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Undergraduate students' perceptions of the development of generic competences and their relevance to the engineering profession

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Generic competences are essential for engineers' career advancement. However, different approaches for managing these competences across educational programmes in engineering exist. Our research aimed to explore the perceptions of undergraduate naval-engineering students enrolled in an elective leadership subject of the most relevant generic competences in the engineering profession. This study also identified their perceptions of developments and areas needing improvement. Applying the inductive method, the study was conducted through a content analysis of 63 portfolios used by undergraduate students at a polytechnic Spanish university. The findings conveyed that 'collaborating and teamworking' and 'managing and leading' were the most relevant groups of generic competences identified as important for career development. To enhance generic competence training in engineering education, our results propose an integrative perspective of these as a framework. The results reinforce the call for a better understanding of generic competences and metacognitive and conative endurances, supporting a more personalised integration of a holistic view of educational programmes in engineering.

Keywords: student perception; assessment; generic competences; engineering education; portfolio; leadership/management

Introduction

Several studies of engineering education have applied portfolio practices to help students develop key skills and competences in engineering design (Alha, 2004), knowledge management (Lockledge & Weinmann, 2001), and personal reflection and career planning (Campbell & Schmidt, 2005). The use of portfolio practices allows self-constructed learning and is intended to give engineering students effective engineering as well as interpersonal

skills (Yueh, 2013, p. 100). Likewise, Hartmann et al. (2017) recognised that understanding the order of importance of generic competences benefits engineering leadership educators, whose aim is to better prepare students for industry. Self-assessment allows students to evaluate their own learning, particularly their achievements and their results (González-Betancor et al., 2017). Moreover, participating in assessment helps students develop skills that are in the development of highly valued skills in the labour market, such as a critical attitude towards their work (Moreno-Murcia et al., 2014). However, students' self-assessment of the development of their skills may be deficient (Taras, 2010) and require the application of more-appropriate methods for evaluating their own learning (Besterfield-Sacre et al., 2007).

The main goal of this study is to gain greater knowledge about the importance of generic competences in the engineering education environment, linking the study of these competences with the development of portfolio practice (Paulson et al., 1991). As a method that enables students to present evidence and justification for their self-assessment, the portfolio is used to avoid shortcomings in self-assessment methods (Besterfield-Sacre et al., 2007).

This study design is based on a content analysis of reflective portfolios (Smith & Tillema, 2010) that naval-engineering students enrolled in an elective leadership and managerial skills course produced in the last two years of their studies. The reflective portfolio integrates students' self-assessments concerning generic competences and provides evidence of their recognition of accomplishments and awareness of improvements in terms of identified deficiencies or shortcomings.

Literature review

Perspectives on defining generic competences and their importance in higher education

Various conceptualisations or labels are used to define generic competences. The most common definitions refer to basic, cross-disciplinary, holistic, key or transferable skills (and, or attributes or competences), employability skills, or 21st century competences (Carter et al., 2019; Jääskelä et al., 2016; van Laar, van Deursen et al., 2017). However, Tight (2020) highlighted that these different conceptualisations can be considered alternative labels, where the contents are essentially similar.

Several studies have investigated the understanding of the development of generic competences in active learning environments (Groen et al., 2020), university students' perceptions of the acquisition of generic competences (Olmedo-Torre et al., 2016), or the importance of developing the affective and emotional dimension of generic competences (Montalvo-Garcia et al., 2021). In the European context, the Tuning Model (González & Wagenaar, 2003) grouped the main generic competences into instrumental, interpersonal and systemic categories. This model was later adopted in Spain by the Spanish National Agency for Quality Assessment and Accreditation (ANECA, 2021), and under this framework, each Spanish university adopted these competences when defining its study plans. Both the literature and the regulatory models highlight the importance of competency-based learning in the European Higher Education Area (EHEA) for developing a curriculum (Rauhvargers, 2010).

Generic competences in engineering education

Integrating generic competences into the curriculum poses challenges for engineering education. Therefore, competences of socially responsible professionals (Chan et al., 2017), customer centricity, ethical decision-making and behaviour, teamwork and adapting to change should be considered (Meier et al., 2000). From the perspective of graduates, academic study plans should focus on improving students' decision-making, problem-solving, and management skills (Riu et al., 2020). Moreover, personal attributes and behaviours are

becoming increasingly important and decisive hiring factors for a career in engineering (Lappalainen, 2011). Likewise, a multidisciplinary approach to technical and non-technical fields has also become even more relevant in higher education (Rhee et al., 2013).

The literature provides different perspectives on the analysis of the generic competences of engineering undergraduates and young professionals. For instance, the characteristics of an effective engineer are linked with the ability to work well under pressure, leadership skills and interpersonal abilities, among others (Newport & Elms, 1997). Some authors agree on the relevance of generic competences for engineers, such as problem-solving, creative thinking and adaptation, communication and listening skills, teamwork, innovation and motivation, as well as professional attitudes and business, technical and expanding skills (Archanjo de Souza et al., 2020; Male et al., 2011; Passow & Passow, 2017; Suleiman & Abahre, 2020). However, skills such as professional and ethical responsibility were perceived as less relevant for students compared to teamwork, oral communication, critical thinking, problem-solving and self-management (Chan & Fong, 2018).

Specific studies on leadership as a generic competency have explored leadership development as a collaborative and relational process focusing on critical social perspectives (Dugan & Humbles, 2018). As cornerstones of exceptional leadership (Collins, 2001), a range of broad (Cooper et al., 2007) and specific attributes exists, such as humility and professional will. Emotional intelligence exerts a significant impact on leadership efficacy (Goleman et al., 2002) and is a distinguishing aspect of successful leaders (VanderPal, 2014). In engineering training, social-emotional competences are identified as important (Chisholm, 2010), and emotional intelligence partially mediates in the relationship between employability skills and employer satisfaction (Kumar et al., 2019). In addition, it has an impact on student performance (Fakhar et al., 2019). Boyatzis et al. (2017) differentiated between technical skills and social and emotional skills to predict how engineers could be more effective,

although they acknowledge that the debate about the exact nature of emotional intelligence is ongoing. Other authors have asserted that emotional competences can be understood as the practical application of emotional intelligence (Huezo-Ponce et al., 2020; Cherniss, 2010).

The literature does not provide information about standard frameworks, resulting in divergent and convergent results. Therefore, we aim to explore an integrative overview of the development of competences and gaps in students' perspectives in a specific engineering field.

Portfolios as a reflective learning tool

Meeus et al. (2006) identified two types of portfolios used in higher education. One has as its purpose the acquisition of specific, profession-related competences; the purpose of the other is learning competences (e.g. the ability to work independently, to plan, to reflect, to modify behaviour, etc.). Learning competency plays a vital role in professional development pursued immediately following graduation (Elliott, 2003). In this vein, several studies have identified more competence-oriented educational formats and assessment tools emerging in higher education courses (Baas et al. 2019). Regarding assessment tools, Porter and Cleland (1995) defined portfolios as 'a collection of artifacts accompanied by a reflective narrative that not only helps the learner to understand and extend learning but also invites the reader of the portfolio to gain insight about learning and the learner' (p. 154). Different types of portfolios (Cole et al., 2000) share three core elements: collection, selection and reflection (Hamp-Lyons & Condon, 2000).

This study focuses on the reflective portfolio and the personal development portfolio. The reflective portfolio is a collected array of work providing evidence of growth and accomplishments to be put forward for promotion and admission to graduate programmes. The personal development portfolio represents a self-appraisal with the

inclusion of an action plan (Smith & Tillema, 2010). Regarding the relationship of the use of the portfolio tool to the development of metacognitive competences, metacognition is driven by planning, monitoring and organising (Zimmerman, 2002). Evaluation using the portfolio allows students to reflect on their own learning process, which influences the construction of basic metacognitive skills (Meyer et al., 2010). The portfolio serves to support learning and validate student learning outcomes (Roegiers, 2011), and it encourages learning improvement solutions (Popescu-Mitroia et al., 2015). Metacognition is also related to the pedagogy of integration (Peyser et al., 2006), which allows the student to make sense of the learning process by integrating and associating the elements learned. Thus, as a learning medium, the portfolio is intended to record learning performance through four aspects: cognitive endurance (fostered by assignments completed); metacognitive endurance (fostered by considerations of the assignments); affectional endurance (fostered by the student's original achievements); and conative endurance (fostered by indications for how to eliminate or reduce specific deficiencies or shortcomings) (De Ketele & Roegiers, 2009; De Ketele (1993 cited in Frunză et al., 2008, p.38).

The affective, cognitive and conative modes of mental functioning are considered interactive elements in human intelligence and personality (Snow et al., 1996). Affection is related to feelings, emotions, mood and temperament, while cognition involves the strategies one uses to link concepts and skills to apply knowledge (Kurczewska et al., 2017). Conation is subdivided into motivation (one's orientation to internal and external goals) and volition (perseverance and the will to learn, among other characteristics) (Ruohotie & Koiranen, 2000). The constructs of metacognition, meta-affection, and metaconation illustrate the dynamics of the learning process and represent a student's competences for reflecting on his or her learning and, consequently, changing or improving it (Kurczewska et al., 2017).

Finally, the concept of endurance has been studied as an element of personality (Direito et al., 2019). Murray's theory (2007) defined endurance as 'the protensity of a behavioral trend. This includes "power of endurance", persistence and conative perseveration' (p. 148). Indeed, within their personality test, Costa and McCrae (1998) defined the personality trait of conscientiousness as the sum of facet scales labelled Competence, Order, Dutifulness, Achievement Striving, Self-Discipline, and Deliberation (p. 120). Costa and McCrae (1998) found an association between their definition of conscientiousness as a personality trait and needs for Achievement and Endurance as defined by Murray (2007). These traits are equivalent to the definition of grit by Duckworth et al. (2007), which is related to working arduously to cope with challenges and maintaining one's effort and interest for long periods despite failure and adversity (p. 1087). For Binder (1996), endurance pursues a performance goal, in addition to retention, which is identified in the learning stage as related to maintenance.

Thus, for the purpose of this study, we use the concepts of metacognition and conation combined with endurance. The reason is that, in developing their portfolios, students are asked to present evidence for their achievements by individually reflecting upon an action plan to address the improvements needed. This process of reflection on the retention of what has been learned contemplates aspects of metacognition and conation as well as the will to continue learning about certain aspects. In this sense, the use of the portfolio tool seeks to facilitate the student's reflection process, or states of conscience (Conscientiousness), which are related to the student's motivation to improve her or his progress. Through reflection using the portfolio, the student identifies an action plan regarding the aspects that motivate or those that require improvement.

Furthermore, exploring students' perceived competences in generic competences could include direct measures such as a portfolio or standardised test scores (Chan et al.,

2017). In this vein, Leighton (2019) noted that, in order to help students learn, there is a need to balance an external, instructionally relevant assessment process with an internal, psychologically relevant process. For Leighton (2019), this integration of the processes of diagnosing, learning and making proposals to improve learning is defined as 'getting the learning right' (p. 811).

As such, this study delves into the reflective thinking of engineering students enrolled in an elective leadership course. The focus is the learning process conducted in a leadership training course as expressed in their written reflective and personal development portfolios. Specifically, we sought to address the following research questions:

RQ1: Which generic competences do undergraduate naval-engineering students enrolled in an elective leadership course consider most important for their professional career development?

RQ2: Based on self-assessment, what perceptions do undergraduate naval-engineering students enrolled in an elective leadership course have about metacognition and the conation of their development of generic competences?

Method

Study context, participation and sample

University education in Spain is divided into three cycles: bachelor's, master's and doctoral degrees. The bachelor's degree is expected to take four years (Organic Law for the Improvement of the Quality of Education – LOMCE, 2013). This study was conducted with third- and fourth-year undergraduate naval-engineering students enrolled in an elective course on leadership skills at a Spanish technical university. The elective course is a module of 60 face-to-face hours with two weekly sessions. The subject course plan includes 12 content modules related to managerial skills. Assessment activities included individual reflective and personal development portfolios (40%), group projects (45%) and individual

tasks (15%).

At the beginning of the academic year, the students were presented with the subject course plan and the guide for implementing the portfolios. The definition of the concept of generic competences was explained to students within the framework of the Tuning Model (González & Wagenaar, 2003). The guide for the development of the portfolio sets out basic elements that the student should consider. These include reflections on their understanding of managerial skills and related competences, which competences they perceived to be most important for their profession (RQ1), which competences they believed they had developed by the end of the course, and what proposals they had for improving these based on their self-assessment (RQ2). The students did not have a predetermined list of generic competences to assess. Thus, to develop the portfolio, they were asked to (i) conduct further research on generic competences, (ii) select and include activities conducted throughout the course, (iii) assess their learning based on these, (iv) assess their generic competences, (v) conduct SWOT and TOWS analyses (Helms & Nixon, 2010), and (vi) draft an action plan for the maintenance and further improvement of the assessed competences.

Over three academic years (2017, 2018, 2019) 74 students were enrolled. Of these students, 83.8% were enrolled in the fourth year, and 14.9% were women. The sample included students between 23 and 28 years of age with three to six years of work experience, which raises the mean. It should be noted that the students were asked only whether they had work experience—not necessarily experience related to their field of study. We excluded undergraduate students who did not submit the portfolio activity at the end of each academic term. The total final sample comprised 63 undergraduate students. Table 1 describes participants' general profiles. Due to participants' differences in regard to sex, nationality, age and work experience, we chose not to analyse the data based on different profiles in order to avoid a lack of case representativeness.

Table 1. Description of the general profile of the final sample

	Profile of participants
Number of undergraduate students	63
Sex	11 females/52 males
Average work experience (years)	2.8
Average age	23.2
Academic cycle	7 (3rd year)/56 (4th year)
Nationality	Spain 57, Morocco 2, Italy 1, Brazil 1, Colombia 1

Data collection and analysis

The study employed a qualitative research design (Conger, 1998) based on document content analysis (Silverman, 2006). This allowed an exploration of the perceptions of students enrolled in an elective leadership course regarding the importance of generic competences for their professional careers and the perception of their development of these competences based on self-assessment. The method adopted for this study was to gather cumulative student portfolios over the 2017, 2018 and 2019 academic years. The purpose of the research was explained to the students, and their written consent was requested. Participants' anonymity and confidentiality were preserved by not revealing their names and identities in the collection of data from the portfolios, in the content analysis or in the report on the study's results.

In the content analysis, we avoided using preconceived categories for the inductive approach to analysing the data, instead allowing categories and their labels to flow from the data (Elo & Kyngäs, 2008; Hsieh & Shannon, 2005). We used the QSR Atlas.ti computer-assisted qualitative data analysis software to manage and inductively code the data (Sabariego-Puig, 2014). It should be noted that, in the inductive method, when data are used as a basis for generalising, inferences are always inductive, and unlike deduction, inductive

conclusions contain statements that are not reaffirmations of existing knowledge and premises (Ketokivi & Mantere, 2010). In the deductive approach, observation is guided by theory and, thereby, observations are selected based on their relevance to the theory being tested. By contrast, in the interpretive induction process, the researcher plays an active, deliberate role in the organisation and assignment of meaning to data and tackles a problem from the perspective of theoretical sensitivity to existing concepts, ideas and theories, without direct use of these theories (Kuczynski & Daly, 2003; Blumer, 1986). Therefore, on a practical level, one of the ways in which interpretive induction is applied is through the use of theoretical sensitivity. Rooted in the tradition of grounded theory, theoretical sensitivity implies taking stock of personal and professional experience, the existing research literature, and the relevant theoretical concepts and perspectives (Strauss & Corbin, 1990). Hence, the proposed method is not based on analysing and grouping data from a pre-existing categorisation of generic competences. Instead, it uses theoretical sensitivity to observe, identify and analyse how the students discussed and related the generic competences in their reflections on their profession by means of a process of metacognition and metaconation in the use of the portfolio.

The process of inductive analysis comprises different phases: (i) selecting the unit of analysis, (ii) making sense of the data, (iii) open coding, (iv) developing a coding sheet, (v) grouping codes, (vi) carrying out categorisation, and (vii) applying the abstraction process and developing a conceptual map of categories. These steps allow researchers to discuss the results in light of the existing theoretical basis (Elo & Kyngäs, 2008; Hsieh & Shannon, 2005; Silverman, 2006).

Following these seven phases, the analysis began with both researchers reading all the data (text data from 63 portfolios) repeatedly to achieve immersion and acquire a sense of the whole. This was followed by an initial analysis by each researcher approaching the

texts by taking notes and labelling for codes related to each research question, which became the initial coding scheme (Tesch, 1990). This initial analysis of open coding was applied to five portfolios from each group of years (15 portfolios in all 2017, 2018 and 2019) that comprised the cross-sectional data. Throughout the analysis process, care was taken to ensure validity and reliability (Silverman, 2006). Issues pertaining to reliability were addressed via independent analysis by both researchers, leading to discussion and, eventually, consensus regarding the map of categories. Using the constant comparative method (Silverman, 2006), we ensured validity by beginning the analysis with a relatively small amount of data, generating a set of categories, testing emerging categories linked to the two research questions, and then moving on to the larger dataset. Overall agreement between coders was 90.21% (McHugh, 2012).

After this initial analysis, preliminary codes were established (drafting a coding sheet). We then coded the remaining portfolio text data (and recoded the original data) using the coding sheet and adding new codes when we encountered codes that did not correspond to existing ones (Hsieh & Shannon, 2005). The next step was to sort the initial coding into categories based on how different codes were related and linked. We used these emergent categories to organise and group codes into meaningful clusters as main categories that were then linked to the research questions (Patton, 2015). When organising and grouping codes, we conducted an abstraction process (Elo & Kyngäs, 2008) whereby each category was labelled using content-characteristics words. Then, subcategories with similar topics were grouped together under the overall categories, and these were grouped as main categories.

For the coding process related to RQ1, we coded the texts by searching for those generic competences that students considered important for their professional career development. For example, a search was conducted for mentions of competences of an analytical, cooperative, decision-making nature, among others, which the students indicated

as significant for practicing their profession. For the coding process related to RQ2, we searched for comments regarding students' perceptions about the development of their generic competences, as well as mentions of the recognition of possible shortcomings in their development and their proposals for improvement. We particularly looked for any new competences that might be emerging that would change or complement the competences explored in RQ1.

Similarly, we sought to directly compare how the categories might appear among the documents. The frequency of the categories related to the competences and, thereby, linked to the research questions was verified in all the documents by grouping the analysed portfolios (Sabariego-Puig et al., 2014). This grouping allowed us to select the frequency with which the groups of codes appear in the set of portfolios (Chávez & Yamamoto, 2014), as presented in Table 3. Thus, the total percentage of the frequency of the categories is presented.

Finally, an analysis of the co-occurrence of the categories and subcategories was conducted to identify any possible relationships between the competences cited by the students, using network analysis in Atlas.ti (Sabariego-Puig et al., 2014). To describe the results, we focus on the co-occurrences of the competences of the general categories that had a greater number of mentions by students.

The inductive analysis phases resulted in the design of a map of categories that is used to report the results (see Table 2).

Table 2. Map of categories

RQs	Main category	Overall category	Number of subcategories*
1. Which generic competences do undergraduate naval-engineering students enrolled in an elective leadership	Most important generic competences for naval-engineer	Managing and leading	11
		Collaboration and teamworking	15

course consider most important for their professional career development?	career development	Personal attributes	18
		Analytical	11
		Emotional	5
		Creation process	6
		Business-related	7
		Engineering field relevant	5
2. Based on self-assessment, what perceptions do undergraduate naval-engineering students enrolled in an elective leadership course have about metacognition and the conation of their development of generic competences?	Metacognitive endurance (recognising the development of competences)	Managing and leading	9
		Personal attributes	7
		Analytical	5
		Emotional	4
		Collaboration and teamworking	12
		Creation process	4
		Business-related	2
	Conative endurance (recognising needs for improvements)	Managing and leading	4
		Personal attributes	11
		Analytical	1
		Emotional skills	5
		Collaboration and teamworking	8
		Creation process	7
		Business-related	1

Note: *These categories are described in Table 3.

Results

The importance of generic competences in the engineering profession

To answer RQ1 and RQ2, we present Table 3, which displays the subcategories for each set of overall categories. Regarding RQ1, of the total number of portfolios, the general categories most mentioned by the students were collaboration and teamworking (26.4%) and managing and leading (25.3%). Analytical competences (11.9%), business-related competences (10.6%), personal attributes (8.7%), and creation-process competences (8.2%) comprise the second group of categories, which appeared less frequently in the documents. Finally, even less

frequently mentioned were the categories of emotional competences (4.9%) and competences relevant to the engineering field (4.1%).

Table 3. Overall categories and subcategories based on students' most-valued generic competences in the engineering profession and self-assessment on the recognition of the development of generic competences and needs for improvement.

Overall categories	**Subcategories***	**(%) F**	**% F in all portfolios**	
			Metacognitive endurance**	**Conative endurance*****
Collaboration and teamworking competences	*Teamworking*	63.5%	9.4%	2.7%
	Communication	48.6%	20.2%	12.1%
	Conflict resolution	39.1%	9.4%	1.4%
	Negotiation	29.7%	8.1%	
	Initiative	9.4%	13.5%	
	Listening ability	8.1%	4.0%	1.4%
	Attitude	6.7%	4.0%	4.0%
	Social skills	4.0%	4.0%	
	Authority and respect	4.0%	4.0%	2.7%
	Ability to compromise	4.0%	5.4%	
	Manage information	2.7%	1.4%	
	Organisation		4.0%	9.4%
	Networking			1.4%
	Others	(each < 2.0%)		
Managing and leading competences	*Leadership style*	55.4%	6.7%	4.0%
	Ability to motivate	40.5%	14.8%	
	Time management	40.5%	5.4%	18.9%
	Ability to delegate	17.5%	5.4%	4.0%
	Adaptability to change	14.8%	21.6%	
	Support and supervision	12.1%	2.7%	
	Talent management	10.8%		
	Interpersonal skills	8.1%	8.1%	
	Persuasion	8.1%	9.4%	
	Stress management	6.7%	5.4%	2.7%
	Adaptation to multicultural environment	1.35%		
Analytical competences	*Problem-solving*	24.3%	5.4%	
	Decision-making	24.3%	5.4%	4.0%
	Self-knowledge	17.5%		

	Diagnostic skills	14.8%		
	Assessment and evaluation	6.7%		
	Self-criticism	4.0%	8.1%	
	Criticism	2.7%		
	Logical thinking	2.7%	4.%	
	Change and risk management		1.4%	
	Others	(each < 2.0%)		
Business-related competences	*Planning*	41.8%	2.7%	2.7%
	Strategic vision	18.9%	1.4%	
	Management	9.4%		
	Organisational skills	8.1%		
	Implementation	6.7%		
	Conceptual skills	4.0%		
	Executive skills	1.3%		
Personal attributes	*Responsibility*	10.8%	22.9%	
	Security	10.8%	8.0%	10.8%
	Charisma	8.1%	2.7%	1.4%
	Autonomous learning	6.7%		
	Confidence	5.4%		
	Passion	5.4%		
	Patience	4.0%	2.7%	16.0%
	Concern for personal image	4.0%		
	Concentration capacity	2.7%		12.1%
	Dynamism	2.7%		
	Enthusiasm	2.7%		
	Social responsibility	2.7%		
	Continuous learning and coaching		14.8%	
	Honesty		13.5%	
	Resilience		9.4%	
	Self-demand			12.1%
	Stubborness			8.1%
	Others	(each < 2.0%)		(each < 2.0%)
Creation-process competences	*Creativity*	41.9%	9.4%	4.0%
	Innovation	20.2%	1.4%	1.4%
	Entrepreneurship	4.0%	1.4%	1.4%
	Tolerance of failure		5.5%	2.7%
	Fear of unforeseen changes			8.1%
	Risk-taking			2.7%
	Self-motivation			1.4%
	Others	(each < 2.0%)		
Emotional competences	Self-awareness	25.6%	9.4%	5.4%
	Empathy	8.1%	15.5%	4.0%
	Assertiveness	2.7%		1.4%
	Self-confidence	2.7%	1.4%	1.4%

	Self-control	2.7%	8.1%	1.4%
Engineering field relevant competences	Technical skills	20.2%		
	Financial management	4.0%		
	Digital skills	4.0%		
	Resource management	4.0%		
	Project management	2.7%		

Notes: F = Frequencies; *For RQ2, subcategories are italicised; **recognition of the development of competences; ***recognition of need to improve competences.

In the most-mentioned category (collaboration and teamworking), teamworking (63.5%) and communication (48.6%) were the competences identified most frequently. The analysis of co-occurrence between these competences (see Figure 1) identified that the students related leader communication capacity to their role in promoting group development. Students associated teamworking competences with communication and conflict resolution. Communication competences were directly associated with negotiation and conflict resolution. Leadership style, a competency related to the managing and leading category, appeared as an aspect that helps promote teamworking, and is influenced by the competences of negotiation, communication, and charisma. Leadership style was directly associated with negotiation and influence in conflict resolution capacity. A comment from a student illustrated several of these relations:

> A leader must know how to motivate, delegate, coordinate, appreciate good work by praising it, be consistent with the rules he/she applies, be critical of his/her expectations of work and know how to communicate his/her complaints properly, keep his/her word, as well as be a resource person for the team…

This association between communication, negotiation and charisma is clearly identified in a remark by a student who mentions these aspects as important in exercising leadership:

> …for me, a person's a leader when s/he is able to influence how people think or behave, motivating them…, using different personal attributes such

> as charisma or self-confidence…, as well as the ability to socialise with others…

In addition, students acknowledged that engineers in leadership roles should try to identify group members' individual skills and be able to optimise these competences within the team, as exemplified by this comment:

> A good leader should be able to get the best from any group and also be able to enhance individual team skills in a way that brings them together in order to benefit the group as a whole […].

The second most-mentioned group of subcategories within collaborating and teamworking were the ability to manage conflict (39.1%) and negotiating skills (29.7%) (Figure 1). Moreover, some analytical competences such as problem-solving and decision-making are linked with teamworking, conflict resolution and negotiation capacity. Charisma as a personal attribute was also related to conflict resolution, and creativity appears as an important factor in conflict resolution capacity. Finally, the students directly associated negotiation with financial management capacity, an important aspect in the role of the engineer in project management and the ability to make decisions.

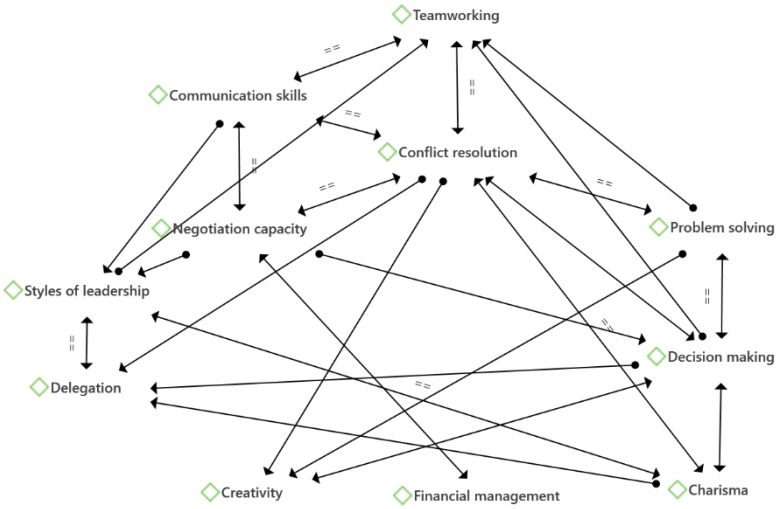

Fig. 1 Network of relationships between the subcategories of collaboration and teamworking competencies

In the second most-mentioned general category (managing and leading), we coded the style of the leader based on mentions of adaptation and the use of personal resources to be able to adapt to the needs of the group and to the context of the project. Leadership style (55.4%) was noted as the most-cited subcategory. The analysis of the co-occurrence of this subcategory (see Figure 2) showed that the students directly relate leadership style with time management, ability to motivate others, delegation skills, and talent management. Some of these relationships are illustrated by this comment:

> The advantage of being a good leader is to be able to develop your personal resources and adapt them to each situation; it also means managing your own and other people's time […].

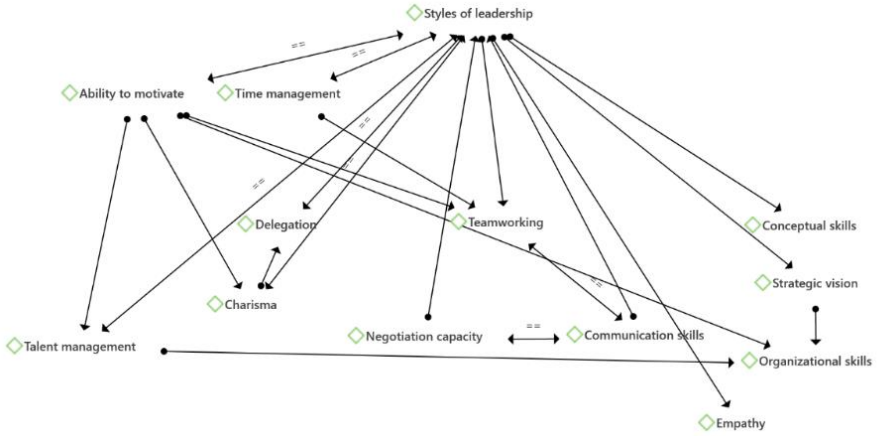

Fig. 2 Network of relationships between the subcategories of managing and leading competences

Indeed, time management was the second group of subcategories most often mentioned by the students (40.5%), together with motivation capacity (40.5%), particularly when keeping up with project objectives. It is mentioned that one of the main challenges for a leader is being able to connect with members of a team and provide sufficient motivation to respond to their deepest needs. This result draws attention to the personal role and style of the leader when ensuring members' engagement.

Regarding the third general category most alluded to by the students (analytical competences), problem-solving (24.3%) and decision-making (24.3%) were the most cited subcategories. The analysis of the co-occurrence of these subcategories (see Figure 3) highlighted that the students directly associate decision-making capacity with problem-solving. Problem-solving is linked directly to conflict resolution and, at the same time, is interdependent with adaptability to change, self-criticism, innovation and creativity. Several of these relationships are exemplified by this remark:

> The management of unforeseen problems is a reality in the field of different engineering projects, and sometimes there are crises that must be solved quickly […]. It also means that decisions should be made, sometimes without much time to work them out as one would like to […].

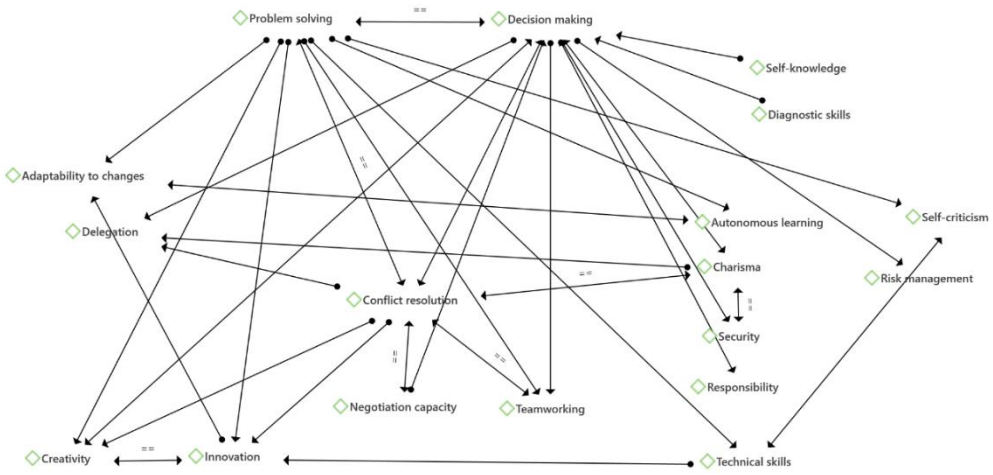

Fig. 3 Network of relationships between the subcategories of analytical competences

Moreover, decision-making depends on the capacity for self-knowledge, diagnostic skills and risk management but was also related to a set of personal attributes (charisma, security and responsibility). Specifically, self-knowledge was reported as necessary for learning to recognise errors and sources of problems, as well as being important for having awareness of the roles that limited knowledge, experience, resources, etc. can play in the performance of certain tasks. Being aware of one's own capacities and being able to reflect

on the different types of knowledge that a professional may have for implementing a solution might enhance analytical processes and decisions. One student's comment entails several of these aspects:

> […] an engineer in my field must know how to analyse the problems that may arise and know how to compare them. In addition, they must have the ability to be self-critical and to think of ways to ensure that such problems cannot arise […].

In the fourth general category that students cited most often (business-related competences), the analysis of co-occurrence (see Figure 4) identified that a leader must know which direction to take with a group, which requires strategic vision and planning. However, being able to plan goals and objectives was associated with knowing how to delegate, convey the corresponding responsibilities, and manage potential problems or conflicts that might arise. The following remark highlights these aspects:

> […] an engineer in my field usually assumes the overall responsibility of a project, which implies the need for great leadership skills, since it will be necessary to know how to direct, most importantly, to plan and delegate tasks to be able to coordinate resources and work within a limited budget and deadlines.

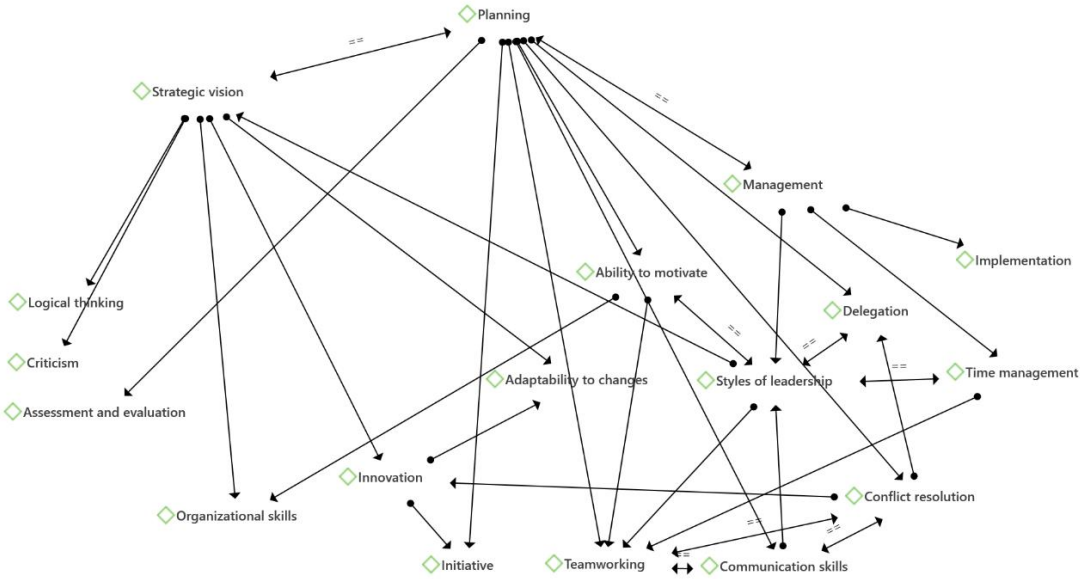

Fig. 4 Network of relationships between the categories of business-related competences.

In the personal attributes category, security (10.8%) and responsibility (10.8%) were the attributes cited most and were associated with decision-making capacity. Security reinforces the ability to connect with the team and achieve objectives, goals and tasks by using a variety of personal tools and was perceived by students as being relevant when convincing others. Responsibility, meanwhile, was linked to the idea of compromise and authority. The following statement sketches out these aspects:

> The leader of a project should be a responsible person who is able to encourage the participation of the members of the group […]. The group should visualise the leader as someone responsible in terms of assuming his/her authority and being punctual when assigning tasks, monitoring, delegating, providing feedback […].

In the *creation-process competences,* most students, when indicating the importance of creativity and innovation, linked these to problem-solving and trial-and-error situations in the process of creating value, as illustrated by this remark:

> […] creativity and innovation are vital for any engineer because an engineer must be resourceful and get solutions to problems by bringing about innovative and revolutionary products that could be translated into added-value for the businesses […]. And this is only achieved through trial and error […].

In the general category of emotional competences, self-awareness was the most relevant, particularly in managing stress, adapting to unforeseen changes, managing time well or performing teamwork. The following comment illustrates these aspects:

> The awareness of oneself and, therefore, the ability to keep our emotions under control, is especially recommended, particularly in order to be able to continually face new working challenges that require an extraordinary capacity to adapt […].

Finally, in the category of *competences relevant to the engineering field,* the students related technical skills to a group of several business-related (planning and conceptual) skills, managing and leading (leadership style), and analytical (self-criticism) competences. The following remark illustrates a few of these relations:

> […] any engineer must have developed technical skills, but the moment that an engineer steps up further in his/her career, he/she must develop human skills to interact with subordinates and superiors, as well as skills that allow him/her to analyse the best way to proceed […].

Students' self-assessment of the development of generic competences

To examine RQ2 (see Table 3), the results are described by grouping students' perceptions about their development of generic competences as (i) metacognitive endurances: perceptions about the recognition of the development of a set of generic competences, and (ii) conative endurances: perceptions about the need for improvement. In regard to metacognitive endurances, the general categories that the students indicated as those

competences they achieved most were collaboration and teamworking (27.2%) and managing and leading (24.7%), followed by personal attributes (22.6%). Emotional competences (11.3%) and analytical competences (7.5%) comprise the second group of competences, pointed out less frequently in the documents. Finally, creation-process competences (5.4%) and business-related competences (1.3%) were mentioned least as competences students had achieved.

Regarding conative endurances, the general categories most indicated by the students as competences needing improvement were personal attributes (38.5%) and collaboration and teamworking (20.0%). On a secondary level, creation process (12.3%) and emotional competences (7.7%) were identified. The last group of competences that students reported as needing further development were analytical (2.3%) and business-related competences (1.5%).

In the general categories of collaboration and teamworking, communication and initiative were the top developments cited by students. The analysis of co-occurrence identified that the perception of communication development was directly associated with the perception of progress in the initiative competences. Specifically, recognition of the development of communication competences was also linked to the improvement in conflict resolution and negotiation skills, as well as to a set of analytical (decision-making), emotional (empathy) and managing and leading (ability to motivate others, leadership styles and persuasion) competences. In turn, the perception of the development of initiative was related to the recognition of achievements in security and responsibility, to collaboration and teamworking (attitude) and managing and leading (ability to motivate other members of the group) competences (see Figure 5).

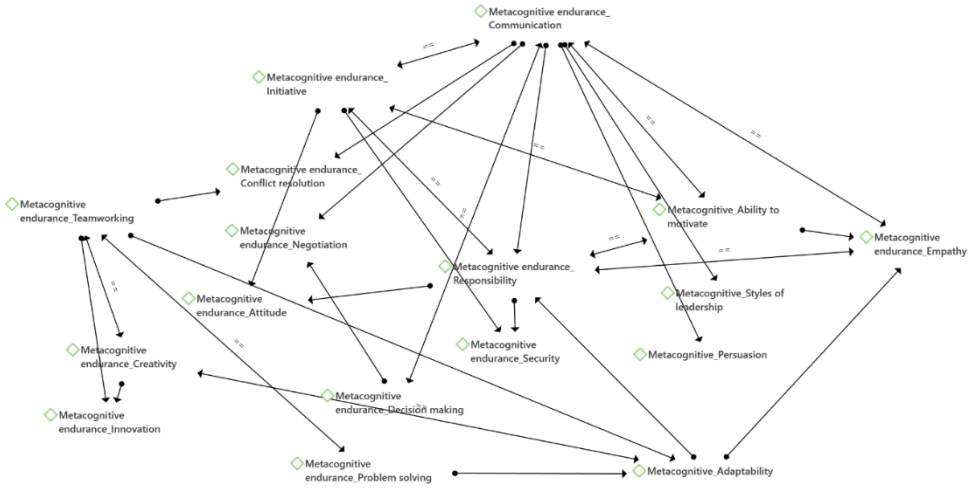

Fig. 5 Network of relationships between the subcategories of metacognitive endurances for the collaborating and teamworking competences group.

In addition, when analysing co-occurrence, the need for improvement in communication was seen as directly associated with an improvement in creativity and was linked to shortcomings in the development of competences such as teamworking, conflict resolution and planning (see Figure 6).

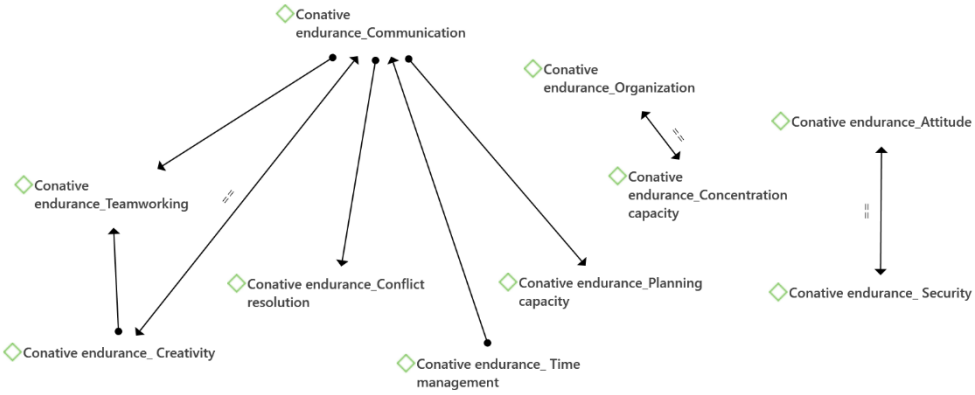

Fig. 6 Network of relationships between the subcategories of conative endurances for the collaborating and teamworking competences.

Organisation was the second most-mentioned competence needing improvement and was also associated with the need to improve the ability to concentrate. Finally, improvement in attitude was related to the need to improve security. Some of these aspects are exemplified by these comments:

I consider myself a person who knows how to express myself, so I would know how to explain myself to others, in terms of what I want them to do or how problems must be dealt with […].

I find it difficult to consider the opinion of others. It is also worth saying that one of the points that I would like to improve more is communication […].

In the second most-reported general category *(managing and leading)*, the students perceived more progress in competences such as adaptability to change and ability to motivate other team members. The analysis of co-occurrences (see Figure 7) revealed that adaptability to change is related to a set of creation-process (creativity and tolerance of failures) competences, emotional (empathy and self-control) competences, and personal attributes such as responsibility and honesty. Several of these associations are illustrated by this comment:

> […] I consider myself a cooperative and participative person, capable of quickly solving any problems that arise. I can adapt quickly to circumstances and improvise.

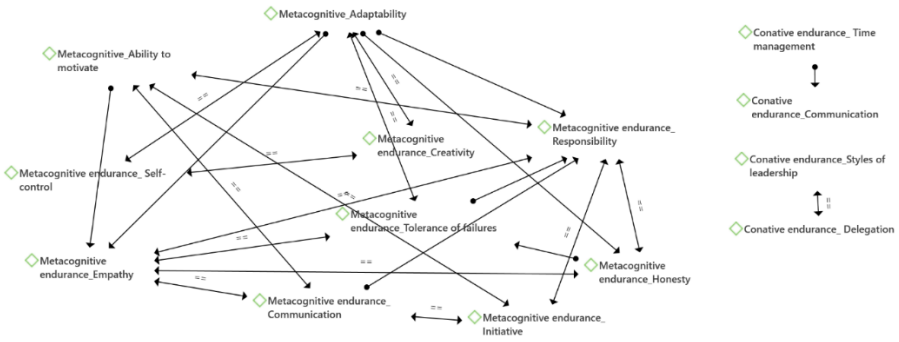

Fig. 7 Network of relationships between the subcategories of metacognitive endurances for the managing and leading competences group.

Furthermore, the ability to motivate others was directly associated with the development of other collaboration and teamworking competences (communication and initiative) as well as with creation-process (empathy) competences and with responsibility.

The following remark embodies some of these relationships:

> […] I think that in exercising different tasks and responsibilities, I am a good communicator; I take responsibility for the management and presentation of the work, I try, through positive messages, to encourage people to participate more […], and I have initiative when making important decisions.

In relation to the perception of needs for improvement, time management was identified as being developed, although it was more frequently perceived as requiring improvement (18.9%), as illustrated by this remark:

> I consider [myself] to have good organising skills, but it is very difficult for me to manage time properly […].

Leadership styles were directly associated with the ability to delegate and also recognised as areas needing improvement, as portrayed by these quotations:

> I have realised that knowing the characteristics of each employee and the leadership style to be applied at all times can increase the performance and effectiveness of the project while the group is consolidating.

> I don't consider myself a good leader, and it's hard for me to delegate work, so I haven't had many good experiences in the group activities conducted […].

In the third group of most-mentioned general categories (personal attributes), responsibility was perceived as the one that students achieved to the greatest degree. The study of co-occurrence associated responsibility with the development of honesty and also security. The achievement of improvements in responsibility was also linked to the development of other competences of collaboration and teamworking (attitude, initiative and communication), managing and leading (ability to motivate others and adaptability to change), and emotional (empathy) competences (see Figure 8).

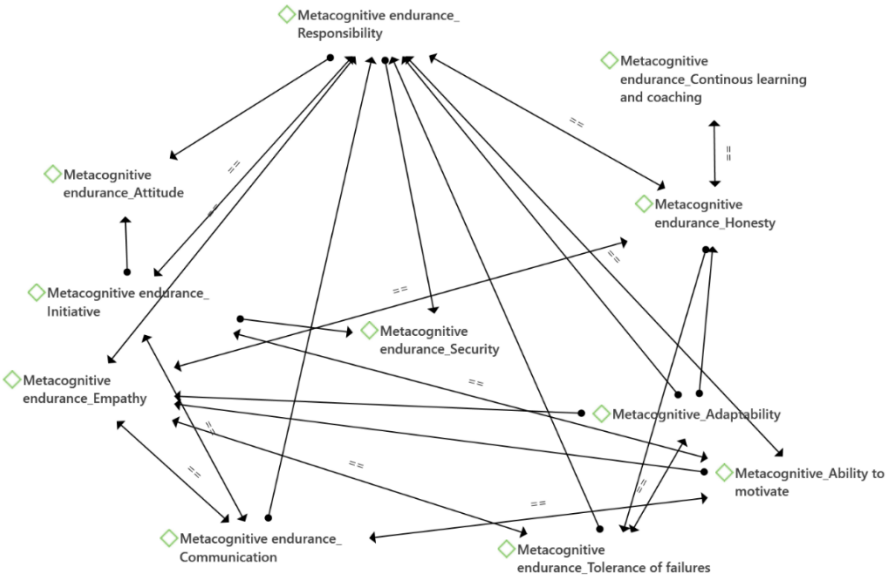

Fig. 8 Network of relationships between the subcategories of metacognitive endurances for the personal attributes group.

The second group of attributes that were directly associated and perceived to have been achieved to the highest level were continuous learning capacity and honesty. Specifically, perception in the development of honesty was related to progress in emotional (empathy) and creation-process (tolerance of failures) competences. Some of these relationships can be appreciated in the following comments:

> […] I consider [myself] to have well-developed qualities that make a person a good leader, such as having character, initiative, responsibility and self-confidence, among others […].

> […] I see myself as an honest person, with a desire to learn constantly, to be better, with professional goals, modest and humble […] with values and priorities […].

Patience, concentration and self-demand capacities were the personal attributes that students mentioned most as requiring improvement. Improving patience was also directly associated with the need to improve the ability to concentrate.

Likewise, improvement in the ability to concentrate was associated with the need for further development in organisational capacity. Finally, the students perceived self-demand as a competence needing improvement and related it to the need for further development in the ability to deal with unknown problems and challenges (see Figure 9).

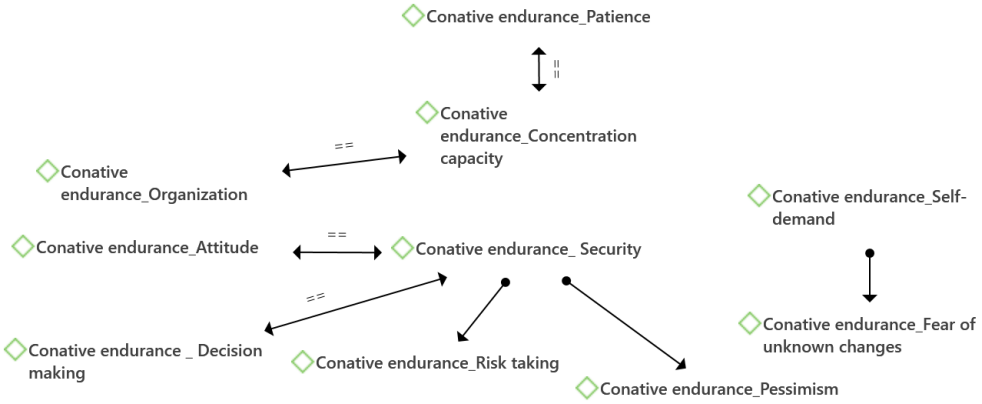

Fig. 9 Network of relationships between the subcategories of conative endurances for the personal attributes group.

In the emotional competences category, students acknowledged empathy, self-awareness, and self-control as the most important developments, although they were mentioned less frequently as competences needing further improvement.

In the analytical competences category, self-criticism and decision-making were identified as competences that were perceived as being developed to a higher degree. However, students identified potential problems in decision-making capacity as being associated with a lack of security or problems regarding attitude. Additionally, the need to improve problem-solving was associated with the development of other competences such as planning, adaptation or teamwork.

Creativity and tolerance of failure were the most-developed creation-process competences but were also reported as those in need of the most improvement. Finally, in

the least-reported category (business-related competences), planning capability was the only competence identified both as being developed and needing improvement (<3%). Thus, the students associated planning with problem-solving capacity, and when it is mentioned as needing improvement, it is related to the lack of communication skills.

Discussion and conclusions

Collaboration and teamworking, as well as *managing and leading* emerged as the most-relevant competences within the eight groups of categories of generic competences cited by students enrolled in an elective leadership course as important for the development of their professional career. The combination of teamwork and adequate communication skills was seen as having priority among the competences that a naval engineer should master, affirming the results of previous studies (Male et al., 2011; Suleiman & Abahre, 2020). However, using authority, respect and compromise when working in teams was considered less important, in contrast to a study by Newport and Elms (1997). This finding contributes to the importance of the discussion within curriculum reinforcement of the need to foster improved competences of commitment and compromise (Meier et al., 2000).

Other studies have identified leadership-related competences such as leading, coordinating and supervising (Suleiman & Abahre, 2020). However, our findings specifically add the importance of leadership style when using personal resources to adapt to different situations, thus contributing to the significance of working on leadership-style adaptation and behaviours in the engineering profession.

Our results differ from other studies that identified engineering graduates' lower perceptions of the importance of emotional competences for employability in comparison to technical competences (Chisholm, 2010). This indicates a systematization of emotional competences, noting that improvement in this competence is related to the improvement of

other groups of generic competences, which are aspects not pointed out by previous studies. Similarly, we would suggest that the use of the portfolio exercise may also have contributed to influencing students' perceptions as it allowed for more in-depth consideration and contextualisation of a group of integrated competences rather than looking at them separately. These results underscore the need to foster emotional competences in future engineers' educational programmes, especially in the design and understanding of how these competences influence and complement another set of generic competences when promoting improvements in professional practice.

Other studies that explored transferable skills and personality characteristics (Chan & Fong, 2018; Newport & Elms, 1997; Archanjo de Souza et al., 2020) identified the importance of the ability to motivate and the capacity to adapt. In contrast with these studies, our results suggest that adaptability to change is related to several specific personal attributes, such as responsibility and honesty, as well as creation-process competences (e.g. creativity and tolerance of failure) and emotional competences (e.g. self-awareness and self-control). These results broaden the understanding of leadership competences as a relational process (Dugan & Humbles, 2018), ordering and ranking the group of competences and their relationships. Our findings also indicated that students were concerned about improving their time-management capacity, which was identified as the most important competence needing improvement. This finding reinforces the need to foster performance management, which involves learning to meet deadlines and budgets while working on projects (Passow & Passow, 2017), within educational programmes.

Our findings present specific attributes that have not been individually analysed by other studies. Students identified patience as a personal attribute for regulating frustration, diversity, etc., and concentration capacity is considered to need improvement in light of the lack of it having a negative influence on careers. Although *specific personal attributes* were

previously studied in leadership models (Cooper et al., 2007; Collins, 2001), our results suggest a stronger link between *personal attributes* and managing and leading, collaboration and teamworking, and creation-process competences.

Self-criticism as an analytical competence was not directly noted in other study findings (Suleiman & Abahre, 2020; Male et al., 2011) and was mostly related to the individual capacity to manage one's performance, such as expanding skills (Passow & Passow, 2017). Decision-making was also depicted as needing improvement, coupled with needs for improvements in personal attributes such as security and collaboration competence such as attitude. On the one hand, these results might suggest a practical implication for working on the design of study programmes that aim for enhanced integration of the set of analytical competences. On the other hand, the results may offer a framework for combining training methods and activities that enable students to practice these competences.

Our results further indicated that students were not overly concerned when reflecting on their need for further improvement on creation-process competences. The importance of these findings lies in the evidence that, even if creativity and innovation were identified as important competence factors for engineers (Male et al., 2011; Suleiman & Abahre, 2020), engineering students might not be aware of how these generic competences could inform and strengthen their professional practice. Likewise, our results identify creativity as a principal component of the set of competences required in creative processes, in contrast to previous studies that examined creativity as an isolated competence (Male et al., 2011) or as part of a process of analytical thinking or problem-solving (Passow and Passow, 2017; Suleiman and Abahre, 2020). These results suggest that, in order to improve training in creation-process competences, an integrative perspective that relates collaborative, leadership and emotional competences should be considered.

Using a mostly inductive qualitative methodological approach, the present study looked at a relatively small number of students taking a specific elective leadership course within a naval-engineering programme. Subsequent studies could apply other qualitative or quantitative approaches. In addition, a future research focus could address diversity in multicultural groups, social responsibility in an engineer's profile, leadership styles in relation to advancing in one's career, or implications related to emotional competence for different engineering professionals according to their sex. It should be noted that the method of analysis applied to students' reflections through the use of the portfolio allows for identifying their emerging competences and highlights the metacognitive and conative processes. It also enables an exploration of the integration of the learning of competences and how students relate to them. Furthermore, the template for the analysis of integrated generic competences identified by the present study can be adapted for studying other specialised engineering fields in order to explore similar and contrasting patterns, which might generate implications for an improved design of personalised educational training.

Moreover, the groups of competences identified in this study can be used in future research to compare the perceptions of students enrolled in management-skills courses with the perceptions of those who select other types of elective subjects (technical subjects) to confirm whether the categories are identified and related in a similar manner. Furthermore, such a comparison can be extended to other specific engineering courses to explore the relationship between the competences identified and those included in the curricula for various engineering degrees.

Future research could also analyse the extent to which young professionals already in the labour market value the competences that undergraduate students identify as important. Furthermore, studies could be conducted on the self-assessment of generic competences using portfolios to include a study extended to professors within the subjects they teach on

different courses of the degree in naval engineering or other studies. This could examine how professors perceive, value, and reinforce certain generic competences identified by students in their self-assessments.

Disclosure statement

There are no relevant financial or non-financial competing interests to report.

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