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RESEARCH ARTICLE

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The influence of perceived teacher and peer supports and barriers in female Spanish engineering undergraduates through their own voices

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Abstract

The goal of the study was to analyze the influence of perceived teacher/peer supports and barriers on career development in female engineering undergraduates based on Social Cognitive Career Theory. Thirteen students studying various engineering degrees participated. The results of a qualitative methodology, life stories, and focus groups, showed that the students perceived more teacher and peer supports than barriers from primary school to university. Students' perceptions of teacher support increased due to the climate they promoted in the classrooms, and the delivery of challenging lessons, mainly in subjects such as mathematics, technology, and computing. Peer influence became stronger at university, and was one of the most important factors in students achieving their goals. The main barriers they perceived were being discouraged from choosing Science, Technology, Engineering, and Math-Information Technology, Electrical Engineering (STEM-ITEE), feeling isolated when beginning ITEE courses, and negative comments.

KEYWORDS

focus group, life story, social supports and barriers, STEM-ITEE, women

1 | INTRODUCTION

The fourth industrial revolution is different from previous revolutions because of the speed of Research and Development and Innovation (RD&I). This creates huge demand for engineering and technology professionals, and requires investment in education to encourage study and work in these areas (Banco Bilbao Vizcaya Argentaria Research, 2017). Women are not highly represented in this sector—only about 30% of engineering, science, or technology graduates are women, and women are responsible for only 22% of authorship in the scientific arena, even less when research is the only activity. According to data from the Organization for Economic Co-operation and Development (OECD, 2017), only between 4% and 15% of patents are written by women. Gender equality in scientific innovation is one of the main goals of policymakers in this area. In engineering, the scant presence of women is most obvious in civil engineering and telecommunications (OECD, 2017).

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Analysis of why there are so few women in engineering has been the topic of much scientific research (Fouad et al., 2017; Garriott et al., 2019; Mozahem et al., 2019; OECD, 2019a, 2019b; Sainz, 2017).

2 | SOCIAL COGNITIVE CAREER THEORY

Social Cognitive Career Theory (SCCT) is one of the most widely used models for explaining engineering students' choices, career preferences, academic and professional objectives, and successes (Lent & Brown, 2019; Lent et al., 1994). The theoretical corpus of SCCT is made up of cognitive-personal variables: self-efficacy beliefs, people's beliefs about their ability to successfully do a certain task, their outcome expectations about what they will achieve by the academic choices they make; and the academic and professional interests or preferences and the goals people have in relation to what they have studied (Lent & Brown, 2006).

The SCCT model is completed by the contextual variables perceived supports and social barriers (Lent et al., 2000, 2018). These are what a person perceives as helping (supports) or hindering (barriers) them achieve their academic and professional objectives. Four types of supports or barriers have been identified: teachers, peers, family, and financial (Lent & Brown, 2019; Peña-Calvo et al., 2016). The theoretical SCCT model suggests that understanding how barriers and perceived supports affect academic-professional progress is important in determining whether someone has considered all of the possible, effective options in the decision-making process. Although these variables are not included in the core of the model, we believe that they should be studied given their weight in predicting perceptions of self-efficacy, outcome expectations, and goals (Fouad & Santana, 2017; Lent et al., 2003, 2010; Navarro et al., 2007; Nugent et al., 2015; Turner et al., 2004).

2.1 | The influence of teacher supports and barriers—from SCCT—on women's perceptions of self-efficacy in scientific and technology studies

The 2030 program for education (Howells, 2018; United Nations Educational, Scientific and Cultural Organization [UNESCO], 2016) recognizes the importance of peers and teachers—along with the need to establish a framework of social relationships to ensure quality education—with the term "co-agency." This emphasizes the need for collaborative teaching-learning contexts with peers. It suggests that students should have interactive, mutually supportive relationships with peers and teachers, among others, that will help them progress toward wellbeing (OECD, 2019a, 2019b).

Supports and barriers do not appear in a vacuum, but are accompanied by the reactions of others, and there is an undoubtable interaction between teacher and peer supports and barriers (Lent & Brown, 2019). The influence of teacher supports and barriers on women's perceptions of self-efficacy in engineering is one significant source of improvement in student self-efficacy.

Research has shown that counselors and teachers have an important role in facilitating people's learning experiences, especially for people from minority groups. The combined influence of support and barriers on perceived self-efficacy in female engineering students has been found to have lower predictive value than in their male classmates. However, when engineering students were examined in more detail, women were found to perceive better support from their teachers and peers than their male classmates, fewer peer-barriers and a similar level of teacher-barriers (Byars-Winston et al., 2017; Inda-Caro et al., 2016; Lent et al., 2005, 2011).

Studies have also shown that teaching support and peer-barriers have the greatest weight in perceptions of self-efficacy. When teacher support is greater, there is more likely to be better perception of self-efficacy in engineering students. When there are more peer barriers the weight of teacher support is greater, there is more chance of increasing the perception of self-efficacy in engineering students, whereas when there are more peer-related barriers (not feeling accepted by others, not identifying with peers, not receiving support from friends to continue engineering courses), students are at greater risk of feeling ineffective and this may determine academic decisions. The three main variables that improve outcome expectations and professional decisions (finding a good job, a good salary, having social recognition, and the family valuing their career, among others) are perceptions of teacher and peer support, and in a negative sense, perceptions of peer-barriers (Brown et al., 2018; Lazarová et al., 2019; Lent et al., 2019). Students' perceptions of support from teachers in this field—the feeling that teachers help at difficult times, and that students are being treated appropriately in gender terms, along with a general sense of teacher support—seems to be the most important factor in developing interest in academic and scientific engineering activities. With respect to students' study-related goals—finishing their course by a particular time or specializing in a particular engineering field—the most important variables are the number of barriers they perceive coming from their peers and their perceptions of teacher support (Byars-Winston & Rogers, 2019; Garriott et al., 2019).

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2.2 | Statement of the problem

Only 12% of the women who complete their education in engineering in the European Union work professionally in the field. In Spain, 40% of those who work in engineering Research & Development are women, and the percentage in research is 39% (Instituto Nacional de Estadística, 2018). Women abandon this professional field because of issues such as a lack of confidence in themselves to do the work, a feeling of vulnerability in the face of stereotypes, the significant commitment, and the perception that this field will not satisfy their personal needs (Block et al., 2011; Buse et al., 2013; Fouad et al., 2017). Previous research has analyzed the fit of the SCCT model and the role of perceived supports and barriers in this theory (Jung & Kim, 2020; Lent et al., 2018; Navarro et al., 2019; Turner et al., 2019) from a quantitative perspective. Few studies have focused more deeply on these supports and barriers throughout women's lives, grounded by SCCT model, using a qualitative approach (Mozahem et al., 2019). In fact, some studies with an SCCT perspective have focused on mentoring programs for engineering in higher education (Mendez et al., 2017). Most studies have addressed this topic using other theoretical frameworks (Banerjee et al., 2018; Dos Santos, 2019; Wilkins-Yel et al., 2019), have not centered on women as a key aim (Fouad et al., 2011; Madamanchi et al., 2019), or have focused on high school students (Carnemolla & Galea, 2021).

2.3 | Research questions

In order to apply the SCCT model to understand how perceptions of support and barriers from teachers and peers influence female Spanish engineering students' academic (e.g., choose technology subjects, complete an engineering major in the next semester) and professional decisions (e.g., working on projects involving engineering, doing satisfying work) from primary school to university, we posed the following research questions:

How is the teaching-staff and peer supports meaning to understand women's perceived self-efficacy in the STEM field during their academic lives?
What type of influence do the teacher supports and barriers have on female engineering students' interests and goals?
How do peer supports and barriers influence female engineering students' interests and goals?

3 | METHOD

3.1 | Research design

We used a phenomenological-hermeneutic method because we wanted to engage with people's lived experiences, the most important material to study for our research project (Van Manen, 2003, p.86). Because the aim was to analyze the introspective process to understand how perceived teacher and peer supports and barriers influenced women's self-efficacy, interests, and goals in engineering, it was important to understand a participant's life as they themselves experienced it (Van Manen, 2003). Although the quantitative approach would indicate the magnitude and power of these factors, we wanted to understand how they were constructed throughout the participants' lives.

The design of this study was descriptive and cross-sectional, the aim was to define and categorize life events to describe and discover the possible teaching and peer supports and barriers which had an influence on female engineering students' behaviors and decision-making. Hypothesis statements are not suitable for this type of design (Kuckartz, 2014).

Furthermore, the use of a qualitative methodology, combining the results of two techniques—life stories (LSs) and focus groups (FGs)—increased the explanatory power of the study in the construction of pro-STEMM-ITEE educational environments. Consequently, it allowed us to determine the contextual factors that helped these women choose certain academic courses and the engineering profession in a social context in which women are underrepresented due to stereotypes about academic courses, fields of knowledge, and professions (Fouad et al., 2017; OECD, 2019a, 2019b).

The justification for choosing these two techniques in this study is important in education because of their potential to produce types of interactive situations that allow us to understand the academic and professional decision-making process, and allow the results to be generalized. In that regard, in addition to the above, another reason for choosing the LSs technique is that it has some benifits worth highlighting: one result of the diachronic structure and teleological nature of the action is that it allowed us to establish causal links and work with objective narratives. In turn, analysis of the cases as a whole allowed us to obtain the core of this diachronic structure and provided an in-depth description (Geertz, 1997) that illuminated the study objective. It is also worth mentioning that choosing analysis of "situation categories" in the LSs presented recurring processes that occurred in similar situations and this offered the possibility of going from the particular to the general—this use of LSs allows

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the findings to be generalized. More specifically, we can see the generalized value of the results of this field study with a small number of cases because the specific microcosm that we studied is within a larger context that consistently associates gender with a certain knowledge branch. So, using these two axes, gender-science/technology, we can describe and discover the logics of action produced by the interactions between social agents (school, friends) culminating in a successful decision-making process helped by the supports and despite the barriers perceived by the agents participating in the process throughout their lives.

In addition, it is clear that the filtered expression of childhood memories was important for the study. Because of the open nature of the LSs, the students were able to explain themselves, go into detail, clarify, and describe situations that affected their decision-making processes; indicate the most important events and those which affected them most; and explain why decisions changed, what they might have been, etc. On the basis of this free construction of the story, the subsequent FGs allowed us to collect the connections and interference that might have been produced by perceived support or barriers on the way to reaching their final decisions to start STEM, and specifically engineering, degrees.

3.2 | Participants

The sample comprised 13 women who were studying for engineering degrees. Their mean age was 21.47 years old ($SD = 1.77$). They were studying the following degree courses: computer engineering, software engineering, mechanical engineering, and telecommunications engineering. All of the participants gave their written informed consent and the study was approved by the appropriate review committee in the autonomous community in which the study was performed (code: 115/19).

3.3 | Data collection

3.3.1 | Life story

A LS is "a narrative description of a part of the lived experience" (Bertaux, 2005, p.36; Denzin, 1970; King & Horrock, 2010) to analyze "categories of contextual situations" of participants, which drive students from an unequal starting point toward an academic, professional position. This specific nature of the study breaks with the deterministic nature of the first studies which used this study technique.

The participants are asked to construct a story in which they give "filtered expression" about the topic which is the objective of the study. Once they have agreed to that, the story guides and focuses the data collection process. To help them remember and look backwards over the life processes which have helped or hindered their decision making, the participants are offered a script of points to try and remember that they can use as a reference in constructing their LS (Figure 1).

In order to help understand the information from the participants, it is useful to know that Spanish secondary education is split into two phases: ESO (Compulsory Secondary Education, usually ages 12–16) and Bachillerato (Higher Secondary Education, usually ages 17–18). During ESO, students can select some subjects and drop others depending on the school. In Bachillerato, students tend to pick a branch, which are collections of subjects based on humanities, arts, science, technology, or health.

3.3.2 | Focus group

The criteria to be part of the group were to be a woman and to be studying engineering. The objective was to discover the trends and patterns in the protagonists' stories from questions posed by the researchers (Krueger & Casey, 2015). The questions were designed following the SCCT model of career development in order to discover whether perceptions of teacher and peer support and barriers influenced participants' academic choices. The FGs were held in the students' surroundings in their university engineering schools, in a quiet room that was not too large, was a comfortable temperature, and had comfortable seating. Two researchers with experience in FGs participated in the sessions, one as a guide and the other tasked with ensuring that the session was recorded correctly and the technology worked appropriately, monitoring the progress of the conversations, and assisting the guide-researcher as needed. Each discussion group lasted a maximum of 2 h.

3.4 | Procedure

The first step was to obtain approval from the regional ethics committee. Then, once approval was obtained from the management of the university schools of engineering and computer engineering, each of them sent a mass email to their students informing them of the study and including the research team's contact details so that students could make direct contact. The email included an explanation of the aims of the study and its voluntary nature.

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My Life Story as Engineering Student

Hi!

We'd like you to tell us the path lived during your life years, not only in the family context but also with your Friends, school (teachers, mates, etc.) which made you take the decision to study an Engineering Degree.

Feel free to describe your life, your opinions and your interpretations about the experiences lived through the process of taking decisions in your academic life.

Don't worry to be exhaustive in the details, the most important thing is that the story must be loyal to the feelings and the emotions felt in each situation/moment.

Try to describe each moment as you lived them, don't worry about explaining nor justifying.

Describe the emotions, and feelings. We don't need right writings, only writings according to your experience.

FIGURE 1 Script to help remembering the life story

The students who responded to the email were invited to a meeting in which they were given details of the study objectives and procedures, and in which they completed an informed consent document. Timescales were set for them to produce their LSs. Finally, dates and times were set for the FGs. The participants participated in both the FGs and in the LS activity, providing a written LS. The students received a certificate of participation in the research project.

Once the study was completed, we prepared a report with the overall results for the management of each of the university schools involved.

3.5 | Data-analytic strategy

The method used was triangulation of data, meaning that there were two sources of data collection via two methods: the LSs and the discussion groups (Villareal, 2017). Similarly, we used "open codes" or "live" coding where, from the participants' voices we were able to access their perceptions of support and barriers related to the educational environment and their peers. We triangulated the evidence which facilitated both individual and overall analysis of each case. The use of triangulation adds strength to the study as it ensures the reliability and validity of the information we obtained. When the narratives the participants provided were similar in the life histories and the FGs this gave the information more substance (Villareal, 2017), addressing one of the main criticisms that is leveled against qualitative studies.

Content analysis considered three aspects of the narratives: (a) the path, this included the events and objective situations the students had experienced, and "how they experienced (or perceived) them"; (b) the meaning of what they related, what the students thought about the perceived teacher/peer barriers and support; and (c) what was told, the objective discourse, what the students wanted to say about what they know or believe about their academic career.

For data analysis, once all of the stories and FGs had been analyzed, we created a grid incorporating the indicators found from the 13 participants about the mix of support and barriers they reported in their academic decision-making about studying Science, Technology, Engineering and Math-Information Technology, Electrical Engineering (STEM-ITEE). This information represents the descriptive and explanatory indications from each student and allowed us to identify the patterns of each student's choices. Starting with a comparative analysis, we considered the items that recurred between cases and used these to determine the importance of perceived social support/barriers on the path toward studying STEM-ITEE subjects. In parallel, via saturation analysis from examining the support elements appearing in the stories as a whole, we examined whether the indicators we found agreed with the contextual variables posited from SCCT (Lent et al., 1994, 2000, 2018; Lent & Brown, 2006, 2019).

4 | FINDINGS

The 13 women described how their teachers and peers influenced them, and how these factors helped or hindered their efforts to achieve the academic goal of studying engineering, interconnecting their experiences diachronically.

Figure 2 shows that the participants indicated more supports than barriers in the education system. Teacher support was the main source in the subjects' personal stories. Five of the 13 students had scaffolding during their secondary schooling (ESO) which helped them to choose engineering courses, with the most support during primary schooling. Guidance toward a course was the second most commonly perceived support in the Bachillerato stage, and to a lesser extent in ESO. Most barriers were reported in the two stages of secondary schooling. Six students talked about having experiences during ESO related to school actions, such as school guidance, which

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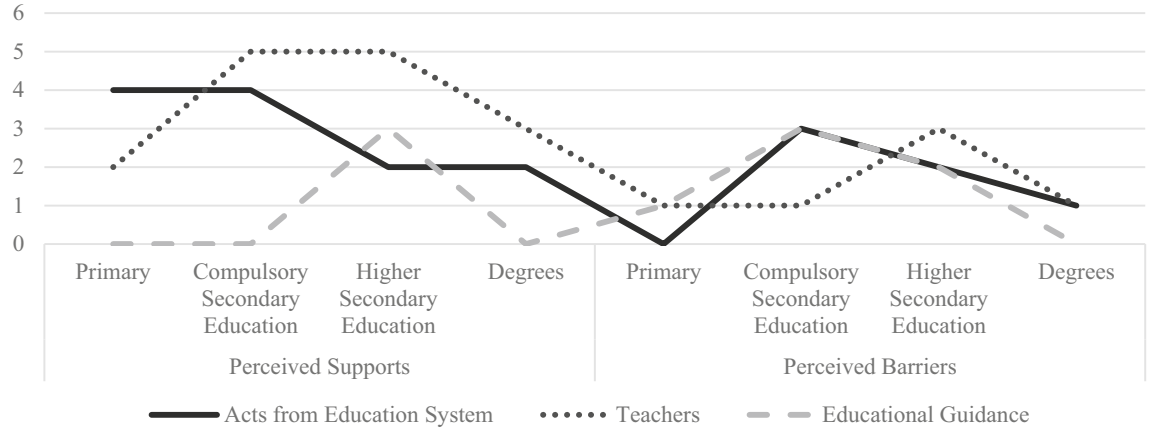
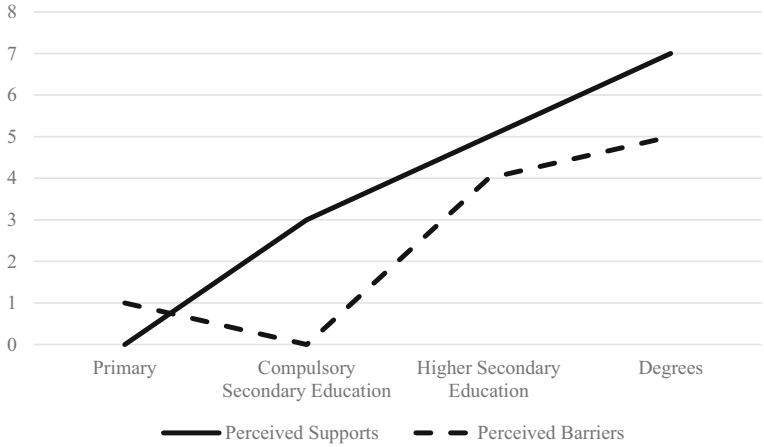


FIGURE 2 Perception of school supports and barriers in female Spanish engineering undergraduates

FIGURE 3 Perception of peers' supports and barriers in female Spanish engineering undergraduates



made it more difficult or did not help their decision to study engineering. Similarly, three participants spoke about having experiences with teachers during Bachillerato which had a negative impact on their choice to study engineering.

Figure 3 shows the engineering students' perceptions of peer support and barriers. Again, the protagonists spoke about more support from peers than barriers. However, on this occasion no categories emerged from the live analysis. The students described more support and barriers from peers at university compared to previous stages of education. However, at the beginning of their student lives, in primary education, they recalled more barriers than support. In both variables, we saw a positive relationship between educational stage and remembering vivid experiences with peers which influenced their choice to study engineering.

Figures 2 and 3 indicate a balanced relationship between the two sources we analyzed. The educational stages with most reported teaching barriers, ESO and Bachillerato, is where the engineering students perceived increased support from their peers, and university, where they also indicated teaching barriers, was where peer support was highest. Once we completed the preliminary evaluation, we looked more deeply at the 13 personal histories that led our protagonists to their course of study following the SCCT model.

4.1 | The influence of perceived teacher and peer supports and barriers on self-efficacy

Students' perceptions that they felt they could count on direct teacher support was one of the constants in the FGs and LSs, when in secondary school classrooms they were given opportunities to tackle individual challenges and successfully complete tasks, improving their self-efficacy—especially in math and technology (R3).

> "Also, when I started in the first year of secondary school, I have very good memories of the math teacher as I gained a lot of confidence and he made me enjoy the subject.

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TABLE 1 Perception of Teachers' supports and barriers in female engineering undergraduates

			1	2	3	4	5	6	7	8	9	10	11	12	13
Perceived teacher supports	Educational level	PE		x		x		x						x	
		CSE		x		x		x							x
		HSE				x								x	
		Univ.						x	x						
	Teachers	PE				x								x	
		CSE			x		x	x			x				x
		HSE			x	x	x		x		x				
		Univ.			x				x					x	
	Educational guidance	PE													
		CSE													
		HSE		x							x			x	
Perceived teacher barriers	Teachers	PE									x				
		CSE							x						
		HSE	x				x		x						
		Univ.								x					
	School center	PE													
		CSE				x		x	x						
		HSE						x	x						
		VE										x			
	Educational guidance	PE		x											
		CSE						x	x		x				
		HSE											x		x

Abbreviations: CSE, compulsory secondary education; HSE, higher secondary education; PE, primary education; Univ, university; VE, vocational educational.

Really, he is one of the few teachers that I remember as if he had taught me yesterday" (R13, LS).

"[...] something odd happened, my teacher who taught us chemistry and math in ESO taught us the Bachillerato content, and in Bachillerato, taught us university level content. We opted for science" (R13, FG).

"I always say that if you're stuck and have no idea what to do, go straight to the teacher and get them to give you some guidance or tell you how to solve the problem, or something, don't stay there stuck looking at the problem because it won't solve itself" (R3, FG).

"In high school, in ESO, I had a teacher in technology who, well I wasn't getting good marks, so he helped me and if for example toward some, for instance we were in an exam and I did not know what I was doing, so, he came over and told me, and guided me more or less toward what I had to do. And this helped me a little to keep going... to keep going with this. Right. And also when we had to do IT and all of that he also used to help me quite a bit (...) (R3, FG).

"Teachers are fundamental in whether you enjoy a subject or not" (R12, FG).

In terms of teaching barriers, there was an absence of mentors or teacher role models within technology, as well as teachers' being obsessive about a subject (Table 1).

In one case, during ESO, a subject indicated a markedly feminist take (R7) that the focus of the subjects did not correspond to student expectations because there were no references to female scientists:

"(...) I started ESO, when I started getting questions about which degree I would do so

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> I could organize my last years at secondary toward that. I reached the conclusion that the healthcare branch was what I should do....” I fooled myself thinking that biotechnology would cover both branches (health and technology). By then we had not seen, in any of the technology subjects, the names of any women who had changed the world of science with their theories or laws, so in fact I did not have any references I could identify with in the scientific world like the teachers in the scientific field” (R7, LS).

In the FGs, this same participant said:

> “(...) Ever since I was small, we had male physics and math teachers, I have no female references” (R7, FG).

Among the perceived barriers, the influence of the school as an educational institution emerged. During Bachillerato, no support was indicated from schools, but barriers were noted.

In these cases, the subjects on offer affected how students progressed through the Bachillerato toward one field of knowledge or another, although it did not affect the academic path as a whole as in no case was it a reason students gave for abandoning science/technology courses, their goals stayed the same. Nonetheless, it was an influencing factor, and for some students it served to mark the passage or transition from science courses in Bachillerato toward studying technology courses at the beginning of university. We found the opposite in 40% of cases, with students alluding to the scant number of subjects offered by the *school* linked to STEM-ITEE. It was strong and continuous in only one case (R6). This student found barriers to her studying computer engineering from the *school*, thanks to the limited number of courses offered in this area.

The educational guidance counselor returned as a barrier. In some cases, when the students asked for guidance about choice of courses and which route to follow, it was the guidance counselor, or some other teacher or head of studies at the school whose various “arguments” discouraged the students from choosing STEM-ITEE courses. In other cases, students reacted to the advice with a strategy of active opposition (R6). It is worth noting that in none of the cases did the guidance personnel persuade the students away from their professional choices of engineering, changing their perceived self-efficacy (R6).

> “I can sum up those four years with something that my math teacher said (...) Also, the guidance that the school gave us was useless for me, I didn't even consider it, as I ended up studying something related to humanities or history” // “(...) When I had to choose which branch of Bachillerato to do, I raised it with the head of studies, and as I told him that my first idea was computer engineering, I didn't have everything decided but under no circumstances did I want to do technical drawing, he recommended I do the health branch” // “another key moment was when, in the second year of Bachillerato, I also met the [female] IT engineering teacher in the school and told her what I wanted to study. She told me what never occurred to me, that it was a course that I would never truly finish, that I would have to keep on training and learning, I love challenges, so rather than discouraging me, it made me more determined to study that subject” (R6, LS).

> “Women tend toward caring subjects, there is misinformation, from school it would be good to have one talk a year, from when we are small” (R6, FG).

> “In the first term of fourth year ESO, one teacher told my mother that I shouldn't do any mathematics degrees, that I would be unable to pass, and instead I should choose a humanities course. That comment made me seethe” (R7, LS).

> “[...] they guide you toward caring degrees, they put you off. Also, we have to decide so quickly” (R7, FG).

Various cases noted friends' support for choosing engineering. Friends may help a student be more confident in their decision, increasing their self-efficacy. At university, 6 of the 13 students indicated support from their peers for continuing their degree courses (Table 2). Their friends help them to improve their self-efficacy.

> “[...] the group of friends I've got here is the best support that I have at the moment, they're doing the same thing as me, they know how you feel, if you have a bad day they'll understand. There's also support from classmates. I don't see any competition, I can open up to any classmate and they'll explain things” (R4, FG).

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TABLE 2 Perception of Peers' supports and barriers in female engineering undergraduates

		1	2	3	4	5	6	7	8	9	10	11	12	13
Perceived peer supports	PE													
	CSE			x			x			x				
	HSE			x					x	x	x	x		
	VE										x			
	Univ.				x		x		x		x	x		x
Perceived peer barriers	PE									x				
	HSE	x	x	x						x				
	Univ.	x	x		x	x						x		

Abbreviations: CSE, compulsory secondary education; HSE, higher secondary education; PE, primary education; Univ, university; VE, vocational educational.

In terms of barriers, six of the participants spoke about barriers in connection with the choice of technology course, one reflected about how alone she felt when she made her decision, affecting her perceived self-efficacy, and having doubts:

> "My best friends had "abandoned" me and had decided to do other branches, and although I knew most of the people in my class, it hurt to be separated from them (well, yes, it was only a different class, we were still in the same school and we spent breaktimes together, but it wasn't the same)" (R2, LS).

> "When I had to choose my Bachillerato I already knew that I wanted to do telecommunications, so I chose technology. There were only 3 girls, and I have to say that one of my best friends one day said to me that technology was 'for boys'" (R9, LS).

Vicarious learning is a process that we see in the perception of peer barriers,

> "I know that I don't want to do the Masters here, because I've got friends who are doing it and they're traumatized" (R5, FG).

> "There were comments that made me feel small, 'what am I doing here with these people' I felt I did not fit, not having a female classmate. They made me feel small. That I did not fit in, having only one female classmate. (R1, FG).

Last, various participants indicated a lack of understanding on the part of their peers about the difficulties of studying their engineering degree:

> "[...] my outside friends knew that we were doing engineering but they didn't appreciate it. I don't have the support of outside friends. I started to appreciate more the support of friends in the faculty. Maybe they thought that I was exaggerating everything and it wasn't true we had tests every week." (R4, FG).

> "[...] it doesn't depend on you being a student no. My friends are on courses that only have final exams and don't appreciate it, they say "you never get tired of studying" I tell them it's because I cannot stop, on this course you cannot." (R2, FG).

4.2 | The impact of perceived teacher and peer supports and barriers on interests and goals

In this category, 6 of the 13 participants indicated things that happened during their schooling (Table 1), four indicated a liking for specific subjects, for example R2:

> "[...] I've always been more attracted to science subjects rather than the arts, although I do not dislike the arts. Even in secondary school, when anyone asked me what my favorite subject was it was math, something my friends never understood. 'How can you like math more than PE or art?'" (R2, LS).

In terms of perceived teacher support, we saw the influence of significant teaching figures, when they had taught a subject so that it was enjoyable (good school climate) and interesting. There is a path in which this was key in the choice of university course (R5), revealing

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more interest for technology (Table 1). This participant said:

> "(...) what I enjoyed depended on the teacher in secondary school. The important thing is to have a good teacher" (R5, FG)

> "I took biology and technology, I chose technology because of the teacher" (R5, FG).

Subjects highlighted doing activities in Bachillerato that drew them toward the areas of study, directing their goals to science and engineering:

> "In the second year of Bachillerato they had open days at the University of Oviedo and I went to the Chemistry faculty because I was interested in doing a chemistry degree, but once I was there, I was much more attracted to what they did in Chemical Engineering" (R12, LS).

On access to university and guidance toward specializing in technology:

> "Open days in EPI. Motivation. This was what led me to study electronic rather than industrial engineering (...) I chose electronics that day and now I'm studying for that degree" (R7, LS).

In addition, students also perceived teachers' personalities as a support when choosing an academic route, affecting their interest, even to the point of choosing different subjects:

> "I was really lucky my Bachillerato group in industrial technology was really well behaved and my teacher helped us and supported us all equally" (R7, LS).

> (...) first year chemistry, because of the teacher, he was so dynamic, he encouraged us to ask questions and create, he led us step by step to the exam, you did not feel pressured. (R7, FG).

One of the teacher supports the participants highlighted was the role of the educational guidance counselor (Table 1). It was a source of support for three of the participants, R9 and R12, and to a lesser extent R2, for whom guidance class served as a time for reflection that the student used, on her own initiative, to decide to study STEM-ITEE. This reinforced their goals in this field:

> "I have to say that in my school -in Bachillerato- we were lucky enough to have academic guidance classes and sessions, with attitude and aptitude tests, and a psychologist who gave us advice. They also brought in ex-students to tell us about their university and work experience to help us choose our own degrees. They took us to university open days and brought university professors from the campus to explain each course to us. They never made any distinction between the boys and the girls" (R9, LS).

> "I had good guidance, and when I started Bachillerato I knew what I was doing" (R9, FG).

> "I had a counsellor that we could ask whatever we wanted, they looked for help for me, they gave me guidance, and they also organized chats with students already at the university" (R12 LS).

> "If I was going to keep studying, I was sure that I would do the Bachillerato first and then decide. So it was clear, the Bachillerato was the next stop. I remember, once I finished that year a school guidance counsellor came to see us and asked us to fill out a survey of some kind. In it they asked us what our plans were at that time for the future, and I remember I wrote that I would continue studying at university, and in the question 'What would you like to do?', the three answers that came to me then were math, computers or industrial engineering. My father has always really liked new technology (...)" (R2, LS).

Only in one case (R10) was the branch chosen based on the academic courses on offer. This student had limited financial resources and could not do the Bachillerato in "her school" because "they charge," and so decided to change direction toward vocational training. Once this decision was made the courses on offer by the vocational training center also influenced the choice of course, and she chose "nursing auxiliary" because there were few options available:

> "When I started secondary school, there were no subjects related to technology, and I

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found most of the subjects boring." When she had the chance, at the end of the fourth year of ESO, she chose the technology stream. "That same year, I stopped doing French to be able to at last take the subject that I had felt had been missing during that time, IT." What they taught us was gobbledygook, but even if it was, I was excited to have it as a subject and learn new things" (R4, LS).

When I started secondary school (...) the only subjects I could choose between were IT and French in the first 2 years, and French and classical culture in the last 2 years. As I said before, English wasn't my strong point so I wanted to do IT, but really my marks were pretty good, and in my school they expected the better students to do French, so that was my fate" (R6, LS).

"When I finished the fourth year of ESO, in my school you went on to pay for the Bachillerato, and as my family couldn't pay, I had to change to a public school. There I thought (after listening to some talks in my school about vocational training) why not start a vocational course" // "On finishing the fourth year of ESO (...) it seemed like a good idea to my mother and we decided on a vocational course to sign up for. There wasn't a great deal on offer, and we decided that I would study to be a nursing auxiliary (lower level) and then a lab technician (higher level) (R10, LS).

There were various cases in which students did not like a teacher or subject, and decided on an academic path to stop taking that subject, affecting their interests. Where they did not like a subject or teacher who taught science, such as biology or physics, this led to them choosing technology (R1, R5). There is one path in which this circumstance determined the choice of university course (R5). In other cases where students disliked a technology subject, such as technical drawing, this determined what they specialized in, and from Bachillerato on, they thought about choosing a degree in a technological field which did not include these subjects.

"[...] during the first year of bachillerato, biology classes started to be less enjoyable, so in the second year I changed to the technology bachillerato" (R1, LS).

As regards peers, also they are a reference and students may choose a branch because a friend is has also chosen it; in other cases, they are sources of information and advice about a knowledge area. It was friends who served as support for this student (R10), first in her choice of nursing (goals), and then in her choice of IT engineering (Table 2). At older ages, friends or boyfriends can support decisions, encourage, or help financially, even altering the life project so that the individual does a course they prefer—these two happened together in one case (R10) and were what led to confirmation of her choice to do computer engineering—and changing or affecting former interests and goals (R8, R11).

"[...] So as a classmate who signed up with me to be a lab technician was going to go into nursing, I went along with her // (...) When I started I made friends, almost all civil engineering students. I had never been interested in engineering, to be honest, I had no idea what it was. And when they explained what they did, and what they earned, their outcomes, especially in IT, which I had always been interested in, I said ... that's what I've been looking for! So my partner and I saved up, we moved to Oviedo, and here I am in the third year of computer engineering. It's a hard course, but I love it" (R10, LS).

"I didn't know what I would do in Bachillerato or what I was going to study. I chose subjects based on friends." (R10, FG).

"One of the reasons I decided to go into engineering was a friend who at that time was in the first year of a double degree in math and computer science in Madrid. He told me that no one goes into university knowing it all and most people start from scratch." (R8, LS).

"Socially it affected me internally, because here making your group of friends, you've got things in common. You end up forming bonds that you don't have with people from outside." "[...] But between them, classmates can help you keep up" (R8, FG).

"[...] I started to ask a friend of mine who was in the fourth year of a degree about what they did and what the subjects were like and she helped me a lot. So I decided to do

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> software engineering, I wasn't 100% certain, but between my friends, family and my boyfriend I came to a decision (...) (R11, LS).
>
> "[...] the friendships here are the biggest support, they understand you best. María, we study together, helps me a lot. Your classmates always help you, some send you recordings that explain things and the like." (R11 FG).

5 | DISCUSSION

As stated in the study objective, the 13 participants narrated their life processes leading to being engineering students, highlighting the roles of teachers and peers as two important influences in the creation of their academic and professional goals (Lent et al., 2000; Peña-Calvo et al., 2016). The results show that the answers to the three research questions are affirmatives. We will look at each one in more detail:

5.1 | The influence of perceived teacher and peer supports and barriers on self-efficacy

This study showed how what teachers said during Bachillerato affected the participants' perceptions about whether they could continue studying subjects such as math or technology, and in fact the study highlighted the influence of teachers' words on girls' parents. Peers had an influence on the perception of being an effective student in subjects such as physics and computer engineering. The perception of efficacy in these subjects increased when these students started their degrees and compared their performance with their peers. These findings are connected to the need to promote collaborative teaching/learning (OECD, 2019a, 2019b). However, the students reported more teacher barriers, and this needs to be taken into account in order to train teachers to be aware of the power of their counseling, for instance, when teachers use a team teaching strategy, they can improve their own and their students' skills (Aarnio et al., 2021; Vesikivi et al., 2019).

5.2 | The impact of perceived teacher and peer supports and barriers on interests and goals

When it came to academic interests, in both their LSs and in the FGs, the protagonists expressed being hindered by teachers both in secondary school and at university. This interest centered on specific subjects which even led some to reject an academic path. Teachers who helped them choose technology courses demonstrated characteristics including teaching skills which created good learning climates, creating and communicating a trusting relationship with the student (UNESCO, 2016). In addition, they were identified as academically demanding teachers who had high standards when evaluating students, even delivering teaching-learning above the educational level the students were in.

These perceived supports increased students' interest in subjects such as mathematics, technology, and computer science—the three subjects that are fundamental to later studying ITEE courses. Some participants said that teachers were the fundamental figures in them being interested in and appreciating a subject. The educational guidance counselor emerged as both support and barrier, in both cases influencing the construction of academic goals. Previous studies have been able to confirm that academic goals are the final construct to appear in the progress of an academic trajectory (Inda-Caro et al., 2016). The present study was no different, the students did not begin to have clear ideas of their academic-professional goals until they were studying Bachillerato.

The educational institution acts as both a facilitator and a barrier. It is a barrier when there is an absence of subjects related to STEM-ITEE or when students' lack of enjoyment in subjects makes them less likely to choose technology paths. This research highlighted the influence of peers on the student's goals. This is in line with previous quantitative studies with similar populations (Peña-Calvo et al., 2016).

This study allowed us to look more deeply at how teachers and peers influence our students, to the point of determining their academic and professional choices. The results reinforce the studies and lines of work from the OECD (2019a) within the 2030 strategic plan, which reinforces the need to create support networks and help students progress and reach their academic goals. The present study demonstrates that when female students perceive personalized, motivating learning processes which consider their needs and interests, that is key in determining their vocational choices, with the teacher and peer relationships becoming central elements in the process. In addition, the second factor noted in the OECD (2019a) 2030 strategic plan is that it should be soundly based on knowledge, based on the voices that emerged in this study, the participants acknowledged the value of teachers with high expectations and requirements in their teaching-learning processes.

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5.3 | Limitations of this study

One possible limitation of this study is not considering other supports or barriers, however, we wanted to look deeply at the roles of peers and teachers to follow on from the line begun in the previous quantitative study. In fact, we clearly showed that these were the two strongest influences on the main variables in the SCCT model (perceived self-efficacy, interests, goals, and outcome expectations) (Inda-Caro et al., 2016). In this study, we did not find explanatory lines about outcome expectations. This might be viewed as a limitation of the study itself, where the qualitative methodology was not capable of detecting this relationship. However, it is important to remember that the SCCT model does not establish any direct influences of supports and barriers over outcome expectations (Lent & Brown, 2019).

Another weakness may be sample size, looking at the study from a quantitative perspective. However, from a qualitative perspective, and considering the methodology used—LSs and FGs—the researcher had to analyze the participants' words, traveling with them to discover supports and barriers which could be decisive for their interests, goals and self-efficacy in the engineering field; the main point was to perform a deep analysis of these people's lives.

5.4 | Future implications

This study opens an essential line of analysis for future work on the SCCT model and the presence of women on engineering courses. Most studies to date have had a more quantitative perspective, very few have looked deeply at this model following this research method. The main contribution of this study is that it has allowed us to discover the dynamics of influence of teaching and peer support on the progress of doing a degree in engineering. In fact, these results were shown to Directors of Engineering Schools, they realized the importance of the teacher's role and how they can bias or change the goals or the perceived self-efficacy of female students. In addition, the educational authorities join the university institution to implement STEM programs since the primary school in order to support, help and encourage students to keep their technological interests, taking into account several social agents (teachers, peers, family, IT companies and, research institutions) (Asturias4STEAM, 2019; Educastur, 2022). In this vein, the future line research is focused to guide these institutions to understand the effect of teaching-staff, peers, family on choices of STEM-ITEE fields.

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