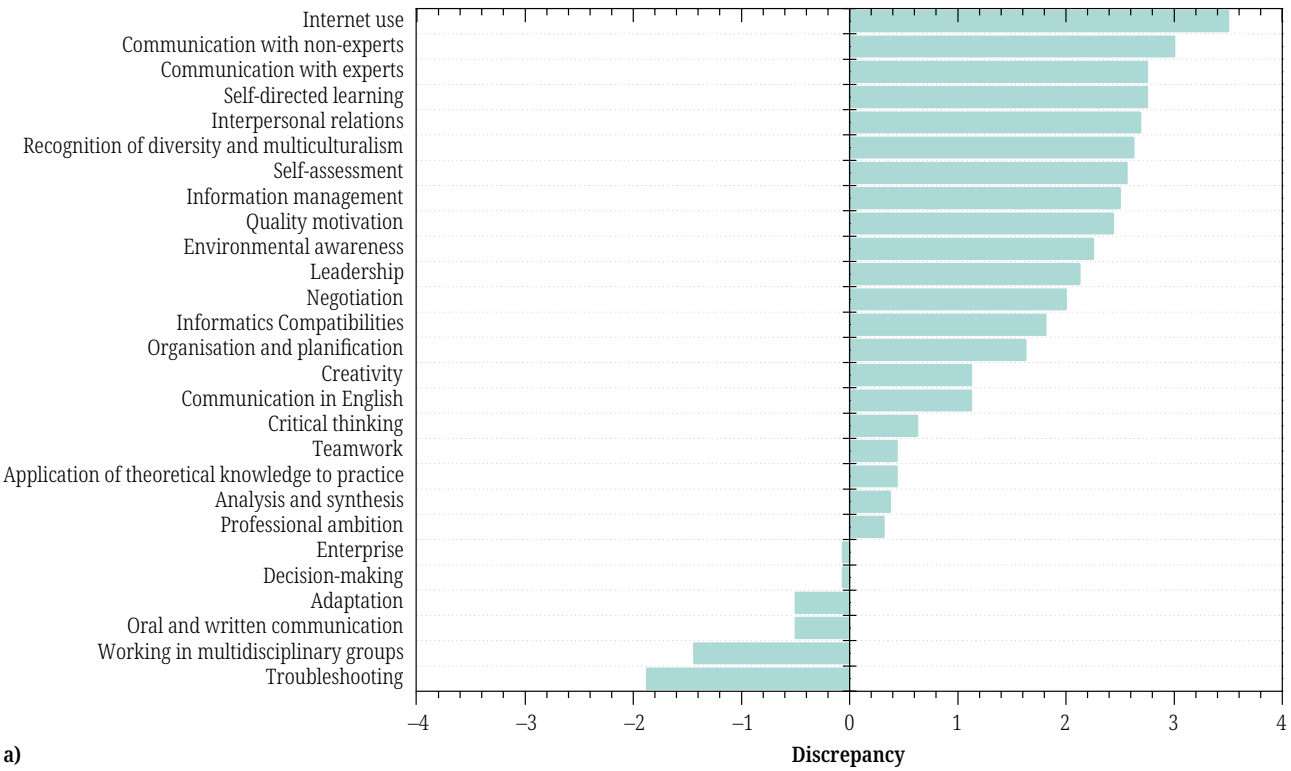
Table 1. Perception of competence relevance of the three groups of stakeholders

Competence	Importance (%)		
	Students	Educator	Employers
Analysis and synthesis	18.75	27.78	33.33
Organisation and planification	12.50	44.44	66.67
Oral and written communication	25.00	38.89	25.00
Informatics Compatibilities	12.50	11.11	0.00
Information management	0.00	11.11	8.33
Troubleshooting	31.25	66.67	58.33
Decision-making	18.75	38.89	16.67
Teamwork	25.00	11.11	33.33
Working in multidisciplinary groups	31.25	44.44	33.33
Interpersonal relations	6.25	0.00	33.33
Recognition of diversity and multiculturalism	6.25	0.00	0.00
Critical thinking	18.75	50.00	16.67
Self-directed learning	0.00	38.89	8.33
Adaptation	25.00	22.22	16.67
Creativity	12.50	5.56	33.33
Leadership	6.25	11.11	8.33
Enterprise	18.75	5.56	25.00
Quality motivation	6.25	16.67	8.33
Environmental awareness	12.50	22.22	0.00
Application of theoretical knowledge to practice	18.75	5.56	16.67
Internet use	6.25	0.00	8.33
Communication with non-experts	0.00	11.11	0.00
Communication with experts	0.00	5.56	0.00
Professional ambition	18.75	0.00	8.33
Self-assessment	0.00	0.00	8.33
Negotiation	6.25	5.56	0.00
Communication in English	12.50	5.56	0.00

The results show two distinct patterns of behaviour. On one hand, students' opinions are not focused on specific competencies; rather, the responses are averaged across different competencies, with none exceeding 35% of responses. The second pattern of behaviour is that educators and employers present a more uniform opinion on the most relevant competencies for environmental science students.

All stakeholders consider troubleshooting to be one of the most important competences, which is in line with the specialised literature and didactic guides on 21st-century skills [9], [27], and [28]. However, for employers and students, other 21st-century skills highlighted by the National Research Council [9], such as CT, are not among the most important but are of intermediate importance. Furthermore, teachers are the most aligned with 21st-century competences, and the majority of respondents agree that the most important competences are adaptability, self-learning, CT, working in multidisciplinary groups, decision-making, communication, organisation and planning, and analysis and synthesis. All these competences are considered by the literature to be key competences for environmental sciences [29].

An analysis of the discrepancy between the perceived importance of the work needed and the actual work performed to achieve each competence is a useful comparison. This comparison can be conducted for each stakeholder group. Figure 2 illustrates the extent of the discrepancy between the work done and the importance perceived for each competence and stakeholder group. In the figure, a negative discrepancy value indicates that relevance is higher than the level of work done during the ESD; in other words, these are the points for improvement in the degree program. On the other hand, an excess of positive discrepancy indicates that too much work has been done for the relevance indicated by the participants. The results indicate that, apart from a few exceptions, most competencies have been developed to a high degree, regardless of the importance attributed to them. This is evident in Figure 1. However, some competencies that, according to the survey respondents, have been extensively developed generate a negative discrepancy; in other words, they have been worked on less than the relative importance of the other competencies (see Figure 1).



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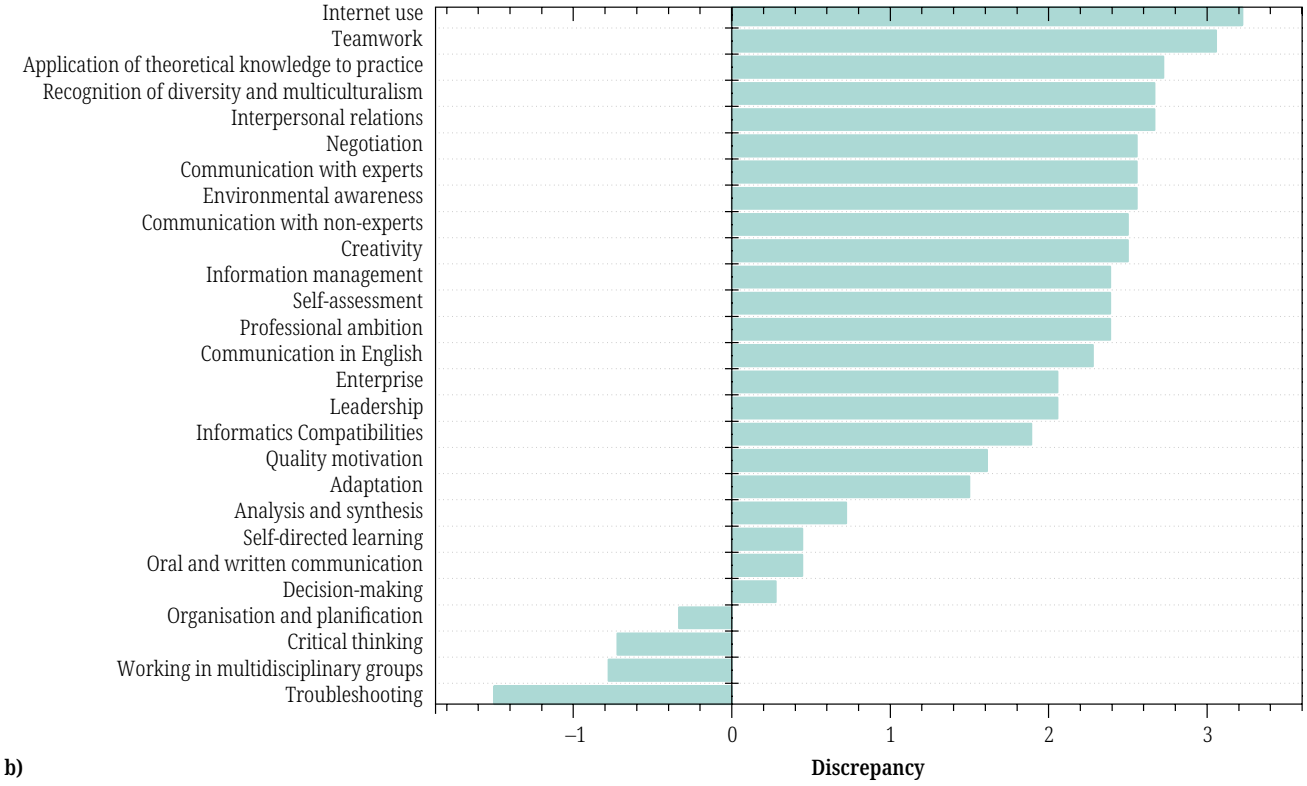

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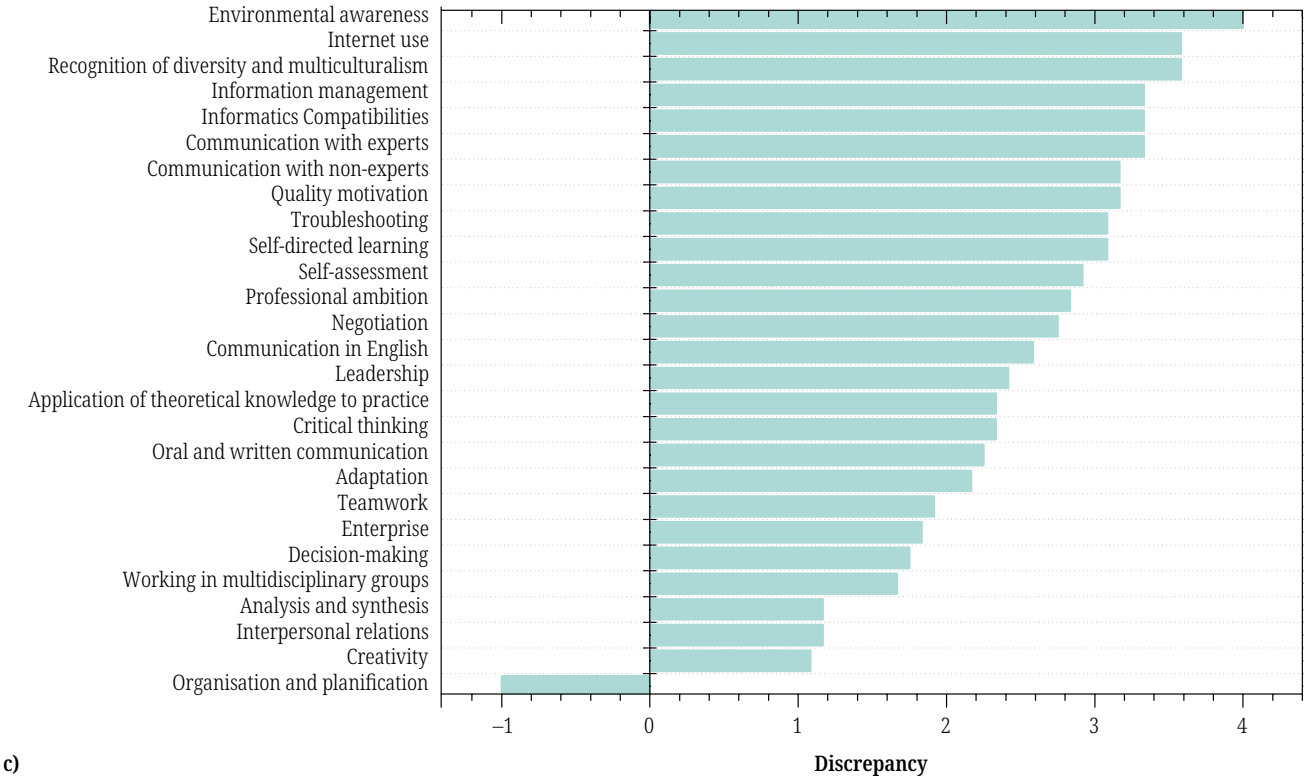

c)

Fig. 2. Work-importance discrepancy analysis (a, students; b, educators; c, employers)

5 DISCUSSION

The growing interest in entrepreneurship and leadership competences over the last decades [10], [11], and the main challenges highlighted in the academic literature and by the United Nations [30] contrast with the results reported in surveys regarding the level of development of students in the ESD (see Figure 1). Therefore, the competences mentioned above should be reinforced through various activities in this degree. Typically, these competencies are most frequently developed in highly entrepreneurial degree programs and remain relatively underdeveloped in science degrees [31]. However, other entrepreneurial competences such as organisation and planning, working in uniform and multidisciplinary groups, or the interpersonal relations necessary for a business environment can be considered key competences in this context [6]. They have been perceived by all three groups as mostly overdeveloped or very overdeveloped.

In the case of the competence of "applying theoretical knowledge to practice", there is a noticeable divergence in the results among the group of employers. While the majority of them indicate a high degree of development, 8% perceive it as very underdeveloped. The same trend is reported for educators (11%). However, students indicate that this competence has been inadequately developed during their learning activities (31%). One of the primary challenges facing the contemporary higher education system is the interconnection of concepts and the application of theoretical knowledge to practice [32]. It is not only a matter of educators reinforcing knowledge or developing skills but also of students being able to interrelate concepts and apply what they have learned to the "real world" [8]. The greatest discrepancy between work and importance in the student survey results is problem-solving, which coincides with the educators' responses (see Figure 2). As already mentioned, this competence is key to students' professional and personal development [3]. In this sense, it is key that educators begin to introduce teaching strategies such as problem-based learning [33] or flipped classrooms [34], where the teacher acts as a learning guide and the active participation of students encourages the development of competence in applying theoretical knowledge to practice [35]. These methodologies reinforce the connections between theory and the real world, favouring the competence of CT, which should also be strengthened in view of the discrepancy in the results of the group of teachers (see Figure 2). CT can be enhanced by collaborative learning methodologies or by drawing analogies between learning and the real world [9]. In this sense, the degree in environmental sciences presents a wide range of practical hours where students should develop this competence [36]. However, most practical classes have predefined scripts, which hinder the development and enhancement of applying knowledge to practice [33]. In alignment with the above descriptions, students exhibit less proficiency in problem-solving, analysis, and synthesis than indicated by the other two stakeholder groups. The development of this skill is complex from the educator's point of view, as the didactic activities that promote the development of these competences, such as problem-based learning, imply student motivation and involvement. Despite the implementation of these methodologies, studies have indicated that the development of problem-solving and knowledge application competencies has not been achieved. Nevertheless, the same methodology has proven to be highly effective in other comparable contexts [27]. Conversely, some competence activities are currently utilised within the Environmental Science degree programme, yet students may not perceive that they are developing them in an appropriate way. The opinion of the students regarding

the work carried out to achieve CT competence allows us to demonstrate the above hypothesis. The definition of CT is complex and open to debate [37]. However, the result of a Delphi project defines it as "purposeful, self-regulatory judgment which results in interpretation, analysis, evaluation, and inference, as well as an explanation of the evidential, conceptual, methodological, criteriological, and contextual considerations upon which that judgement is based" [37]. Evidently, teaching activities that allow the development of problem solving, and the application of knowledge necessitate the enhancement of CT skills, as they pursue "thinking outside the box" [38]. Therefore, it is debatable whether the claim that CT has been excessively developed or very overdeveloped (69%) is a valid conclusion. On the contrary, educators argue that this skill should undergo more intensive development, yielding results comparable to those seen in the other two competencies. For employers, the most important skills are organisation and planning, as well as other skills such as entrepreneurship, creativity, teamwork, communication, and the ability to analyse and synthesise information (refer to Table 1). These competencies are all linked to management activities, which are crucial skills sought after in job searches. A recent study [39] examines the most utilised competencies on the LinkedIn platform for job searches, with most aligning with the key competencies identified by employers in this survey. The results suggest that a subset of the surveyed students prioritise competencies highly valued by employers, as indicated by their greater interest in entrepreneurship, creativity, teamwork, and interpersonal skills compared to what teachers reported. In contrast, educators tend to be more in line with employers' expectations regarding competencies such as communication, organisation, and planning, as well as the ability to synthesise and analyse information. This aligns with the need to enhance all "interpersonal competencies" [40].

It is pertinent to highlight the fact that students and employers consider environmentally sensitive competences to be of low interest, in contrast to the UN Agenda 2030 or the EU guidelines that underline the importance of sustainability issues [41]. In particular, the GreenComp framework serves to operationalize the Green Pact strategy, highlighting the importance of environmental sensitivity, among other aspects. GreenComp considers four competence areas: embodying sustainability values, embracing the complexity of sustainability, envisioning sustainable futures, and acting for sustainability. Each of these areas is further divided into three distinct competencies. It must be acknowledged that the competencies encompassed by the GreenComp appear to overlap with those addressed in the Recommendation on Key Competences for Lifelong Learning [42]. It is evident that to enhance sustainability and green innovation within a given country or region, it is imperative that new professionals within a given sector are equipped with the requisite environmental awareness skills [43]. The competence of environmental sensitivity may encompass some other competences [43], as stated by other authors, but its encouragement and motivation for environmental science graduates is key.

It is worth noting that the low interest given to skills such as the use of the Internet as a means of communication and as a source of information (in the graph) also deserves comment. In contrast to the students' opinion, the Digital Education Action Plan 2018–2020 [44] should be taken into account because of its relevance for all levels of education. It is considered a trigger for the European Education Area, the European Social Pillar Action Plan, and the 2030 Digital Compass. In other words, the entire digital spectrum is a priority for the European Commission. In particular, the DigCom framework, which directly affects the realisation of learning by serving as a reference for design and assessment, envisions two competence areas out of five that can be directly connected to digital skills. The DigComEdu framework also

emphasises the importance of digital skills for those who may become teachers at the relevant postgraduate level; in Spain [45], it updates the reference framework for digital competence in teaching with the aim of improving the quality of the education system and ensuring equity. In this sense, all [2]. However, the descriptor of this competence is somewhat ingrained in the new generations who have been born into the digital world, and the use of a tool such as the Internet is taken for granted and does not need to be emphasised as much in higher education. The competence of group work generates a discrepancy in results since teachers consider that it has been overemphasised compared to its importance (refer to Table 1); however, students consider this discrepancy minor since this stakeholder group gives it higher relevance. Another competence that should have increased focus in the degree due to the discrepancy and the high relevance given to it by all stakeholders is the work in multidisciplinary groups (see Figure 2). It should be noted that the degree has a system of work placements in companies that is compulsory for all students and where this competence is promoted; however, this workload may be too low to fully develop this skill.

6 CONCLUSIONS

According to the results, most competencies have been adequately developed across all three stakeholder groups. However, employers have indicated that the level of effort required to attain these competencies is greater than what students and educators report having been done. Employers' emphasise the need for further development in "entrepreneurial skills" such as communication, leadership, negotiation, entrepreneurship, and decision-making. The opinions of students and educators are not entirely consistent with those of the employer group. Nevertheless, students have indicated that the emphasis on the application of theoretical knowledge in practice should be increased. While educators' prioritise 21st-century skills such as CT, problem-solving and adaptation, on the other hand, contrary to official organisations' emphasis, students perceive digital competences and environmental awareness as less important compared to other general competencies. It is also recommended that problem-solving and CT competencies be reinforced in accordance with the findings of the discrepancy in perceived importance between work and education, as revealed in the surveys of teachers and students. Obviously, the results are applicable to the specific case of the ESD at the university analysed. However, they do allow us to identify the discrepancies that can arise between educators, students, and employers about the key competencies that should be broadly developed during university degrees. Finally, it is necessary to increase the presence of active methodologies that improve key competencies, such as CT and problem-solving.

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