ANEXO 9. Capítulo de conclusiones en inglés

CHAPTER 10. FINAL CONCLUSIONS

Both men and women should feel entitled to be strong. It is time we saw the genders as a whole rather than as a set of opposites. We must stop challenging each other.

Emma Watson – Actress and activist.

This chapter presents the conclusions of this doctoral thesis and answers the objectives and research questions that were posed in Chapter 1. Describing the main contributions of the work carried out allows us to accept the hypothesis formulated at the beginning of the research: The opinion that the Spanish university population has about STEM (Science, Technology, Engineering and Mathematics) tertiary studies concerning gender, that is, the ability to perform STEM tasks by men and women, is conditioned by personal factors, such as gender, academic characteristics, and family and contextual factors.

In addition, this chapter identifies the limitations encountered during the development of the doctoral thesis, sets out a series of future lines of work, and establishes who the beneficiaries of this research are.

This chapter is organised into seven sections. Section 10.1. presents the contributions and results for achieving the general objective of the doctoral thesis. Section

10.2. answers the research questions. Section 10.3. contains the conclusion. In 10.4. the limitations encountered in the development of this doctoral thesis are pointed out. In section 10.5. the future lines of research are indicated in 10.6. the beneficiaries of this thesis can be determined. Finally, this chapter closes with section 10.7. the results associated with the thesis (scientific publications, research projects, and international stays) are presented.

10.1. Contributions and results for the achievement of the general objective of the present doctoral thesis

The general objective of this doctoral thesis is: To find out the opinion that the Spanish university population of all branches of knowledge has about higher education STEM studies concerning gender to detect stereotypes.

Specific objectives and different stages in the research were planned to achieve the main objective. The following three sections present the results that have been achieved. Section 10.1.1. describes the results on a theoretical level. Section 10.1.2. presents the results obtained at the methodological level, using the QSTEMHE questionnaire and its model based on five dimensions. Finally, section 10.1.3. highlights the results obtained in the research, using the two non-experimental studies applied in 2020 and 2021.

Although the results presented in the three sections aim to achieve the general objective, the results in section 10.1.3 directly allow the general objective of this doctoral thesis to be achieved. By analysing and interpreting the data collected in the two non-experimental studies, it is possible to identify the opinion and gender stereotypes about STEM studies.

10.1.1. Understanding the gender gap in tertiary STEM studies in the European space as a systemic phenomenon associated with intrinsic factors

A Systematic Literature Review (SLR) and a systematic mapping in the Web of Science and Scopus databases have been carried out on the scientific production of the existing gender gap in the European educational framework concerning higher STEM studies for this doctoral thesis. Based on the results obtained, it can be concluded that scientific production on this topic of study is booming. Research is being carried out in Germany, Spain, the United Kingdom, Ireland, Italy, Portugal, Denmark, Belgium, Finland, Slovenia, Norway, Scotland, Latvia, Estonia, and the Czech Republic. Some studies have

been applied in a single location, while other research has been carried out in more than one European area.

Furthermore, regarding the populations to be investigated, the focus is mainly on the tertiary student population, especially university students. However, it has to be considered that the gender gap does not only concern the university as an institution. Early childhood, primary and secondary education, and the workplace are also areas where certain gender gaps, such as the one studied in this thesis, are presented, reflected, and developed. For this reason, some of the studies of the finalists in the SLR and mapping process have not only been applied to the university student population (8 studies) but also to secondary education students (7 studies), primary education students (3 studies), university and secondary education students (3 studies), primary, secondary and university students (1 study), and women university graduates (1).

The Systematic Literature Review in this doctoral thesis allows us to determine which modulating factors of the gender gap in STEM higher education, specifically in the European educational framework—finding out what the factors have been made possible by analysing other research and studies implemented by other researchers. The understanding that the gender gap is a system-wide problem is among the scientific contributions of this SLR. It is not just a problem of girls and women, and they are not responsible for the existence of the gender gap. The education system, business, and society are spaces where horizontal segregation originates and perpetuates (Craig et al., 2019; Margolis & Fisher, 2003; Lehman et al., 2017; Sax et al., 2017). Among the reasons for this are the culture of feminisation and masculinisation of studies and professions, and gender roles acquired early. The gender gap is not biological or cognitive but is caused by various social and cultural factors. Therefore, it is essential to combat gender stereotypes and patterns from childhood. In this way, it is critical to involve the spaces above (education, business sector, and society) in fighting the gender gap in STEM tertiary studies and the family and community agents in which the person socialises.

Also, the literature provides an understanding of the magnitude of the Stereotype Threat (Cheryan et al., 2015, 2017; Corbett & Hill, 2015; Spencer et al., 1999) and the Leaky Pipeline (Alper, 1993). Stereotype Threat has been linked to higher anxiety and stress levels in women (Nguyen, 2016). This threat is documented in women's performance in male-stereotyped occupations (O'Brien & Crandall, 2003) and particularly in computer

science (Cheryan et al., 2013; Master et al., 2016). Given that the STEM sector has been socially ascribed to men (Blackburn, 2017; Nosek et al., 2009), women may fear rejection in studies and careers. Finally, another stereotype about the STEM sector is that people who pursue STEM studies are geeks, a phenomenon referred to as the nerd stereotype (Margolis & Fisher, 2003).

As indicated above, horizontal segregation is a problem forged in society and reflected in education. In education and socialisation, girls and future women assimilate and acquire gender roles and patterns perpetuated by social constructs. In some cases, they are led to drop out of STEM studies because they fear conforming to the stereotype of being educated in a field they presumably do not belong. This is how the Leaky Pipeline is evidenced by the loss of female representation in higher education in science, technology, engineering, and mathematics.

The naturalisation of women's presence in STEM fields, both educational and occupational, would mitigate the norms and culture of the STEM sector, which are primarily male-dominated (Cheryan & Plaut, 2010). It is essential to overturning the androcentric cultural dominance of scientific and technical education and workspaces (Cheryan & Plaut, 2010) to foster a sense of belonging to the STEM sector (Lewis et al., 2016) and to enhance self-efficacy (Eddy & Brownell, 2016),

To combat the constructs that perpetuate the gender gap, the barriers girls and women perceive to stabilize STEM fields must be addressed (ISACA, 2017). Perceived barriers include the lack of female role models and references, gender bias, a hostile work environment, the pay gap, and the lack of a natural work-life balance. It is essential to integrate motivated and qualified people, regardless of gender, into STEM studies and STEM jobs. This will make the environment more flexible and less hostile.

It is necessary to break social rules and stop attributing family care to women to achieve a safe space that facilitates a sense of belonging. Family co-responsibility must be promoted so that both men and women have the same opportunities to consolidate and promote themselves within the sector (Weisgram & Diekman, 2015). Furthermore, it is essential to break with existing false beliefs about STEM professions in this regard. Studies in the literature have revealed that career goals differ by gender (Ceci & Williams, 2010; Diekman et al., 2010), with boys and girls expecting to pursue careers in different fields (Han, 2016; Sikora & Pokropek, 2011). Boys wish to pursue physics, mathematics,

or engineering careers, while girls tend to expect to pursue careers in the life sciences or health-related professions (Han, 2016; Sikora & Pokropek, 2011). Some research has shown that women tend to prefer occupations where they can help and work with others (Su & Rounds, 2015) and where they can help others and contribute to the community (Diekman et al., 2010, 2015; Edzie, 2014), while men tend to prefer working in production and with objects (Guo et al., 2018). These gender differences are associated with gender disparities in STEM fields (Diekman et al., 2010; Su et al., 2009; Woodcock et al., 2013). Along the same lines, research has shown that men tend to significantly value those professions where higher income, power, and prestige are generated compared to women (Eccles et al., 1999).

In this way, false beliefs that STEM occupations do not address the community must be abolished. Many people in the West, especially women, still consider STEM professions male domains (Nosek et al., 2009). Any profession can be directed towards community service since it is the goal set by the student, worker, or researcher that establishes it. Eradicating this false belief will make it easier for those who choose their studies to consider entering STEM studies for community objectives.

Finally, the SLR has also provided insight that just as the system is implicated in horizontal segregation and the struggle to combat it, so too are intrinsic factors. Personal goals, outcome expectations, and interests shape which higher education studies to pursue. For this reason, attention should be paid to these elements as well as to self-concept, motivation, attitudes, performance, and self-efficacy.

10.1.2. Questionnaire with university students on STEM studies in Higher Education (QSTEMHE) and its model

An instrument has been created to study and analyse these factors to determine the modulating and conditioning aspects of the gender gap in higher STEM studies. The questionnaire is designed to be applied in any country, although it has been implemented in Spain for this doctoral thesis. For the thesis, the questionnaire has been applied on two occasions, first for the empirical validation of the construct through a pilot study and on a second occasion with a larger and more representative population sample. This second study has been possible to confirm the validated model empirically.

After a review of instruments created by other authors, five questionnaires were selected (Banchefsky & Park, 2018; Duncan et al., 2019; Godwin, 2014; López Robledo, 2013; Rossi Cordero & Barajas Frutos, 2015) on which to base and inspire the questionnaire of this doctoral thesis: Questionnaire with university students on STEM studies in Higher Education (QSTEMHE). Based on this questionnaire, the QSTEMHE, it is possible to analyse the gender stereotypes that people have about STEM studies in higher education. As well as being applicable in any country, it can be used with any group of students or graduates from higher education. It can be used with people of different gender identities and ages, regardless of sexual orientation, nationality, geographical area, or whether they belong to a public or private institution. Thus, the QSTEMHE questionnaire contributes to science, as other researchers will be able to use it in their contexts to address gender biases of study groups about STEM higher education.

The Questionnaire with university students on STEM studies in Higher Education (QSTEMHE) is made up of closed questions in Likert format to study the presence of gender stereotypes quantitatively. There are also five open-ended questions from which to explore gender stereotypes expressed verbally. Finally, the questionnaire collects data on educational background, social and family background, and motivations for choosing higher education. From this socio-demographic information, gender stereotypes can be analysed regarding educational, family, social, and motivational traits and characteristics.

As initially mentioned, the QSTEMHE has been empirically validated to test the validity and reliability of the construct. The results obtained in this research and those that may be obtained in future research are based on criteria of scientific rigour. Based on the pilot study, the first validation stage was carried out by employing correlational analysis, Reliability Analysis, and Exploratory Factor Analysis. Finally, the validation was finalised in a second stage, using a more extensive, representative population sample. Thus, Confirmatory Factor Analysis and Composite Reliability Analysis were added to the analyses already used.

Finally, the complete initial version of the questionnaire can be consulted in Annex 1 and the complete final version, after empirical validation, in Annex 2. However, the ordinal items by which gender stereotypes are studied in the QSTEMHE questionnaire are presented below:

- 26. If a woman decides to enter a traditionally masculine field, she will be more successful if she adopts the prevailing male customs and behaviours.
- 28. Having men and women work side-by-side increases the likelihood of conflict.
- 33. University studies are more important for men than for women.
- 34. Women must sacrifice their careers to support their children/family.
- 37. In the IT field, a man's performance will be better than a woman's.
- 38. Women are capable of developing useful software.
- 39. At home, boys do more practical activities with their parents than girls (e.g. cars, tools, computers, etc.).
- 41. Boys prefer STEM-related hobbies.
- 42. There are more boys than girls in STEM studies as they are more freaks.
- 43. Women working in STEM areas have to be/act like men.
- 44. To have a successful career in STEM you need to think and act like a man.
- 45. Girls are not as good as boys in STEM issues.
- 46. Girls are not as interested as boys in STEM issues.
- 47. STEM themes are more masculine than others.
- 48. Girls have fewer natural abilities than men for STEM issues.
- 49. Most girls are better at other things (such as letters/languages) and choose studies in which they are better.
- 51. University studies in STEM are generally more attractive to boys.
- 52. I feel restricted by the gender labels people attach to me.
- 53. I feel restricted by the expectations people have of me because of my gender.
- 54. In my childhood home, I was taught that men should act like men and women should act like women.
- 56. I have been teased or bullied for acting like the opposite sex in the past.
- 59. Science is helpful in my everyday life.
- 60. Learning science has made me more critical in general.
- 61. Science and technologies will provide greater opportunities for future generations.

An explanatory model of the elements involved in the gender gap has been obtained as a product of the QSTEMHE instrument and its empirical validation. Twenty-four criterion variables form the final dimensionality of the model, and they are distributed in five

dimensions, which are Gender Ideology (D3_IG), Perception and Self-Perception (D2_PAP), Interests (D1_INT), Attitudes (D4_AC) and Expectations about Science (D5_EXC) (Figure 101).

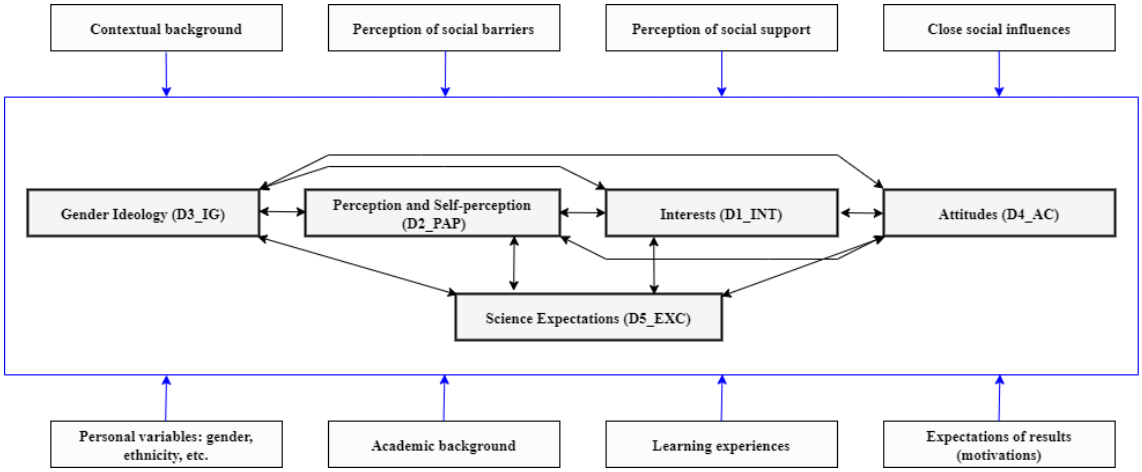

Figure 101. Final empirical dimensionality of the instrument. Source: Own elaboration.

The five dimensions at the model's core are collected in a nucleus or core in the model. As explained in Chapter 7, Gender Ideology (D3_IG) is related to the social conception of gender roles and patterns. According to Banchefsky & Park (2018), there are four possible stances towards gender ideology: gender blindness and its opposition, assimilationism, and also, gender consciousness and its opponent, segregationism. On the other hand, in terms of Perception and Self-Perception (D2_PAP), the erratic perception of STEM studies significantly impedes women's ability to pursue STEM career paths (Diekman et al., 2010). In turn, self-perception may also lead to low-interest rates and enrolment or continuation.

Regarding Expectations about Science (D5_EXC), these relate to the expected outcomes of science and the study of science. Furthermore, Attitudes towards science (D4_AC), according to Osborne et al. (2003), can be understood as the feelings, beliefs, and values that a person has about an object, which can be, in this case, science, science at school, the impact science has on society, the science-based labour market, and even scientists themselves. Finally, as for Interests (D1_INT), these are linked to motivation and the fulfilment of expectations. In the educational field, interests represent a dynamic process in which motivations are related to the factors surrounding the person, such as the immediate social environment, the nuclear family environment, the extended family environment, the peer group, and the culture where the person has been socialised.

On how the five dimensions relate to each other, gender ideology defines how a person interprets gender. There are positions that value gender by recognising that all people are equal and have the same rights regardless of their gender and that although men and women might have different ways of doing things, both ways would be valid. However, there are also oppressive positions whereby women are subordinated to gender roles. Thus, depending on a person's gender ideology, they will either value women as equally valid and competent as men or, on the contrary, they will find differences in their ability to perform. However, distinctions are not only established at the level of perception but also at the level of self-perception. Women may feel more comfortable or insecure in a STEM space depending on their self-perception of their ability to perform STEM tasks. Thus, the feeling of belonging or lack thereof towards the STEM environment may increase or decrease expectations towards science and, therefore, attitudes and interests.

However, Gender Ideology, Perception and Self-perception, Expectations about Science, Attitudes, and Interests do not function as an independent core. Environmental factors and personal background influence the conditions under which they occur. Extrinsic factors that condition the core are contextual background, such as culture, perceived social barriers, gender patterns, perceived social supports, role models and role models, and close social influences, both positive and negative. On the other hand, intrinsic modulating factors are personal variables such as gender, age, nationality, etc., also academic background, learning experiences, and motivations.

Finally, just as the questionnaire created and validated in the framework of the thesis (QSTEMHE) has allowed data collection for this research and is a valuable tool for other research and the scientific community, the same is true for the proposed and presented model. Just as there are other explanatory models for the gender gap in STEM higher education, such as the Social Cognitive Career Development Theory (SCCT) (Lent et al., 1994), the presented five-dimensional model is proposed in the framework of this dissertation: Gender Ideology, Perception, and Self-Perception, Expectations about Science, Attitudes, and Interests.

10.1.3. Opinions and gender stereotypes expressed by the Spanish university population on STEM higher education studies concerning gender

The last result is the one that directly allows us to achieve the general objective of this doctoral thesis: To find out what is the opinion of the Spanish university population on all branches of knowledge about higher university STEM studies about gender, to detect stereotypes.

Two non-experimental studies were carried out to determine what the Spanish university population of all branches of knowledge thinks about STEM university studies concerning gender. The first study, the pilot study, was applied using non-probabilistic snowball sampling in 2020. With a larger sample, the second study was implemented in 2021, using simple random probability sampling. Both studies were applied to university students from all branches of knowledge in public and private universities in Spain.

Participants had an active role in the research through both studies, as the results have been obtained directly from their participation, opinion, and discourse.

Regarding the pilot study results, analysing the behaviour of the variables of the Gender Ideology dimension, among all the possible motivations for choosing their studies, the motivation to select higher education because of the possibility of working on projects is the one that shows the least predisposition to gender stereotypes. On the other hand, gender stereotyping rates are higher for engineering and chemistry students. Finally, about previous interest in STEM domains, those who have previously shown interest have lower average values concerning gender ideology. Concerning the dimension of Perception and Self-perception, it should be noted that those whose decision was judged by a male teacher exceed the expected values, i.e., they obtain less desirable results. The influence of the motivation to work on projects is reiterated in the significant differences found in the dimension of Expectations about Science. Those who choose their studies, for this reason, have high expectations about science, which is positive. It should also be noted that those who previously showed an interest in STEM disciplines have higher expectations than those who did not show this interest. Finally, for the Attitudes dimension, not only teachers play an essential role, but also the family, since the more the father has advanced studies, the lower the weights become.

Regarding the quantitative results obtained in the second study of the doctoral thesis (n= 2101), the findings show that gender stereotypes in STEM education continue to persist. There are still beliefs that boys do more hands-on activities with their parents than girls; boys prefer STEM-related hobbies; there are more STEM boys than STEM girls because they are geekier; girls are not as interested in STEM as boys are; most girls are better at other things and choose different types of studies, such as arts; and STEM studies at university are generally more attractive to boys.

In addition, there is still a problem associated with stereotypes. A high percentage of participants still feel constrained by gender labels and the expectations placed on them by these labels. Moreover, some participants have been teased or bullied for acting as socially stipulated as being of the opposite sex.

These preliminary results are accentuated by the fact that, while a high percentage have had an interest in STEM areas at some point in their lives, 30% fewer have participated in any STEM activities. This indicates that they may perceive barriers to accessing these fields.

Further analysis of internal factors (motivations), positive external influences (role models/referents), and negative external influences (people who judged or questioned) shows that these are elements that also condition their views on STEM and gender. First of all, it has been corroborated that men are more inclined toward stereotypical thinking than women for the study carried out. Regarding the influence of belonging to STEM or not, men are more predisposed to biased thinking whether they belong to STEM or not, while women are more prone to bias than non-STEM women, probably because of their lack of proximity to the field.

Concerning motivations, it has been found that those aimed at collective benefit, networking, and community service, together with the motivation to choose higher education due to attraction to it, generate less predisposition to stereotypical thinking than those aimed at self-interest and individualism perpetuation of family tradition. However, the former motivations, those directed at society and networking, are more associated with feeling constrained by gender labels and expectations, especially for women.

Regarding having been judged or questioned at the time of making the decision about which higher education studies to pursue, it was found that the fact that the decision was

subject to value judgements aggravated the possibility of stereotypical thinking, given that such questioning could lower self-concept and self-confidence and therefore alter perception and self-perception.

Finally, regarding role models and references, the optimistic view is that there are both female and male role models in diverse settings such as the family, peer group, teachers, and other types of characters, such as those considered prestigious in the discipline or idols in audiovisual content space and video games. However, some, but not all, male role models increase the likelihood of biased thinking. This also happens in the case of girls who have had their female teachers as references.

Finally, regarding the opinion expressed verbally in the open questions, it is true that some people, both men and women, are aware that gender stereotypes and patriarchal culture have historically oppressed and still oppressed women. However, there are still men and women who are convinced that we are all equal and have the same rights and opportunities. Some people are against affirmative action measures because they believe that instead of making equality possible, they promote unnecessary actions from and towards inequality.

Thus, it is understood that social and cultural reluctance perseveres, which is acquired by both men and women, to suppress the gender stereotypes that constitute a discriminatory system.

10.2. Answer to the research questions of this doctoral thesis

This doctoral thesis aims to demonstrate the hypothesis: The opinion that the Spanish university population has about tertiary studies in the STEM areas concerning gender, that is, the ability of men and women to perform STEM tasks, is conditioned by personal factors, such as gender, academic factors, and family and contextual factors.

Different research questions have been posed to demonstrate this hypothesis. The research questions posed in this doctoral thesis are organised in two blocks. The first six questions can be answered based on the results obtained in the first block of the doctoral thesis. The last four questions can be answered based on the results obtained in the second block of the thesis. The research questions, organised in the two blocks, are answered in the following sections.

10.2.1. Research questions of the first block of this doctoral thesis

10.2.1.1. Are gender roles, biases, and stereotypes factors in deciding what higher education to pursue?

As explained by the Social Cognitive Model of Career Development (Lent et al., 1994; Lent & Brown, 1996), occupational vocation is shaped by elements that are not innate but socially constructed and contextually acquired. Among the social and contextual factors are gender stereotypes. The phenomenon called the gender gap originates from socio-cultural factors, especially gender roles and patterns, which chronicle segregation (Spertus, 1991).

10.2.1.2. Is the decision affected by the cultural context?

As stated in the Self-Efficacy Theory (Bandura, 1977) and the Social Cognitive Theory of Career Development (Lent et al., 1994), individuals are immersed in a cultural and social context that conditions the perception and self-perception of task performance, thus affecting the value of self-efficacy. This conditioning stems from gender stereotypes, stereotypical behaviour manifestations in training or work environments, and one's motivations.

10.2.1.3. Do family, educational environment, and peer group influence the decision?

Motivations are conditioned by the value of the family and the attribution of family care. Also, the family background, the transmission of messages by teachers, and the peer group play an essential role in the individual's decision (Gottfried et al., 2017; Kang et al., 2019; Lent et al., 1994).

10.2.1.4. Is perceived self-efficacy about performance capabilities in a STEM task contingent on pre-established social constructs?

The Social Cognitive Theory of Career Development (Lent et al., 1994), preceded by Bandura's Self-Efficacy Theory (1977), explains that segregation is not caused by biological, innate, inescapable, and reasoned factors due to purely sexual causes; instead, segregation is produced by social constructs based on social representations, understood as stereotypes (Bourdieu, 1984).

As stated in Bandura's Self-Efficacy Theory (Bandura, 1977), self-efficacy refers to the belief that a person has the competence to carry out the desired action. Thus, positive self-

knowledge can be enhanced by enhancing the discipline's scientific and confident identity and self-confidence. Moreover, if people gain agency, understood as the ability to act intentionally (Bandura, 1977), they will feel more prepared to engage in what they want to do.

Finally, self-efficacy can modulate the success and failure of decision-making, the performance of actions, and resistance during their development. In socially masculinised fields, such as the STEM sector, women tend to have lower levels of self-efficacy (Spencer et al., 1999), especially in the technology sector (Arning & Ziefle, 2007).

10.2.1.5. Are the motivations for pursuing one or other studies aligned with social factors and what is expected of each person according to their gender?

Culture is replete with gender roles that are socially constructed based on people's expectations based on their sex. Gender biases are unnatural constructs created in societies based on people's expectations. Thus, studies reveal that the occupational expectations of adolescents are still segregated by gender in the sense that boys and girls expect to pursue careers in different fields (Han, 2016; Sikora & Pokropek, 2011).

10.2.1.6. Is the under-representation of women in STEM studies associated with the feminisation and masculinisation of studies and professions?

The phenomenon called the gender gap, caused by the social construction of biases, influences the feminisation and masculinisation of studies and professions (Blackburn, 2017; Prentice & Carranza, 2002), leading to low female representation in masculinised studies, such as STEM.

10.2.2. Research questions of the second block of this doctoral thesis

10.2.2.1. Is there a belief among university students that men and women are different?

Part of the stereotypes that women have been manifested by attributing to women: empathy, sensitivity, collaboration, complexity, constancy, intuition, reflexive, hardworking, submissive, discreet, low self-esteem, complacent, dedication to others, less capable, preoccupation with physical appearance, gossipy, unbalanced, emotional, disciplined, envious, judgmental, untruthful, exploited in family and society, generous,

undervalued, prudent, cooperative, organisational and complex problem-solving skills, tenderness, warmth, sympathy, warm colours, and much thinking about things.

Whereas men are attributed with: aggressiveness, ambition, competition, physical strength, self-confidence, leadership, independence, capability, more personality, courage, simplicity, carefree, privileged, self-centred, selfish, macho, dominant, paternalistic, reckless, overvalued, success, competence, arrogant, prestige, entrepreneurial, structured, less social, boss, busy, superiority, cold colours, objectivity, and lazy.

On the other hand, some men in the research define women as sensitive, empathetic, organised, emotional, fragile, delicate, caring, less strong, more friendly, used as commercial objects, sexualised, less loyal, more complex, and tending to studies of letters and health.

As for men, their counterparts define them as strong, assertive, dominant, leaders, responsible, aggressive, risk-takers, intelligent, more challenging, daring, more self-confident, misunderstood, and overvalued.

Thus, it is evident that women are structurally and systematically punished, attributing characteristics that hinder their empowerment, as they are presented as submissive. Meanwhile, the patriarchal system and structure continue to grant privilege and leadership to men.

10.2.2.2. Does the university student population find differences between those pursuing STEM and non-STEM studies?

Women define people who study STEM as individuals with some family pressure to do "smart" things, numerate, critical, rigorous, systematic, technical, less sentimental, methodical, rational, intelligent, logical-mathematical intelligence, abstract thinking, agile, nerdy, masculine, self-sacrificing, square-jawed and orderly. The stereotype of the nerd is highlighted by the quality of the geek (Margolis & Fisher, 2003). Meanwhile, women also define non-STEM students as responsible individuals who have to fight against social pressure to do "not smart" things, with pleasure in reading, with sensitivity, empathy, open-mindedness, emotional intelligence, good memory, emotional, sensitive, collaborative, humane, with communicative intelligence, critical thinking, social

commitment, creativity, highly cultured, bohemian, with passion, degrees taken mainly by women, feminine or effeminate degrees, idealistic and dreamy.

On the other hand, men define STEM people as arrogant, introverted, technocratic, cold, rational, ambitious, dogmatic, solitary, dispassionate, sceptical, hardworking, serious, perfectionist, ambitious and geeky. Meanwhile, men, too, define non-STEM students as lost people who do not know what to study, lazy, extroverted, idealistic, creative, passionate, with a good memory, people who get a degree with less effort, and artists.

As can be seen, the stereotype is perpetuated to go into STEM. You need to be methodical and intelligent. To go into a non-STEM discipline, you need to be empathetic and have a good memory. Thus, according to the results, intelligence is exclusive to traditionally masculinised fields and empathy to feminised fields. In this way, it is structurally easy to make a reductionism to two categories where the differences between the two are coincidentally similar to the differences attributed to men and women.

10.2.2.3. Do you think there are typical studies and professions for men and women?

Although not all participants consider this the case, and some even deny it outright, other participants still express stereotypical beliefs.

Thus, some women attribute to men: science, engineering, naval engineering, aerospace engineering, computer science, economics, fireman, soldier, miner, construction and priest; and women are attributed to be beautiful and slim, nurses, midwives, teachers, occupational therapist, social worker, caregiver, and cleaner.

As for men, some of the participants consider typically male professions such as firefighter, surgeon, policeman, military, builder, farmer, stockbreeder, and mechanic. Women are associated with education, caring for others, floristry and catering.

As can be seen, there are still social biases for both men and women that continue to perpetuate the masculinisation and feminisation of studies and, above all, professions (Blackburn, 2017; Prentice & Carranza, 2002).

10.2.2.4. Do you think equal opportunities for men and women in STEM studies and STEM fields of work have been achieved?

Some women consider that the same rights and opportunities in training and employment have not yet been achieved for men and women. They point out that women see their

rights and opportunities as detrimental simply because they are women since, although in the legal framework they enjoy the same rights, in actual practice, especially in private companies, motherhood generates a disproportionate punishment for them due to the social imaginary where prejudices and inequalities are forged.

In addition, some point out that women do not have the same recognition, given that a man's discovery or discovery is more highly valued than a woman's, they also reach fewer leadership positions, and in the STEM field, they are not sufficiently represented, because they are considered to be "men's" things. Some women claim that a woman has to work twice as hard to prove herself as a man, even if she has the same skills and job.

However, while it is true that some are aware of the reality, it is worrying that some women point out that equality between men and women has already been fully achieved, thus showing a lack of awareness of the actual social, academic, and employment impact of women's subjugation to roles and stereotypes.

On the other hand, some men indicate that equal rights and opportunities between men and women have already been achieved in the academic and employment spheres and that women have more privileges than men because positive discrimination measures and quotas are applied, with which they disagree. In addition, some point out that if there are fewer women in the STEM sector, it is because they voluntarily choose other educational fields, not as a consequence of other social or structural conditioning factors.

Other men reveal stereotypes by stating that STEM careers are better suited to men because men have been the great scientists and inventors in history, and therefore, it is rare to see a woman in these sectors.

However, not all men reveal stereotypes or indicate that equal rights and opportunities have already been achieved or that women have more privileges. Some men indicate no equal opportunities because tradition generates inequalities to the detriment of women's growth, mainly because of motherhood, making them even choose between starting a family or working.

10.3. Final conclusion

Based on the results obtained in this research, it is possible to confirm the hypothesis of this doctoral thesis. The opinion that the Spanish university population has about tertiary

studies in the areas of science, technology, engineering and mathematics concerning gender, that is, the ability of men and women to perform STEM tasks, is conditioned by personal factors, such as gender, academic factors, and family and contextual factors.

There is still a long way to go since. While some men and women are aware that equal opportunities for men and women at the academic and employment level have not yet been achieved, many others think that equal rights and opportunities for men and women have already been fully achieved, or consider that the lack of equality is due to stereotypical elements. Also, there are still reductionist binary classifications about what it is to be a woman, be a man, what is expected of a person pursuing a STEM versus a non-STEM degree, or what is meant by profession "for men" or "for women".

Moreover, the tendency towards stereotypical thinking has not yet been abolished, with clear relationships between motivations, referents, having been challenged by studies, gender and belonging to STEM or non-STEM studies, and the opinion on the performance ability of men and women in STEM disciplines. Thus, the research hypothesis that the Spanish university population's opinion of tertiary studies in STEM fields concerning gender is conditioned by personal factors, such as gender, academic factors, and family and contextual factors, can be confirmed.

It is a mistake to consider that the goal of breaking the gender gap in STEM has already been achieved. It is a systemic, structural, and cultural problem in which it is still necessary to continue investing social, academic, and labour efforts, involving all the agents involved in the phenomenon, to implement changes in gender ideologies and perceptions of gender, to abolish roles and biases and, therefore, to remove the patriarchal construction in which discriminations and gaps are forged, solidified and perpetuated.

10.4. Limitations

Regarding the first block of this doctoral thesis, the main limitation encountered was the initial management of the 4571 results obtained in the Scopus and Web of Science databases. However, this limitation was mitigated in the different filtering phases and the volume of publications had been reduced.

Regarding the methodological design of the QSTEMHE instrument of this doctoral thesis, the limitation was found during the review phase of other instruments created by other

authors. Some of the questionnaires that could be useful were not available for consultation and reading, and the items could not be accessed. On the other hand, other instruments focusing on the gender gap only addressed specific areas of the STEM sector, such as computer science or biology. Still, they did not focus on the STEM sector as a whole. Finally, other instruments had not undergone a prior validation process.

About the application of the two empirical studies in the second block of this dissertation, the global health crisis caused by the COVID-19 virus occurred during the dissertation. Face-to-face teaching and some aspects of the research were affected by the situation. The priority was to save lives and prevent infections, which meant that studies that had been planned to be face-to-face had to be adapted to virtual formats. This was the case for the two empirical studies in this doctoral thesis.

First, during March and April 2020, the pilot study would be applied in classrooms. However, the planning was affected with the virtualisation of teaching. The questionnaire was disseminated online, mainly through emails to teachers at Spanish universities and the snowball technique to collect the data. However, the health situation affected the study, as it delayed collecting a sufficiently satisfactory sample.

As the main communication channel, many emails were received daily during the weeks of confinement due to the pandemic. Among the emails received were those related to this research because it was readapted to online data collection. Thus, the high flow of emails and the population's concerns may have led to a lack of interest in participating in the study by answering the questionnaire.

However, the slowing down of the data collection process in the pilot study was not the only limitation. The volume of responses expected with the face-to-face classroom application was higher than the final number of responses, reducing the sample size. Also, in terms of participation, a significant limitation was the low participation by men, which conditioned some gender contrasts and analyses. Although the questionnaire was distributed equally in male and female-represented settings, women were more represented. Also, a limitation encountered was that a large part of the sample belonged to the Social and Legal Sciences branch of knowledge. Another limitation was an equal distribution between men and women, this was also ocurr in groups of the different branches of knowledge; however, the representation of this branch was preponderated.

Concerning the pilot study, the variability of the responses was affected due to the low participation of those invited. During the first stage of the empirical validation procedure, some of the weights obtained were below 0.4, which is the recommended minimum.

On the other hand, although a study with a larger and more representative sample of the population was planned before the health crisis to confirm the model from the second stage of validation and to obtain data for its interpretation, what happened emphasised the need and interest in carrying out such a study. Thus, although the second empirical study of this doctoral thesis was carried out over a long time, due to the slowdown suffered, it was applied between February and May 2021. It did not encounter as many limitations as the pilot study. In this second study of the present doctoral thesis, 2101 persons participated fully, and the sample was representative of the population in terms of branches of knowledge. However, women still had more interest in participating in the study, as there was more female than male representation, although the dissemination was carried out equally between men and women.

10.5. Future research

This thesis establishes a complete theoretical framework for the gender gap in the STEM education sector in Spain. Empirical research has been carried out to detect the need to go deeper into the possible causes and modulating factors that propel horizontal segregation and, in other scenarios, also vertical segregation.

The thesis results show that real and effective equality between men and women in the STEM sector is still far from being achieved. It has also become evident that, although improvements are being introduced at the social and cultural level, gender stereotypes persist.

The gender gap in STEM higher education is a social phenomenon and a systemic problem. As has been explained throughout the chapters of this doctoral thesis, the gender gap manifests discriminatory segregation that is born and forged in the system. The cultural structure and social constructs, the work environment, and the educational space are niches for the gender gap. Therefore, it is necessary to continue to dedicate efforts and invest monetary funds to reduce the gap until it is mitigated in these scenarios.

In this line, it is necessary to continue carrying out outreach interventions for awareness-raising, prevention, and intervention. Thus, as future lines of action, the planning and implementation of training proposals aimed at teachers to learn how to take care of verbal and non-verbal language in the classroom are proposed to avoid the transmission of bias and paternalism based on the gender of the students. Likewise, with these proposals, it is proposed to provide training in preparing inclusive teaching materials. It is necessary to use non-sexist language while also emphasising the representation and visibility of men and women in the content, without differentiating based on gender.

Also, it is proposed to programme them for future teachers to work on preventing the gender gap among students by raising awareness and training students. This proposal is intended to be applied at all educational levels; given that, as is well known, it is necessary to prevent the incidence of segregation from an early age, as this is when gender roles are established and assimilated.

Furthermore, through the different training proposals mentioned above, the aim is to train in and for coeducation. Teachers need to acquire this educational method that defends gender equality without discriminating based on sex. In this way, teachers themselves will be able to value the abilities and performance of students without being conditioned by biases. However, it is also essential use coeducation to empower students with low self-perception due to a lack of a sense of belonging. Also, training in and for coeducation has positive effects, such as: reducing and eliminating the double demands on women to prove their worth, reducing competitiveness between men and women, improving self-concept regarding STEM tasks, and fostering motivation to pursue scientific-technical studies.

It is essential to promote STEM studies and disciplines about the latter. Thus, as future lines of action, it is proposed to implement initiatives to promote STEM areas, demystifying the scientific-technical professions. This can be done by making STEM areas visible as disciplines to benefit the community and society and refocusing motivations. This is expected to strengthen recruitment measures for girls and women. Part of these initiatives can be talks and activities in local, regional, and state public spaces, aimed at any age group and from any academic and work sector, to promote a gender ideology free of roles.

Many interventions already exist in the line of initiatives and should be further promoted and implemented. However, outreach interventions and actions to promote STEM studies and disciplines need to be institutionalised. As is well known, the gender gap is a systemic issue and must be addressed from within the system itself. Exclusionary segregation must be tackled from the institutional level to address it from the decision-making structure, the education system in general, and the university system. Indeed, initiatives and projects are funded through the European framework that aims to close the gender gap, such as the W-STEM project - Building the future of Latin America: engaging women into STEM, coordinated by the GRIAL research group at the University of Salamanca thanks to funding from the European Union's Erasmus+ programme. However, changes need to be established in higher education institutions' strategies and mechanisms of action to be replicated, adapted, and updated in other university institutions and other entities.

It is proposed to collaborate with public bodies and the business sector to promote awareness and training campaigns to promote safe spaces, facilitate a sense of belonging, and train to improve family and work reconciliation plans to respond to this need.

In concluding the future lines of research, the doctoral thesis did not go into qualitative analyses in-depth since the main objective was to test the hypotheses that were contrasted through quantitative tests. The aim was to determine how motivations and positive and negative external factors correlate with gender stereotypes about higher STEM studies. However, the relevance of qualitative research on gender stereotypes is well known. Therefore, as a future line of research, it is proposed to analyse the qualitative content collected through open-ended questions in-depth. For this purpose, the sequence of the phenomenological method and the Grounded Theory guidelines will be followed.

Finally, to find out whether gender stereotypes about higher STEM studies vary according to geography and culture, it is proposed to apply the instrument in international spaces, leading to greater comprehensiveness in European and global samples, both for quantitative and qualitative analyses.

10.6. Beneficiaries

All research generates results to lay the foundations for specific actors to inspire new initiatives and intervention measures, nurturing improvement strategies based on actual

data. Employing the results obtained in the studies of this doctoral thesis, public bodies, both at the international level (especially in Europe) and national level, could design bias prevention plans and socio-educational and business interventions on a national and even European scale. On a smaller scale, regional and local public bodies can consider their improvement mechanisms inspired by the figures achieved and the discourses collected. However, not only public bodies can benefit from the research findings, but also educational institutions, schools, and universities, to implement direct actions on the curriculum, teaching methodologies, content, and style of discourse, regardless of the academic level (ISCED/ISCED) and educational field.

Moreover, as the gender gap is a problem not only in the educational space but also in the labour space, knowing the reality of horizontal segregation can envision the business sector, implementing new equal opportunities and work-life balance plans to mitigate the barrier of stabilisation and promotion due to single-family responsibility.

Finally, research institutes and associations, and entities linked to research and education can consider opening new lines of research, including the gender gap in STEM. If funding is provided to raise the visibility of the problem, it could have a more significant impact on the pursuit of improvement.

10.7. Results associated with the thesis

During the doctoral thesis, I have participated in research projects, contributed to scientific publications, and carried out an international stay.

10.7.1. Scientific publications placed in the context of the doctoral thesis

In terms of scientific contributions, during the period of development of the doctoral thesis, several contributions have been made through scientific articles, book chapters, and contributions to national and international conferences related to the doctoral thesis or topics addressed in parallel to the thesis, such as women's issues, inclusive language, and equality.

Two articles in scientific journals are indexed in JCR, four articles indexed in Scopus, one article indexed in Latindex and Erihplus, four book chapters indexed in SPI, and fifteen conference papers which ten are indexed in Scopus and six in Web of Science.

In addition, three scientific articles are under review process in high impact scientific journals. One of them presents the SLR carried out. Another one presents the Codebook built in the framework of this doctoral thesis. Finally, another article argues the usefulness of CAQDAS for visualising metadata, using the metadata obtained in the systematic review.

The bibliographical references of these publications are presented below.

Articles published in high impact journals indexed in JCR:

- **Verdugo-Castro, S**., García-Holgado, A., Sánchez-Gómez, M. C., & García-Peñalvo, F. J. (2021). Multimedia Analysis of Spanish Female Role Models in Science, Technology, Engineering and Mathematics. *Sustainability*, *13*(22), 12612. https://doi.org/10.3390/su132212612. (JCR SCIE - ENVIRONMENTAL SCIENCES – Q2 (133 de 279); GREEN & SUSTAINABLE SCIENCE & TECHNOLOGY – Q3 (35 de 47); JCR SSCI - ENVIRONMENTAL STUDIES – Q2 (57 de 127); GREEN & SUSTAINABLE SCIENCE & TECHNOLOGY – Q4 (7 de 9) - JIF 3.889).
- **Verdugo-Castro, S.**, Sánchez-Gómez, M. C., & García-Holgado, A. (2022). University students' views regarding gender in STEM studies: Design and validation of an instrument. *Education and Information Technologies*. https://doi.org/10.1007/s10639-022-11110-8. (JCR SSCI – EDUCATION & EDUCATION RESEARCH – Q1 (62 de 267) - JIF 3.666).

Articles published in high impact journals indexed in Scopus:

- **Verdugo-Castro, S**. (2019). Detection of needs in the lines of work of third sector entities for unemployed women in situations of social exclusion. *Pedagogía Social. Revista Interuniversitaria*, *0*(34), Article 34. https://doi.org/10.7179/PSRI_2019.34.12. (SJR 0.11 – EDUCATION – Q4; SOCIOLOGY AND POLITICAL SCIENCE – Q4).
- García-Holgado, A., **Verdugo-Castro, S**., González-González, C. S., Sánchez-Gómez, M. C., & García-Peñalvo, F. J. (2020). European Proposals to Work in the Gender Gap in STEM: A Systematic Analysis. *Revista Iberoamericana de Tecnologías Del Aprendizaje*, *15*(3), 215–224. https://doi.org/10.1109/RITA.2020.3008138. (SJR 0.227 – ENGINEERING – Q3; EDUCATION – Q3; E-LEARNING – Q4).

- Martín-Cilleros, M. V., Sánchez-Gómez, M. C., **Verdugo-Castro, S**., & Verdugo Alonso, M. Á. (2020). Opiniones de la calidad de vida desde la perspectiva de la mujer con discapacidad. *RISTI - Revista Ibérica de Sistemas e Tecnologias de Informação, 38*, 64–78. https://doi.org/10.17013/risti.38.64-78. (SJR 0.142 – COMPUTER SCIENCE – Q4).
- **Verdugo-Castro, S.**, Sánchez-Gómez, M. C., & García-Holgado, A. (2022). Opiniones y percepciones sobre los estudios superiores STEM: Un estudio de caso exploratorio en España. *Education in the Knowledge Society*, *23*, 15. https://doi.org/10.14201/eks.27529. (SJR 0.664 - EDUCATION – Q2; COMPUTER SCIENCE APPLICATIONS – Q2).

Journal article indexed in Latindex and Erihplus:

- **Verdugo-Castro, S**., Sánchez-Gómez, M. C., García-Holgado, A., & García-Peñalvo, F. J. (2020). Rompiendo brechas: Propuesta de orientación sociolaboral con víctimas de violencia de género. *Revista Latina de Sociología*, *10*(1), 24–58. https://doi.org/10.17979/relaso.2020.10.1.6826.

Book chapters:

- **Verdugo-Castro, S**., García-Holgado, A., & Sánchez-Gómez, M. (2020). Análisis e intervención sobre la brecha de género en los ámbitos educativos STEM. In *Estudios interdisciplinares de género.* (1ª, pp. 591–608). Tirant Lo Blanch. (Posición 1 de 105 en SPI – Q1 – ICEE 1037).
- Martín-Cilleros, M. V., **Verdugo-Castro, S**., & Paredes Cabanzo, L. (2021). El lenguaje inclusivo como indicador de avance hacia una sociedad igualitaria. In E. Mena Rodríguez (Ed.), *Nuevos pensamientos, nuevos lenguajes desde la perspectiva de género para nuevas realidades* (pp. 53–65). Octaedro. (Posición 40 de 105 en SPI – Q1 – ICEE 116).
- Sánchez-Gómez, M. C., **Verdugo-Castro, S**., & Gajardo Bustos, I. (2021). Percepción sobre el lenguaje inclusivo en estudiantes de la Educación Superior. In *Nuevos pensamientos, nuevos lenguajes desde la perspectiva de género para nuevas realidades.* (pp. 37–52). Octaedro. (Posición 40 de 105 en SPI – Q1 – ICEE 116).
- **Verdugo-Castro, S**., García-Holgado, A., Sánchez-Gómez, M. C., Domínguez Cuenca, M. de los Á., Hernández-Armenta, I., García-Peñalvo, F. J., & Vázquez-

Ingelmo, A. (2021). Identificación de barreras y motivaciones percibidas por mujeres estudiantes de ingeniería y matemáticas: Estudio de caso en España y Latinoamérica. In *Estudios interdisciplinares de género* (pp. 813–828). Aranzadi Thomson Reuters. https://dialnet.unirioja.es/servlet/articulo?codigo=8199580. (Posición 3 de 105 en SPI – Q1 – ICEE 911).

Contributions to conferences:

- **Verdugo-Castro, S**., Sánchez-Gómez, M. C., & García-Holgado, A. (2018). Gender gap in the STEM sector in pre and university studies of Europe associated with ethnic factors. In *Proceedings of the Sixth International Conference on Technological Ecosystems for Enhancing Multiculturality* (pp. 984–990). ACM. https://doi.org/10.1145/3284179.3284348
- García-Holgado, A., Vázquez-Ingelmo, A., Mena, J., García-Peñalvo, F. J., González-González, C. S., Sánchez-Gómez, M. C., & **Verdugo-Castro, S**. (2019). Estudio piloto sobre la percepción de la brecha de género en estudios de ingeniería informática. In M. L. Sein-Echaluce Lacleta, Á. Fidalgo Blanco, & F. J. García-Peñalvo (Eds.), *Aprendizaje, Innovación y Cooperación como impulsores del cambio metodológico. Actas del V Congreso Internacional sobre Aprendizaje, Innovación y Competitividad. CINAIC 2019 (9-11 de Octubre de 2019, Zaragoza, España)* (pp. 698–703). Servicio de Publicaciones Universidad de Zaragoza.
- García-Holgado, A., Vázquez-Ingelmo, A., **Verdugo-Castro, S**., González-González, C. S., Sánchez-Gómez, M. C., & García-Peñalvo, F. J. (2019). Actions to promote diversity in engineering studies: A case study in a Computer Science Degree. In *2019 IEEE Global Engineering Education Conference (EDUCON), (9-11 April 2019, Dubai, UAE)*. IEEE. https://doi.org/10.1109/EDUCON.2019.8725134
- García-Holgado, A., **Verdugo-Castro, S**., Sánchez-Gómez, M. C., & García-Peñalvo, F. J. (2019). Trends in studies developed in Europe focused on the gender gap in STEM. In *Proceedings of the XX International Conference on Human Computer Interaction* (p. Article 47). ACM. https://doi.org/10.1145/3335595.3335607
- **Verdugo-Castro, S**., García-Holgado, A., & Sánchez-Gómez, M. C. (2019). Age influence in gender stereotypes related to Internet use in young people: A case

study. In M. Á. Conde-González, F. J. Rodríguez Sedano, C. Fernández Llamas, & F. J. García-Peñalvo (Eds.), *Proceedings of the 7th International Conference on Technological Ecosystems for Enhancing Multiculturality (TEEM 2019) (León, Spain, October 16-18, 2019)* (pp. 223–231). ACM. https://doi.org/10.1145/3362789.3362846

- **Verdugo-Castro, S**., García-Holgado, A., & Sánchez-Gómez, M. C. (2019). Analysis of instruments focused on gender gap in STEM education. In M. A. Conde-González, F. J. Rodríguez Sedano, C. Fernández Llamas, & F. J. García-Peñalvo (Eds.), *Proceedings of the 7th International Conference on Technological Ecosystems for Enhancing Multiculturality (TEEM 2019) (León, Spain, October 16-18, 2019)* (pp. 999–1006). ACM. https://doi.org/10.1145/3362789.3362922
- **Verdugo-Castro, S**., García-Holgado, A., & Sánchez-Gómez, M. C. (2019). Percepción de los estereotipos de género asociados al uso de Internet en estudiantes de pedagogía. In M. L. Sein-Echaluce Lacleta, Á. Fidalgo Blanco, & F. J. García-Peñalvo (Eds.), *Aprendizaje, Innovación y Cooperación como impulsores del cambio metodológico. Actas del V Congreso Internacional sobre Aprendizaje, Innovación y Competitividad. CINAIC 2019 (9-11 de Octubre de 2019, Zaragoza, España)* (pp. 629–634). Servicio de Publicaciones Universidad de Zaragoza.
- **Verdugo-Castro, S**., Sánchez-Gómez, M. C., García-Holgado, A., & Costa, A. P. (2019). Mixed methods and visual representation of data with CAQDAS: empirical study. In M. Á. Conde-González, F. J. Rodríguez Sedano, C. Fernández Llamas, & F. J. García-Peñalvo (Eds.), *Proceedings of the 7th International Conference on Technological Ecosystems for Enhancing Multiculturality (TEEM 2019) (León, Spain, October 16-18, 2019)* (pp. 511–517). ACM. https://doi.org/10.1145/3362789.3362847
- **Verdugo-Castro, S**., Sánchez-Gómez, M. C., García-Holgado, A., & García-Peñalvo, F. J. (2019). Revisión y estudio cualitativo sobre la brecha de género en el ámbito educativo STEM por la influencia de los estereotipos de género. In A. P. Costa, I. Pinho, B. M. Faria, & L. P. Reis (Eds.), *Atas—Investigação Qualitativa em Ciências Sociais/Investigación Cualitativa en Ciencias Sociales* (Vol. 3, pp. 381–386).

- García-Holgado, A., **Verdugo-Castro, S**., Sánchez-Gómez, M., & García-Peñalvo, F. J. (2020). Facilitating access to the role models of women in STEM: W-STEM mobile app. In *Learning and Collaboration Technologies. Design, Experiences. 7th International Conference, LCT 2020, Held as Part of the 22nd HCI International Conference, HCII 2020* (pp. 466–476). Springer Nature. https://doi.org/10.1007/978-3-030-50513-4_35
- Martín-Cilleros, M., Sánchez-Gómez, M., Verdugo-Alonso, M. Á., Crespo-Cuadrado, M., Sánchez-García, A. B., Caballo-Escribano, C., **Verdugo-Castro, S**., & Manjón-García, E. (2020). Mujer y discapacidad: Percepción de su calidad de vida. In *Investigación Cualitativa en Educación: Avances y desafíos* (Vol. 3, pp. 623–634). NTQR New Trends In Qualitative Research. Ludomedia. https://publi.ludomedia.org/index.php/ntqr/article/view/190
- **Verdugo-Castro, S**., García-Holgado, A., & Sánchez-Gómez, M. C. (2020). Interviews of Spanish women in STEM: a multimedia analysis about their experiences. In F. J. García-Peñalvo (Ed.), *Proceedings of the 8th International Conference on Technological Ecosystems for Enhancing Multiculturality (TEEM 2020) (Salamanca, Spain, October 21-23, 2020)*. ACM.
- **Verdugo-Castro, S**., Sánchez-Gómez, M. C., García-Holgado, A., & Bakieva, M. (2020). Pilot study on university students' opinion about STEM studies at higher education. In F. J. García-Peñalvo (Ed.), *Proceedings of the Eight International Conference on Technological Ecosystems for Enhancing Multiculturality (TEEM 2020) (Salamanca, Spain, October 21-23, 2020)* (pp. 158–165). ACM.
- García-Holgado, A., **Verdugo-Castro, S**., Domínguez, Á., Itzel, H.-A., García-Peñalvo, F. J., Vázquez-Ingelmo, A., & Sánchez-Gómez, M. C. (2021). The experience of women students in engineering and mathematics careers: A focus group study. In *2021 IEEE Global Engineering Education Conference (EDUCON), (21-23 April 2021, Vienna, Austria)* (pp. 50–56). IEEE.
- Sánchez-Holgado, P., García-Holgado, A., **Verdugo-Castro, S**., & Sánchez-Gómez, M. C. (2021). Breakfast of women researchers: Network of experiences and local group at the University of Salamanca in Spain. *8th European Communication Conference Online. 6-9 September 2021. Communication and Trust. Ecrea. Abstract Book*, 448.

Other contributions:

- **Verdugo-Castro, S.**, García-Holgado, A., & Sánchez-Gómez, M. C. (2021). *Code repository that supports the research presented in the paper 'The gender gap in higher STEM studies: A Systematic Literature Review' (v1.0) [Data set]*. Zenodo. https://zenodo.org/record/5775211

10.7.2. Research projects in which the doctoral thesis was contextualised

In addition to scientific publications, the doctoral thesis presented in this paper has been framed in research projects associated with the latent gender gap in the STEM sector. Data from the projects are compiled below.

European projects:

- **WYRED: netWorked Youth Research for Empowerment in the Digital society**
    - Source of funding: European Union. Horizon 2020, Europe in a changing world – inclusive, innovative and reflective Societies. H2020-SC6-REV-INEQUAL-2016
    - Coordinator: University of Salamanca
    - Principal Investigator: Dr. Francisco José García Peñalvo
    - Partners: Oxfam Italia, PYE Global, Asist Ogretim Kurumlari A.S. - Doga Schools, Early Years - The organisation for young children LBG, Youth for exchange and understanding international, MOVES - Zentrum für Gender und Diversität, Boundaries Observatory CIC, Tel Aviv University
    - Reference: 727066
    - Duration: from 01/11/2016 to 31/10/2019
    - Budget: 993.662,50€
    - Website: https://wyredproject.eu
- **W-STEM – Building the future of Latin America: engaging women into STEM**
    - Source of funding: European Union. ERASMUS + Capacity-building in Higher Education Call for proposals EAC/A05/2017
    - Coordinator: University of Salamanca
    - Principal Investigator: Francisco J. García Peñalvo

  - Partners: Universidad del Norte, Oulu University, Politecnico di Torino, Technological University Dublin, Nothern Regional College, Tecnológico de Monterrey, Universidad de Guadalajara, Universidad Técnica Federico Santa María, Pontificia Universidad Católica de Valparaíso, Universidad Tecnológica de Bolívar, Instituto Tecnológico de Costa Rica, Universidad de Costa Rica, Universidad Técnica particular de Loja, Universidad Técnica del Norte
  - Reference: 598923-EPP-1-2018-1-ES-EPPKA2-CBHE-JP
  - Duration: from 15/01/2019 to 14/07/2022
  - Budget: 862.268€
  - Website: https://wstemproject.eu/

- **Co-thinking and Creation for STEAM diversity-gap reduction (CreaSTEAM)**
  - Source of funding: European Union. Erasmus + KA2 – Cooperation and Innovation for Good Practices. Strategic Partnerships for school education
  - Coordinator: Universitat Ramon Llull
  - Principal Investigator: David Fonseca Escudero
  - Partners: University of Salamanca, Federazione Istituti Di Attività Educative, Bursa Il Milli Eğitim Müdürlüğü, Sadettin Türkün Ortaokulu, Studienseminar GHRF Gießen, Clemens-Brentano-Europaschule
  - Reference: 2020-1-ES01-KA201-082601
  - Duration: from 01/10/2020 to 31/03/2023
  - Budget: 240.736,00 €
  - Website: https://creasteam.eu/

National projects:

- **Incorporation of the gender perspective in university teaching through the training of active and trainee teaching staff**
  - Source of funding: Instituto de la Mujer y para la Igualdad de Oportunidades del Ministerio de Igualdad
  - Coordinator: University of Salamanca
  - Principal Investigator: Alicia García Holgado
  - Reference: 19/5ACT/20
  - Duration: from 15/02/2021 to 01/10/2021

  - Budget: 12.646,00€
  - Website: https://coeducacion.grial.eu

- **Gender-sensitive mentoring programme for women in STEM careers**
  - Source of funding: Instituto de la Mujer y para la Igualdad de Oportunidades del Ministerio de Igualdad
  - Coordinator: University of Salamanca
  - Principal Investigator: Alicia García Holgado
  - Reference: 35/3ACT/21
  - Duration: from 01/01/2022 to 30/11/2022
  - Budget: 23.407,10 €
  - Website: https://mentorias.wstemproject.eu/

On the other hand, I have also participated in a European project not directly related to the doctoral thesis line of research.

- **SIDECAR - Skills In DEmentia CARe. Exchanging psychosocial knowledge and best practice in dementia care**
  - Source of funding: European Union. Erasmus + KA2 – Cooperation for innovation and the exchange of good practices. Strategic Partnerships
  - Coordinator: Alma Mater Studiorum Università di Bologna
  - Principal Investigator: Rabih Chattat
  - Partners: University of Salamanca, Universiteit Maastricht, Institute for Postgraduate Medical Education
  - Reference: 2018-1-IT02-KA203-048402
  - Duration: from 11/11/2018 to 31/10/2021
  - Budget: 431.508€
  - Website: https://sidecar-project.eu/

10.7.3. International stay

Regarding international stays, from 29 May 2019 to 20 September 2019, an international stay was carried out at the University of Aveiro (Portugal), in the Departamento de Educação e Psicologia, del Centro de Investigação “Didática e Tecnologia na Formação de Formadores – CIDTFF". The researcher in charge of the stay was Dr. António Pedro Costa.

The general objective of the stay was to increase the mastery of methodology in qualitative research. For this purpose, two specific objectives were set: (1) to contact webQDA as a support software for content analysis, and (2) to design new visualisation models.

An immersion in the functioning, potentialities and new opportunities of webQDA was carried out, and new possible visual models to import into the software were studied to achieve these objectives. Finally, some visual models were proposed to the webQDA coordinator, Dr. António Pedro Costa, for possible import into the programme.

As a result of the collaboration with the webQDA team, an entry was published in the software's blog, after being invited to do so:

- **Verdugo-Castro, S**. (2019). Seis formas de representar gráficamente los resultados con webQDA. *webQDA*. https://www.webqda.net/6-formas-de-representar-graficamente-los-resultados-con-webqda/?lang=es

Also, as a result of the collaboration process, I have conducted several webinars and courses on the use and management of webQDA.

Finally, contact and synergies continue to exist with Dr. António Pedro Costa to enrich and contribute new ideas to the programme.

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