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Exploring Pre-Service STEM Teachers' Capacity to Teach Using a Gender-Responsive Approach

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Abstract: Teachers' perceived efficacy of their ability to teach using a gender approach is key for future generations to become more gender-sensitive and respectful towards gender inequities. However, little is known about graduate training for gender-responsive STEM (science, technology, engineering, and mathematics) teaching. In this study, after exploring the measurement invariance across countries (Greece and Spain) and sexes (male and female) of the TEGEP (Teacher Self-Efficacy for Gender Equality Practice) scale, a total of 222 prospective secondary school STEM teachers (136 Greek, 86 Spanish) from seven public universities were surveyed. Results showed that (1) the TEGEP has acceptable measurement invariance across countries and among sexes allowing comparison between groups and (2) that Greek and Spanish STEM students finish their master studies without sufficient confidence in gender knowledge, skills, and attitudes to practice a gender-sensitive teaching. The ability to teach gender knowledge was significantly higher in Greek than in Spanish students (4.52 vs. 4.03), while the latter felt more competent than the Greek students in conveying values/attitudes in regard to gender (4.54 vs. 4.83). The study calls for reflection, and considering that gender mainstreaming in STEM is anecdotal and not aligned with existing curricula, seeks to raise awareness and institutional compromise in implementing a gender-responsive approach in STEM. The TEGEP could be utilized to assess and monitor the gender competencies required of graduates in order to provide a more equitable and gender-sensitive STEM education in Greece and Spain.

Keywords: gender equality; gender mainstreaming; self-efficacy; STEM teacher education; pre-service teachers' beliefs; secondary education; scale validation; Spain; Greece

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1. Introduction

Gender equality (GE) is a fundamental right in today's globalized world. It appears as one of the focal points among the principles and values of the United Nations (UN) international law, as well as on the European Union's (EU) jurisdiction and other regions of the world. Achieving GE has become a global priority since the 1970s. The starting point was the global agreement adopted in 1979, in New York, by the General Assembly of the United Nations, the *Convention on the Elimination of all Forms of Discrimination Against Women* (CEDAW) [1], ratified by more than 180 countries, who committed to legislate and develop actions to equalize the rights and privileges of women with those of men. One of those actions included addressing gender equality through education. The need to address the gap between the declaration of principles and its translation in practice soon led to the proclamation of other declarations among which stand the *Beijing Declaration and Platform for Action* [2], the *Education for All* (EFA) movement [3], and the *Agenda 2030 for Sustainable Development* [4], from which the *Incheon Declaration* through the *Education 2030 Framework for Action* provides guidance for implementing Education 2030. The ultimate goal is achieving GE and empowering all women and girls (SDG5) through inclusive and equitable quality education for all (SDG4) by mainstreaming gender equality and human rights at all levels in national education policies, curricula, teacher education, and student assessment (indicator 4.7.1).

As a result of these initiatives, women around the world and other disadvantaged groups have seen their rights increase in many areas guaranteed by gender laws and policies. In Europe, the influence of the Council of Europe has been decisive in guiding the development of equality through the establishment of Gender Equality Strategies, from which the *Gender Equality Strategy* 2020–2025 [5] committed to achieving a Union of Equality, that is to say, a gender-equal Europe. But the achievements so far have been uneven depending on the cultural, political, and socio-economic status of its diverse countries. For instance, in Spain, the ratification of the CEDAW [1] and the country's incorporation into the EU in 1986 were decisive for the development of gender policies. This led to the publication of two laws, PL 1/2004 on *Comprehensive Measures against Gender Violence* and PL 3/2007 for *Effective Equality between Women and Men*. Both laws contributed to raising awareness of gender-based violence, equity in employment, and care of dependent people, as well as giving the green light to same-sex marriage and the expansion of sexual and reproductive rights [6,7]. Specifically, Article 4 of PL 1/2004 entrusts higher education institutions with the task of training for equality (p. 42169), while PL 3/2007 introduces methods and strategies for the effective incorporation of a gender perspective in all policies by adopting a gender mainstreaming (GM) approach, creating equality plans, and establishing a budget to measure GM implementation. Similarly, in other southern European countries such as Greece, the Government adopted the EU recommendations on gender equality and ratified international agreements to enact its own laws protecting women's labor, family, and education rights through PL 1329/83 and promoting equal treatment against all types of discrimination through PL 4443/2016. Despite those advances, inequalities persist, and GE is far from being achieved, as highlighted by the indicators on the Gender Equality Index (GEI). According to the last GEI [8], the European countries with greater GE are Sweden (83.9 points out of 100), Denmark (77.8), and the Netherlands (77.3), and those with less equality are Greece (53.4), Romania (53.7), and Hungary (54.2). Spain ranks sixth in the EU with a score of 74.6 out of 100, clearly above the EU average of 67.9. In the EU context, gender inequalities are most prominent in the domain of power (55.0 points), while the domain of health (87.8 points) is the closest to gender equality, especially in access to health services (98.2 points) and education (99 points). Overall, the GEI shows that advances have been made over the past decades, but there are still significant differences between countries that have recently been intensified by the effects of the COVID-19 pandemic, which in interaction with other sources of inequality (ethnic, cultural, socio-economic, etc.), have contributed to the exacerbation of existing inequalities [9].

Given the recognition of education as a main driver of development by the *Education 2030 Framework for Action*, universities have been forced to align their mission with GE policy commitments by incorporating gender and social justice principles into their basic activities of teaching, research, and innovation. While the Bologna Plan embodied the mandate of GM into university degree guidelines, the European Framework Programs for Research and Innovation (e.g., Horizon 2020) did the same into research guidelines. However, GM implementation has been accompanied by multiple impediments, the most common being resistance to change [10–12], vagueness in implementation and enforcement of GE policies [13–15], and androcentrism still being strongly entrenched in institutions [16,17]. In the field of teaching, a number of research studies [18–31] provide evidence of the absence of a gender-responsive approach in undergraduate and postgraduate studies, confirming that GE training is scarce. Despite existing policies for teaching with a gender perspective, there is a lack of clarity, absence of guidelines, inadequate resources, and poor implementation, monitoring, and evaluation [32]. Even in cases where gender equality training has been incorporated into degree programs, there is a pattern of common weaknesses: (a) programs do not provide university students with enough opportunities to question, acknowledge, and understand their own world views and gender beliefs disregarding gender awareness [33,34]; (b) programs do not address issues of diversity and gender equity rooted in the broader context of society and in the institution itself; (c) programs do not pay attention to the structural and contextual factors that cause inequality [16,35]; and (d) programs do not use a comprehensive approach to teaching gender, but simply add gender subjects to the curriculum instead of approaching implementation and development through a social justice framework [36]. All of these issues reveal the current reality that higher education degrees are failing to prepare gender-sensitive professionals as established in the global indicators [37–39]. In specific, Spain (1.25) and Greece (n.d.) score below the average of the OECD countries (0.60) in the *Measuring Distance to the SDG Targets* report [37], indicating that even though education for GE (Target 4.7.1) is mainstreamed in national education policies, GE is far from being present in curricula, teacher education, and student assessment.

Reversing this situation requires putting into practice strategies to analyze and improve the quality of teacher education. Preparing teachers as agents of change involves a process of reflection and transformation that affects curriculum design and learning outcomes [40–42]. In response to this pressure, various organizations have established curricular directions [24,43–45]. For example, the *Xarxa Vives d'Universitats* (https://www.vives.org/xarxa-vives-qui-som/ accessed on 1 February 2023) led an initiative that brought together 22 universities in Andorra, Spain, France, and Italy to help implement gender mainstreaming in teaching through the design of teaching guides. The network has published 17 guides that have inspired other researchers to develop similar resources and tools [20,27,31,46–50] with the objective of not only providing resources for teaching with a gender focus, but also opportunities to work on gender stereotypes and developing critical thinking skills to avoid gender blindness in future practice. Regardless of these efforts, teaching and research in Spain continue to be mostly androcentric, as evidenced by the fact that only 17% of undergraduate programs incorporate gender-specific subjects into study plans and only 4% of master's degrees include gender subjects [31]. In Greece, the situation is even worse. Although the policy of GM became a reality between 2016 and 2020 in various Greek faculties (Law, Medicine, Psychology, Psychiatry, Physical Education, Military Institutes and Police Schools) [51], the strategy has not been institutionalized, and teaching practices continue to be gender-neutral and dependent on the will of educators [52]. This state of affairs demonstrates that mainstreaming gender into higher education curricula has not been taken as a priority action, evidencing a disappointing implementation whose most direct consequence is that graduates finish their studies without the capacity to teach using a gender-responsive approach.

1.1. Education for Gender Equality in STEM

The outlook of training for gender equality in STEM is not better than in other areas of knowledge from the social and humanities sciences [53]. Given that STEM fields are considered key to promoting innovation, economic growth, and prosperity [4], future STEM professionals should be equipped with the necessary skills to work and live within a gendered equitable world. STEM fields are a sector where gender gaps are highly visible, and therefore, there is a greater urgency to provide future STEM professionals with competencies for identifying existing gender inequalities and its implications on their future practice [23,54]. According to UNICEF's report, *Mapping Gender Equality in STEM from School to Work*, there is a significant gap in the access of women to STEM careers rooted in gender stereotypes, bias, and norms [55]. Even though girls are equally or more likely than boys to achieve math and science proficiency levels in school, they have lower self-confidence in their STEM abilities, thus affecting their engagement, interest, and motivation in the field [55]. The latest statistics from the World Economic Forum also provide evidence of the gender-based disparities in STEM jobs [56], revealing that women continue to be overrepresented in education and health/welfare fields and underrepresented in STEM. The gender gap is most prevalent in information and communication technologies (1.7% of men vs. 8.2% of women graduates) and in engineering and manufacturing (24.6% for men vs. 6.6% for women) despite women having more access than ever through online learning.

Considering that these disparities can be reduced through education via gender mainstreaming and that this strategy has been globally accepted as the mechanism to achieve GE in much of the world [19], preparing STEM professionals to be cognizant and critical of gender stereotypes and inequities is a must. If STEM education should teach students more than science and mathematics, then focusing on the development of a broader student skill set should include not only skills for the 21th century, but skills on how to live and create a more just, fair, and equitable world. As Yogurtcu [57] (p. 1) stated, "we cannot achieve GE without first being educated, . . . without representing it in the education system and recognizing gaps in equal education opportunities for all genders or underrepresented groups". Teacher education institutions play a critical role in the transfer of knowledge, skills, and beliefs to future generations and must educate for gender equity. Liu [58] goes even further, stating that GE is a critical issue in STEM and that inequality issues deserve more attention in this field arguing that "rather than trying to address the lack of equitability and representation of STEM disciplines, the attention for future STEM teacher education . . . should instead be given to a number of inequality issues with regard to gender, ethnicity, immigration status and so on". (p. 132)

The literature provides very few examples on how to incorporate a gender approach in STEM education. Kortendiek [24] identified at least four approaches: (1) the cross-discipline approach (inclusion of a gender module for several courses); (2) the integrative approach (gender across discipline tasks and integrated as part of the subject); (3) the particular explicit approach; and (4) the explicit approach (BA/MA degrees in gender studies). These approaches have been implemented with varying degrees of success. For example, the work of Colatrella [21] at the Georgia Institute of Technology exemplifies the commitment of some STEM educators whose initiatives have contributed to change the neutral vision of gender in STEM by introducing the study of gender issues in the field through an explicit approach to GM. To Colatrella, good practice in GM implementation could be valuable to increase the representation of women and minorities in STEM and in helping prepare them to participate in those fields. Her experience demonstrates that gender studies can bring multiple benefits to STEM education such as: (a) teaching students to analyze how gender, race, ethnicity, class, age, and sexual orientation affect participation in society; (b) promoting understanding of personal and social values and intellectual merit by learning how organizational environments incorporate or exclude individuals on the basis of gender; (c) building institutional capacity and promoting leadership and mentoring to benefit the campus community; and so on. Another exemplary initiative is the entrepreneurial work of the Universitat Politècnica de Calalunya, or UPC [46]. The UPC, aware of the need to increase the number of female students in STEM, began to implement action plans more than 25 years ago. In 2007, it designed its first Gender Equality Plan, with the aim of becoming a more gender-balanced institution where women could have the same opportunities as men in their academic career. At the end of 2018, the team designed a pilot project for including a gender approach into teaching with the focus on training a group of educators and increasing awareness that could help academic staff to teach gender-sensitively. The project concluded on the urgent need to raise awareness not only in faculty but also in students by mainstreaming gender to all disciplines or by introducing specific gender modules and subjects. In addition, because research on GM implementation in teaching has not focused enough on developmental processes, there have been voices calling to shift attention from politics to action by offering guidelines for the inclusion of a gender perspective in STEM disciplines [32,59]. Depending on the nature of the subjects, specific teaching guides and/or modules have been designed in physics [60], medicine [26,61], architecture [62,63], mathematics [64,65], computer science [66,67], and engineering [68,69], but even with these initiatives, progress in GM implementation in STEM is still scarce and anecdotal. To advance the work and improve the quality of STEM education and its capacity to reduce gender inequalities, it is necessary to assess what gender competencies STEM students acquire throughout their training. Not only that, it is also necessary to assess what motivation and capacity to teach with a gender-sensitive approach future STEM teachers have that link to the concept of self-efficacy for gender equality practice.

1.2. Teacher Self-Efficacy for a Gender-Responsive Teaching in STEM

Self-efficacy is a concept that is useful for understanding the motivations and behaviors of teachers. The term was coined by Bandura [70] in his social cognitive theory and has been used to measure the perceived ability to successfully perform a certain task in a variety of settings such as education, health, sports, and work. It has been operationalized in different ways [71,72] and, although originally it was understood as a general teacher characteristic [73], more recently it has been shown to be an attribute domain-specific that can vary across teachers, subject matter, different types of learners, and even across specific fields or domains of teaching [74].

Perceived efficacy is positively related to high-quality instructional processes, student achievement, and teacher well-being [75–77]. Teachers with high self-efficacy tend to believe that they can make a difference in student performance and trust their abilities significantly more than those with a low perception of efficacy [78]. According to Bandura's self-efficacy theory [70], self-efficacious people are more task-involved and persistent in the face of obstacles which applied to the context of science it means that students with high science self-efficacy set more challenging goals and work harder to accomplish those goals than students with low science self-efficacy [74]. Interestingly, among students who intend to major in STEM during college, those who drop STEM demonstrate lower self-efficacy than those who persist in STEM [79]. In other words, self-efficacious people are more likely to display the positive affect, attitudes, and self-directed behaviors needed for active learning than non-self-efficacious people [80]. In teaching gender, self-efficacy translates into having a greater capacity (knowledge, behaviors, and dispositions) in developing a teaching practice committed to gender equity. Hence, training for gender equality in STEM plays a crucial role in shaping how gender issues are perceived, taught, learned, and practiced. If gender competence is lacking, students' learning potential will be limited in responding to current gender diversity needs in the field.

Teacher self-efficacy has been measured using various instruments and scales. Although there is no consensus on the exact number of its components, there seems to be unanimity that self-efficacy is a specific and multidimensional construct that includes at least three types of components: cognitive, behavioral, and attitudinal [70,71]. In the literature, it is easy to find general measures of self-efficacy [72,73] but not specific tools to measure the ability to teach gender-sensitively. We have identified several instruments that measure science self-efficacy [74], computer use self-efficacy [81], self-efficacy in e-learning [82], or even STEM students' perceptions of gender mainstreaming [83] but none to measure self-efficacy for teaching using a gender-sensitive approach, except the Teacher Efficacy for Gender Equality Practice (TEGEP) scale [84]. The TEGEP was built based on the theoretical foundations of Rands's model on gender, [85] Bandura's [70] concept of self-efficacy, and the three elements of awareness recommended by UNESCO [86]. It consists of 22 items distributed in three domains: (1) *cognitive*, which refers to the ability of future teachers to develop knowledge of gender concepts and awareness of inequalities; (2) *attitudinal*, the ability to help others develop gender empathy and break gender discrimination and violence; and (3) *behavioral*, ability to plan, implement, support and evaluate gender-sensitive teaching and learning processes.

Considering that evidence on implementing a gender-responsive approach in STEM has been anecdotal and that, in being so, future STEM students may hardly reach adequate gender competencies and apply those skills and knowledge to their profession, this study aimed to explore to what extent pre-service STEM teachers feel competent enough to support STEM students in becoming gender-aware skilled professionals. To do so, we examined the cross-cultural validity of the TEGEP scale and then the level of Greek and Spanish pre-service STEM teachers' self-efficacy in teaching gender sensitively. The research questions posed in this study were as follows:

(1) Has the TEGEP scale measurement invariance across Greek and Spanish pre-service secondary school STEM teachers and among females and males?
(2) What gender knowledge and awareness, confidence in gender skills, and values/attitudes toward teaching using a gender approach do Greek and Spanish pre-service secondary school STEM teachers have after graduation? Do these beliefs differ by country and sex?

This study will help to evaluate where future STEM secondary teachers stand in both cultural settings and to identify areas of concern where additional efforts are needed to meet current national mandates on GM implementation. The investigation was carried out in Greece and Spain due to the authors' easier access to sample selection given their affiliation or ties with the participating institutions.

2. Materials and Methods

This study involved two different parts. The first part entailed the cross-cultural validation of the TEGEP scale; the second part was a cross-sectional analysis of pre-service secondary school STEM teachers' perceptions of self-efficacy in using a gender-responsive approach by country and sex. The study's methodological approach is graphically represented in Figure 1.

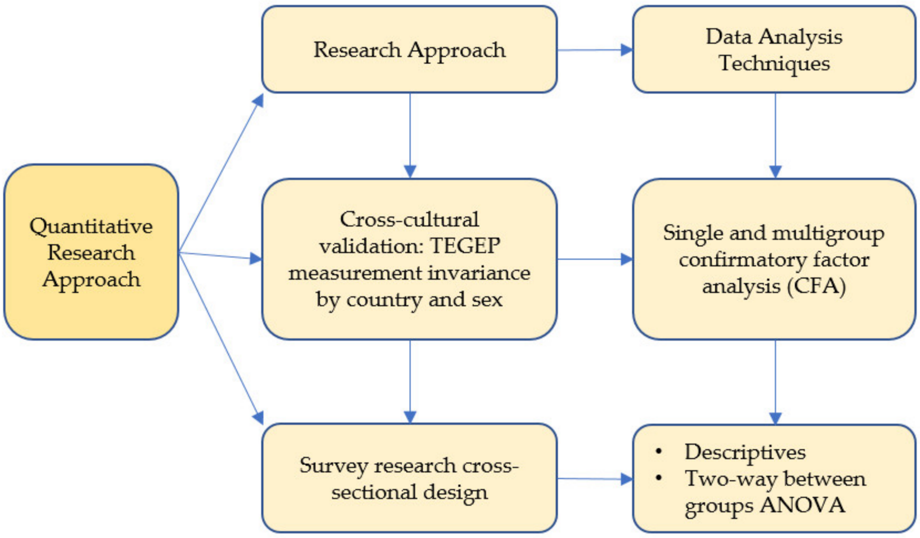

Figure 1. Research methodology, design, and data analysis techniques.

2.1. Participants

Two hundred and twenty-two graduate pre-service STEM teachers (N = 222) pursuing teacher certification in Secondary Education participated in this study. They came from seven public universities, one Spanish (the University of Alicante in Spain) and six Greek (National and Kapodistrian University of Athens, Aristotle University of Thessaloniki, Patras University, Aegean University, University of Crete, and University of Ioannina). In all of these institutions, gender equity and equal opportunities are mentioned as basic principles that guide study plans but, in practice, none of the degrees contained subjects that were taught incorporating a gender-sensitive approach.

The group of respondents (Table 1), made up of two samples purposely selected (61% Greek and 39% Spanish), represented approximately 16% and 40% of last-year cohorts. As a whole, they were predominantly male (60%) and their age ranged from 21 to 52 years old (M = 25.15, SD = 5.65). The Greek sample consisted of 136 graduate STEM students (62 in mathematics, 32 in physics, and 42 in chemistry), 97% Greek and 22 years old on average. The Spanish sample was made up of 86 STEM graduates (30 in science: physics or chemistry, 23 in technology, 14 in engineering, and 19 in mathematics), 99% Spaniards, and 30 years old on average.

Table 1. Respondents' demographic characteristics.

	Whole Sample N **= 222**				**Greek** n **= 136**				**Spanish** n **= 86**			
	M	*SD*	*f*	%	*M*	*SD*	*f*	%	*M*	*SD*	*f*	%
Age	25.15	5.65			22.03	1.48			30.14	6.26		
Gender												
Female			88	39.6			41	30.1			47	54.7
Male			134	60.4			95	69.9			39	45.3
Major												
Maths			81	36.5			62	45.6			19	22.1
Physics			47	21.2			32	23.5			15	17.4
Chemistry			57	25.7			42	30.9			15	17.4
Technology			23	10.3			--	--			23	26.7
Engineering			14	6.3			--	--			14	16.3
Previous gender knowl.												
Yes			59	26.6			24	17.6			35	40.7
No			163	73.4			112	82.4			51	59.3
Importance of gender training	7.04	2.01			6.07	2.82			8.01	1.20		

2.2. Variables and Instrument

The main variable of interest in the study was *teachers' perception of self-efficacy for gender equality practice*. This complex variable was defined as self-perceived competence for teaching using a gender-responsive approach, understood as a pedagogy that pays attention to the specific learning needs of female and male students with the aim of redressing gender imbalances and inequalities. To make it operational, it was broken down into three domains: cognitive (gender knowledge/awareness, behavioral (gender pedagogy), and affective (gender attitudes/values). *Gender knowledge/awareness* was described as the ability to define, describe, identify, and recognize inequalities and gender-related concepts; *gender pedagogy* referred to the ability in implementing a gender-responsive pedagogy; and *gender attitudes/values* to a set of skills to develop in others gender-sensitive attitudes and values.

The Spanish and Greek versions of the TEGEP (Teacher-Efficacy for Gender Equality Practice) scale were used for data collection [84,87]. The instrument consists of 22 items distributed in three subscales that measure self-efficacy in (1) Gender Knowledge and Awareness (nine items), (2) Implementing a Gender Responsive Pedagogy (nine items), and (3) Developing Gender-Sensitive Attitudes/Values (four items). According to self-efficacy measures, item statements begin with the expression 'I can . . . ', 'I am confident . . . ' or 'I am able . . . ' and are answered using a six-point Likert scale ranging from '1 = *Strongly disagree*' up to '6 = *Strongly agree*', with scores close to 1 reflecting a low sense of gender self-efficacy and high scores (around 6) indicating a high belief in one's ability to teach using a gender-sensitive approach. The scale allows obtaining a score by item, factors, and a total score of the instrument as a whole. The Spanish version of the TEGEP was validated with a Spanish sample of undergraduate and graduate science education students [88,89], while the Greek version was substantiated with a sample of student teachers of early and elementary education, Greek philology, physical activity and sports, and science majors [90]. According to these studies, the TEGEP has excellent internal consistency (Cronbach alpha ranging from 0.92 to 0.94) as well as good construct validity. Its three-factor structure is invariant across Early Childhood and Elementary education degrees and between sexes, both in the Spanish and Greek samples. Likewise, the correlations between factors are positive and statistically significant (r = 0.86 between skills and knowledge, $p < 0.01$; r = 0.80 between skills and attitudes, $p < 0.01$; and r = 0.78 between knowledge and attitudes, $p < 0.01$), values that can be considered strong [91].

2.3. Procedure

Cross-cultural research has to face several procedural challenges, particularly, those relating to translation, participant recruitment, and data collection and analysis.

Translation. The original Spanish version of the TEGEP was translated into Greek in a previous study by one of the authors who is native in Greek and multilingual (Greek/Spanish/English) [92]. In the translation process, two types of equivalence were the focus of attention: conceptual equivalence which was carried out through the use of a panel rating process, and linguistic equivalence through back translation techniques [92]. The translation process was completed in three stages. Initially, one multilingual researcher (Spanish/Greek/English) translated the Spanish version of the TEGEP into Greek; then two bilingual Greek/Spanish educators translated the Greek version into Spanish; finally, these three professionals checked the translation to ensure equivalence. No substantial corrections were needed since it was determined that the translations had the same meaning in Spanish and Greek.

Sample recruitment and data collection. The Greek sample was selected purposely from pre-service graduate STEM students seeking teacher certification in Secondary Education. Potential participants were contacted by Facebook and/or email and invited to answer an online Google form questionnaire (https://docs.google.com/forms/d/e/1FAIpQLScCC5Py6WPJ6ocy8qoNh45FQt6OngBYAF2PATrOWjycf-jcUw/viewform?vc=0&c=0&w=1&flr=0 accessed on 4 March 2019) that allowed each participant to complete the form only once. Respondents (n = 136) belonged to six of the 24 public universities in the country and represented 11.40% of the graduates who responded to the invitation. Of those who responded, 45.59% were graduates in mathematics, 23.53% in physics, and 30.88% in chemistry. The Spanish sample, also selected purposely from graduated STEM students, responded to the survey during class time. The schedule of classes was used to identify the whole cohort of students and after permission from the institution was granted, the first author contacted the instructors of the groups to plan survey administration. Before answering the questionnaire, participants were verbally and in written-form informed about the purpose of the study and informed consent was obtained. There was no time limit for responding to the survey, but it took the participants approximately 15 min to complete. Once the questionnaires were collected and verified for completeness they were analyzed by the same researcher. The study was carried out in accordance with the ethical principles of the Declaration of Helsinki and, given its exploratory nature, it was considered exempt from review by the Ethics Committees of the participating institutions. Data was collected in the second semester of the 2018–2019 academic year.

Data analysis. Special attention was given to two basic questions: (1) testing the construct to ensure its comparability; and (2) testing the invariance of its components so that they can faithfully reflect the differences between groups. The following analyses were carried out: (a) preliminary analyses to describe the response profile of the respondents; (b) analyses to assess the cross-cultural validation of the TEGEP (universal and cultural characteristics of the construct); and (c) cross-sectional analysis of responses by country and sex. Preliminary analyses included the calculation of means, standard deviations, skewness and kurtosis of the items, estimation of the reliability of the instrument, and variations between groups. The cross-cultural validation of the TEGEP included, first, a single-group confirmatory factor analysis (CFA) with the whole sample of this study taking the three-factor model identified in previous studies as its basic structure and, second, a multi-group CFA to test the measurement invariance of the TEGEP across samples by country and sex. Goodness-of-fit was assessed using the indices and cut-off criteria recommended by Hu and Bentler [93], Browne and Cudeck [94], and Byrne [95]: comparative fit index (CFI > 0.90), Tucker Lewis index (TLI > 0.90), and root-mean-square error of approximation (RMSEA < 0.05–0.10). Recommendations for non-invariance were ΔCFI and ΔRMSEA > 0.015 [96]. Finally, the cross-sectional analysis of responses for self-efficacy by country and sex was conducted running a set of two-way ANOVAs taking country (Greece vs. Spain) and sex (female vs. male) as independent factors, and self-efficacy in teaching using a gender approach (knowledge, skills, and attitudes) as dependent variables. The SPSS 26 and the AMOS 23 versions were used for all quantitative data entry and analyses.

3. Results

3.1. Preliminary Analyses

3.1.1. Response Profile

The descriptive statistics (whole scale, factors, and items) for each sample are shown in Table 2. Considering that the range of the scale was 1 to 6, the composite score of the TEGEP indicated moderate levels of self-efficacy in both samples (M = 4.46 Greek and 4.27 Spanish). By subscales, scores were also moderate to moderately low in both samples: M = 4.52 vs. 4.03 for Self-Efficacy in Developing Gender Knowledge/Awareness; M = 4.36 vs. 4.26 for Self-Efficacy in Using a Gender Responsive Pedagogy; and M = 4.54 vs. 4.83 for Self-Efficacy in Developing Gender-Sensitive Attitudes and Values, Greek and Spanish, respectively. By items, the highest means were for 'Efficacy in gender terminology' (M = 5.05) in the Greek group and 'Efficacy in criticizing tolerance toward gender discrimination and violence' (M = 5.09) in the Spanish group. On the other hand, the item with the lowest score was 'Efficacy in gender legislation' (M = 3.82 and 3.02) in both the Greek and Spanish groups, respectively. The skewness and kurtosis values were in an acceptable range, between −2 and +2 [97], except for Item 19 'Exercise gender-sensitive attitudes', and Item 21 'Critic about tolerance towards gender discrimination and violence' with values slightly above 2. The correlations between factors were positive, strong, and statistically significant, with higher values within the Spanish sample than within the Greek (r = 0.79 and r = 0.85, $p < 0.01$, between gender responsive pedagogy and gender knowledge; r = 0.60 and r = 0.86, $p < 0.01$, between gender responsive pedagogy and gender-sensitive attitudes; and r = 0.61 and r = 0.76, $p < 0.01$, between gender knowledge and gender-sensitive attitudes). Likewise, the reliability of the TEGEP was excellent with Cronbach's alpha values of 0.94 in the overall scale for both subsamples and 0.90, 0.92, and 0.87 by subscales (0.91, 0.93, and 0.89 Greek sample and 0.90, 0.92 and 0.80 Spanish sample, respectively), coefficients that indicate excellent or very good instrument reliability [98].

Table 2. Univariate normality for the TEGEP items and subscales by country.

		Greece				Spain			
	Skill in . . .	***M***	***SD***	***Skewe.***	***Kurt.***	***M***	***SD***	***Skewe.***	***Kurt.***
	Gender Knowledge/Awareness	4.52	1.00			4.03	0.96		
1	Gender terminology.	5.05	1.11	−1.320	1.25	3.86	1.15	−0.784	0.456
2	Gender legislation.	3.82	1.49	−0.200	−0.808	3.02	1.34	0.047	−0.855
3	Gender equality vs. gender equity.	4.67	1.11	−0.695	−0.199	3.98	1.35	−0.668	0.020
4	Gender roles.	4.10	1.51	−0.346	−0.851	4.08	1.18	−0.908	0.941
5	Gender discrimination.	4.71	1.22	−0.845	0.195	4.51	1.28	−0.869	0.470
6	Gender parity.	4.79	1.24	−1.037	0.692	3.74	1.44	−0.456	−0.656
7	Sex and gender.	4.37	1.65	−0.660	−0.751	4.64	1.40	−0.997	0.384
8	Gender inequalities.	4.76	1.11	−0.751	0.243	4.38	1.12	−0.708	0.807
9	Gender stereotypes.	4.40	1.27	−0.499	−0.245	4.09	1.23	−0.451	−0.131
	Gender-Responsive Pedagogy	4.36	1.08			4.26	0.87		
10	Providing equal opportunities.	4.45	1.36	−0.785	0.121	4.07	1.17	−0.457	0.151
11	Preventing gender inequalities.	4.32	1.14	−0.330	−0.078	4.03	1.13	−0.568	0.566
12	Respecting learning gender styles.	4.30	1.39	−0.573	−0.466	3.84	1.23	−0.372	0.021
13	Fostering gender collaboration.	4.75	1.23	−1.144	1.165	4.64	0.93	−0.820	1.121
14	Implementing lessons with a GP.	4.43	1.34	−0.709	−0.046	4.19	1.19	−0.454	−0.104
15	Involving families in GE plans.	4.04	1.49	−0.499	−0.675	4.20	1.18	−0.484	0.220
16	Conveying values on gender issues.	4.46	1.34	−0.989	0.647	4.60	1.13	−1.168	1.820
17	Collaborating with colleagues.	4.34	1.40	−0.673	−0.289	4.63	1.01	−0.892	1.426
18	Educating on gender issues.	4.19	1.43	−0.653	−0.193	4.12	1.02	−0.306	0.906
	Gender-Sensitive Attitudes	4.54	1.28			4.83	0.82		

Table 2. *Cont.*

		Greece				Spain			
	Skill in . . .	*M*	*SD*	*Skewe.*	*Kurt.*	*M*	*SD*	*Skewe.*	*Kurt.*
19	Exercising gender-sensitive attitudes.	4.87	1.38	−1.455	1.624	5.02	1.02	−1.215	2.145
20	Deconstructing gender stereotypes.	4.78	1.39	−1.255	1.044	4.76	1.04	−0.712	0.640
21	Criticizing tolerance towards gender discrimination and violence.	4.68	1.48	−1.038	0.227	5.09	1.01	−1.580	2.387
22	Speaking up against all forms of gender injustice.	3.85	1.64	−0.343	−0.913	4.45	1.08	−0.364	−0.002
	Whole scale	4.46	0.92			4.27	0.78		

Scale range 1–6 (1 = Min., 6 = Max.).

3.1.2. Cross-Cultural Validation of the Construct

The model of three factors and 22 items of the TEGEP scale supported by previous research [85–87] was taken as the baseline model. The single-group CFA analysis with no constraints resulted in a baseline χ^2 value of 636.79, df = 228, $p < 0.000$, suggesting a reasonable fit for the sample as a whole (χ^2/df = 2.79, CFI = 0.88, RMSEA = 0.09) that provided support for a common three-factor structure of the TEGEP scale (Table 3).

Table 3. Goodness-of-fit indices across country and sex for the TEGEP 22-item three-factor model.

	χ^2	*df*	χ^2/df	TLI	CFI	RMSEA	ΔCFI	ΔRMSEA
Overall (*N* = 222)	636.79	228	2.79	0.873	0.875	0.090		
Country								
Greece (*n* = 136)	544.40	228	2.39	0.856	0.858	0.094		
Spain (*n* = 86)	417.94	228	1.83	0.847	0.849	0.090		
Multi-group invariance								
Configural	962.54	456	2.11	0.849	0.851	0.071		
Metric	995.17	459	2.17	0.842	0.843	0.073	0.008	0.002
Scalar	1091.08	481	2.27	0.828	0.829	0.076	0.014	0.003
Sex	χ^2	*df*	χ^2/df	**TLI**	**CFI**	**RMSEA**	**ΔCFI**	**ΔRMSEA**
Female (*n* = 88)	502.85	228	2.21	0.782	0.784	0.102		
Male (*n* = 134)	489.20	228	2.15	0.879	0.880	0.093		
Multi-group invariance								
Configural	992.49	456	2.18	0.843	0.845	0.073		
Metric	1020.58	459	2.22	0.837	0.838	0.075	0.007	0.002
Scalar	1086.02	481	2.26	0.832	0.825	0.076	0.013	0.001

Note. χ^2 = Chi-Squared; *df* = Degree Freedom; CFI = Comparative Fit Index; TLI = Tucker–Lewis Index; RMSEA = Root Mean Squared Error of Approximation.

3.2. Cross-Cultural Measurement Invariance by Country and Sex

To explore the measurement invariance (equivalence of the model) by country and sex, the three-factor structure of the TEGEP was tested simultaneously by subgroups, first, in the subsamples grouped by country and, then, by sex, imposing increasing restrictions between groups: same factors to check for configural invariance, same factor loadings to check for metric invariance, and same intercepts to test for scalar invariance.

Invariance by country. As shown in Table 3, constraining the factor loadings across the Greek and Spanish samples resulted in acceptable fit statistics, according to χ^2/df (2.39 vs. 1.83), CFI (0.86 vs. 0.85) and RMSEA (0.09 vs. 0.09), which suggested that the three-factor model was equivalent in the samples of Greek and Spanish pre-service secondary STEM teachers. Constraining structural variances, according to which the factorial weights were constrained to be equal across groups also resulted in an acceptable model fit given that the increases in CFI (ΔCFI = 0.008) and RMSEA (ΔRMSEA = 0.002) were below 0.015.

Constraining structural covariances to test equal intercepts across groups also yielded non-significant changes in fit (ΔCFI = 0.014 and ΔRMSEA = 0.003), resulting in close to acceptable fit; that is, in a fit a little bit worse than in the configural and metric models, but still tenable as the CFI increase remained slightly below the established limit of 0.015. Since scalar invariance was supported, these results suggested that TEGEP scores represented the same latent level of TEGEP across Greek and Spanish pre-service secondary school STEM teachers and that the comparisons of means between both groups were appropriate. Therefore, it was found that the TEGEP has tenable construct measurement invariance across both countries.

Invariance by sex. The same three-factor TEGEP model was explored by sex. As reflected in Table 3, the unconstrained model for the subsamples of female and male pre-service secondary STEM teachers showed reasonable fit indices (χ^2/df = 2.21 vs. 2.15; CFI = 0.78 vs. 0.88; and RMSEA = 0.10 vs. 0.09) that were better for male than female participants. Constraining factor loadings and structural variances resulted in non-significant changes in fit (χ^2/df = 2.18, CFI = 0.85, RMSEA = 0.07 vs. χ^2/df = 2.22, CFI = 0.84, RMSEA = 0.07) and increases in CFI (ΔCFI = 0.007) and RMSEA (ΔRMSEA = 0.002) below 0.015, hence, sex satisfied the tests for identical factor structure and equal factor loadings. The scalar model (constraining the covariances) also fit the data relatively well, being the adjustment a little bit worse than that of the configural and metric model (ΔCFI = 0.013 [again close to the limit of 0.015] and ΔRMSEA = 0.002, but both < 0.015) suggesting that the TEGEP has scalar invariance between sexes. Collectively, these results indicated that the TEGEP has measurement invariance across sex, with invariance of form, factor loadings, and factor variances and covariances, leading to the conclusion that the TEGEP is also invariant among sexes.

3.3. Cross-Sectional Analysis of Self-Efficacy by Country and Sex

Since the TEGEP was invariant across country and between sexes, comparisons of means were appropriate. Table 4 presents the results of the 2 × 2 country (Greece vs. Spain) by sex (female vs. male) ANOVAs performed using the composite scores of the entire TEGEP scale and of the three factors. The TEGEP total scores showed that neither the main effect of country [$F(1, 218) = 1.71$, $p = 0.193$] and sex [$F(1, 218) = 0.01$, $p = 0.924$] alone nor in interaction [$F(1, 218) = 1.54$, $p = 0.216$] were statistically significant. The overall pattern of the results by country showed that pre-service secondary school STEM teachers from Greece rated self-efficacy slightly higher than pre-service secondary school STEM teachers from Spain (M = 4.46 vs. 4.27). By dimensions of self-efficacy, statistically significant differences were found. Levels of self-efficacy in gender knowledge/awareness varied across groups. As shown in Table 4, Greek pre-service secondary school STEM teachers, independently of sex, rated their capacity in gender knowledge significantly higher than Spanish pre-service secondary school STEM teachers [$F(1, 218) = 13.16$, $p = 0.000$] being the effect size medium (Eta squared = 0.057). Comparisons of means by item within this dimension (Table A1) indicated that Greek participants showed a significantly higher sense of self-efficacy in using gender terminology ($p < 0.01$), knowing gender legislation ($p < 0.01$), differentiating gender equality of gender equity ($p < 0.01$), understanding the concept of gender parity ($p < 0.01$) and recognizing gender inequalities ($p < 0.05$) than the Spanish participants. Levels of self-efficacy in using a gender-responsive pedagogy did not vary across groups, neither depending on country [$F(1, 218) = 0.45$, $p = 0.504$] sex [$F(1, 218) = 0.04$, $p = 0.849$] nor their interaction [$F(1, 218) = 0.06$, $p = 0.814$]. However, mean comparisons by items (Table A2) revealed that Greek participants rated their ability in providing equal opportunities to all students ($p < 0.01$) and respecting gender learning styles ($p < 0.05$) significantly higher than Spanish participants. Lastly, levels of self-efficacy in developing gender-sensitive values/attitudes varied across groups. As Table 4 shows, Spanish pre-service secondary school STEM teachers reported significantly higher scores for self-efficacy in developing gender values and attitudes than their Greek counterparts [$F(1, 218) = 9.75$, $p = 0.002$], but this capacity varied significantly in interaction with sex [$F(1, 218) = 24.36$, $p = 0.000$].

While Spanish female respondents rated their ability in conveying gender attitudes/values significantly higher than their Spanish male peers, Greek female respondents reported this ability significantly lower than their Greek male counterparts (p = 0.000), being the effect size large (Eta squared = 0.100), according to Cohen [88]. Mean comparisons by item in gender attitudes/values (Table A3) indicated that Greek female pre-service secondary STEM teachers showed a lower belief in their ability to make their students exercise gender-sensitive attitudes ($p < 0.05$), criticize against tolerance toward discrimination and violence ($p < 0.01$) and speak up against gender injustice ($p < 0.01$) than their male peers from Greece and their female and male counterparts from Spain. Conversely, Greek male pre-service secondary school STEM teachers rated their self-efficacy in deconstructing gender stereotypes significantly higher than Greek females and both of their female and male counterparts from Spain ($p < 0.01$). Complete cross-sectional differences by individual items are presented in Tables A1–A3 included in Appendix A.

Table 4. Differences in self-efficacy beliefs in the ability to teach gender-sensitively by factors across country and sex.

	Greece		Spain						
	M	*SD*	*M*	*SD*	*S. of V*	*F*	*p*	*Eta*	**Direc**
Gender Knowledge					Country	13.16	0.000 *	0.057	G > S
Female	4.60	0.94	4.10	1.09	Sex	0.83	0.364	0.004	
Male	4.48	1.03	3.96	0.78	C × S	0.01	0.929	0.000	
Gender Pedagogy					Country	0.45	0.504	0.002	
Female	4.32	0.97	4.26	0.91	Sex	0.04	0.849	0.000	
Male	4.38	1.12	4.25	0.82	C × S	0.06	0.814	0.000	
Gender Attitudes					Country	9.75	0.002 *	0.043	S > G
Female	3.82	1.44	5.04	0.67	Sex	3.76	0.054	0.017	
Male	4.86	1.07	4.58	0.92	C × S	24.36	0.000 *	0.100	$F_G < F_S$
Total scale					Country	1.71	0.193	0.008	
Female	4.34	0.83	4.33	0.82	Sex	0.01	0.924	0.000	
Male	4.51	0.96	4.19	0.74	C × S	1.54	0.216	0.007	

Scale range 1–6 (1 = Min., 6 = Max.); *df* (1, 218); * Significant at 5% or above; Eta squared: 0.01 (small), 0.06 (medium), 0.14 (large).

4. Discussion

The purpose of this study was, first, to explore the cross-cultural measurement invariance of the TEGEP across country (Greece and Spain) and sex with graduate pre-service STEM teachers and; second, to compare differences in teachers' self-efficacy beliefs in their capacity to teach using a gender-sensitive approach. Although teacher self-efficacy is a construct that has been extensively studied in recent decades, little attention has been paid to teachers' perceived self-efficacy for gender equality practice in STEM. Studies that have addressed this issue have examined the validity of the construct using a recently developed measure (the TEGEP) in selected samples from a few individual countries [84–87] without including comparisons that allowed testing the cross-cultural invariance of the instrument by country and sex. While this type of research has been valuable in helping to identify the dimensionality of the 'teacher self-efficacy for gender equality practice' construct, it has been limited to a few countries and samples of undergraduate students from fields other than STEM. Our study contributes to this line of research by demonstrating that the TEGEP enables comparisons across various countries, fields, and degree levels.

The findings of this study provide theoretical support for the TEGEP being a scale composed of three factors that are invariant across countries (Greece and Spain) and between sexes, adding to the construct of self-efficacy in teaching gender-sensitively evidence of its validity in Greek and Spanish contexts as well as in male and female students. These results complement previous findings from Kitta and Cardona-Moltó [87], who examined the construct validity of the TEGEP in a larger and more diverse Greek sample of pre-service undergraduate student teachers (education, Greek philology, physical activity/sport, and science majors) drawn from nine Greek universities, contributing to confirm that the construct is robust and valid for Greek university students across diverse fields and degrees. Additionally, our findings concur with those from Miralles-Cardona et al. [84,88] in whose studies they provided evidence of the measurement invariance of the TEGEP across degrees using samples of early childhood, elementary, and secondary Spanish pre-service school teachers and, therefore, suggesting that the scale is equally valid for measuring self-efficacy for a gender-sensitive practice in Spanish pre-service teachers at both the undergraduate and graduate levels. Given the equivalence of the TEGEP factors across Greece and Spain and among sexes found in the current study, it is appropriate to make comparisons of means between these groups since we are confident that we are measuring the same concepts and the same factors in all these cultural groups.

On a practical level, our findings indicated, first, that the TEGEP can be used to measure pre-service secondary school STEM teachers' competence for gender-sensitive practice both in Greek and Spanish pre-service STEM teachers as well as in male and female and, second, that participants rated their personal ability to teach using a gender-sensitive approach as moderately low with minimal variation response. This pattern of results, slightly higher in Greek respondents than in Spanish, held true not only for the total scale score, but also for Self-Efficacy in Gender-Knowledge/Awareness and Self-Efficacy in Using a Gender Responsive Pedagogy, but not for Self-Efficacy in Developing Gender-Sensitive Attitudes and Values, in which case the Greek group rated their ability for teaching sensitively significantly lower than the Spanish group. In fact, Greek pre-service secondary STEM teachers valued their gender knowledge self-efficacy significantly higher than their Spanish counterparts. But, the Spanish scored higher than the Greeks in their capacity to develop gender-related values and attitudes, especially the Spanish female group. The presence of a statistically significant interaction effect (country x sex) in the ability to have others develop gender-sensitive values indicated that while Greek and Spanish males rated their ability moderately but at a similar level, this was not the case for Greek females who felt significantly less capable in their ability to convey gender values and attitudes than their female peers from Spain, who conversely felt very confident of this specific ability. However, we must not lose sight of the fact that participants' level of gender competence (knowledge, skills, and attitudes to teach using a gender-responsive approach) at the conclusion of their studies was insufficient, not exceeding generally a score of five in any factor, with the exception of a few items such as knowledge of gender terminology and self-efficacy in criticizing tolerance towards gender discrimination and violence in which the Greek and Spanish participants, respectively, scored high. This information should be considered when educating new STEM teachers about gender equality.

The findings that Greek respondents displayed higher self-efficacy in gender knowledge/awareness but not in attitudes than their Spanish counterparts may be explained by differences in the degree of gender stereotypes entrenchment or resistance to gender mainstreaming implementation. As reflected in the *Impact Ranking 2022: Gender Equality* [99] and the *Global Universities Performance Indicators on GE* [19], Greece scores lower than Spain and has a lower GE profile than Spain; therefore, it is not surprising that Greeks overestimated their gender knowledge and skills as a form of resistance to gender training. These results were not unexpected, given that Greek participants valued gender training as less important for their education (6 out of 10) than Spanish participants did (8 out of 10). Consequently, these findings are consistent with those of Kitta and Cardona-Moltó [87] and Miralles-Cardona et al. [84], who found comparable levels of gender competence in undergraduate students in the same cultural contexts, suggesting that the pattern of response holds in graduating STEM students.

An extension of the current research would be to study comparatively the ability to teach gender-sensitively of women and men with high vs. low attainment in STEM. Although research suggests that students with low achievement in STEM tend to show lower self-efficacy than those who persist and succeed in the field [79], it would be interesting to determine if the TEGEP also suits these students in terms of measurement invariance. The results would contribute to enriching TEGEP construct validity and would be very helpful in guiding the development of gender competence among STEM students in a more individualized manner.

4.1. Limitations

There are several limitations to consider in this investigation. First, although the authors followed the same procedure to conduct the survey in both countries, data collection was conducted differently: electronically and virtually in Greece, and on paper and in-person in Spain. This difference in survey administration could have affected both the response rate and the registered information (the online administration could have contained more registration errors than the face-to-face administration). These aspects were not ignored and, consequently, measures were taken to control them by having a single researcher responsible for verifying the accuracy of the collected information. Second, because the responses to the survey were self-reported, there was always the possibility that they could be influenced by social desirability. Third, even though the samples were independent of each other, their demographic characteristics varied in some ways. For example, the Greek sample was more comprehensive of the country's universities than the Spanish sample that came from a single university representative of the Valencian Community. The Greek sample was also larger in terms of size, but not in terms of representation of STEM disciplines, which were better represented in the Spanish sample. In addition, the Greek sample was more masculinized (70% male) than the Spanish sample which was more gender-balanced (55% male vs. 45% female). A fourth limitation of the study refers to the sample size. Although it would have been desirable for the two samples (Greek and Spanish) to be bigger and of comparable size, it was not possible to achieve this goal. Restrictions on access to the informants prevented us from doing so (permission not granted in some institutions and time for face-to-face administration in order to guarantee sufficient participation, specifically in recruiting the Spanish sample). This circumstance limits the generalization of our findings being necessary to be cautious in extrapolating them beyond the characteristics and context from which the samples were taken. Despite these demographic differences and limitations, the evidence of the TEGEP construct invariance across country and sex was not seriously threatened and both the construct invariance across Greek and Spanish pre-service secondary school teachers and among males and females was reported favorably. Finally, the samples were not randomly selected and, although the Greek sample was made up of six of the country's 24 universities, they may not be representative of the population of graduate pre-service STEM secondary school teachers in each country, hence, the generalizability of the findings should be limited exclusively to Greek and Spanish (Valencian Community) cultural contexts. It would be beneficial to conduct additional studies using the TEGEP in other cultural contexts and with a greater representation of STEM disciplines, which would provide additional evidence regarding the findings of this study.

4.2. Implications for Research and Practice

This study has some implications for future research and practice. From a research standpoint, future research should include a call for additional validation studies of the TEGEP in new cultural contexts and settings. It is necessary to increase efforts to better support and understand the construct of self-efficacy for a gender-responsive teaching approach in STEM in unexplored cultures (e.g., other European countries, other continents, other languages) as well as investigate the extent to which the construct can be generalized to other STEM fields/disciplines. Increasing understanding of the universal and emic characteristics of the construct will promote the advancement of research on self-efficacy for gender equality in STEM.

From a practical standpoint, the fact that participants rated their self-efficacy for gender-responsive teaching at a moderate level without receiving previous training in gender issues alerts that these results may be fictitious. Future research should therefore incorporate a qualitative component to investigate the motivations underlying this pattern of responses. Gender competence development requires more attention in STEM teacher education, given that STEM education for the 21st century must not only focus on preparing effective STEM teachers but also teachers who are committed to an equitable and gender-sensitive education. For this reason, the education of future STEM teachers needs to be complemented with an education that contributes to eliminating the prevailing gender stereotypes and inequalities in the field. To improve gender equality competence in STEM teacher education, we recommend efforts to increase gender knowledge, awareness, skills, and attitudes by incorporating gender-specific content into study programs to prompt continuous reflection on gender issues. One of the primary concerns in STEM education today is not only improving the performance of female students but also increasing male and female awareness of gender inequity issues. Gender competency development can contribute to this aspiration of reversing the pattern of teaching science by including gender analysis in STEM curricula and providing opportunities for learning to teach with a gender perspective.

5. Conclusions

This investigation yielded two important findings: (1) the TEGEP demonstrated acceptable measurement invariance by country and sex; therefore, it is a valid measure to assess self-efficacy for gender-sensitive teaching across Greek and Spanish samples of pre-service secondary STEM teachers and among sexes; and (2) that Greek and Spanish pre-service secondary STEM teachers complete their master level studies without adequate preparation and enough confidence to teach using a gender-responsive approach to instruction. The fact that participants from both countries only reported a 'moderately low' level of self-efficacy deserves consideration, but it is not surprising, given that gender mainstreaming in STEM education, despite being mandatory in both countries, is extremely limited and misaligned with the existing curriculum [83,90]. This can be attributed to low institutional compromise and low gender awareness, besides lack of training and indifference on the part of the teaching staff. In order to implement a gender approach in STEM, there is a need to raise awareness and seek institutional accountability. The requirement to meet the demands for a high-quality, inclusive, and gender-sensitive education presents a unique opportunity to incorporate gender equality training into STEM degrees. Future research may help document progressive advancement in this pending task.

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and it was deemed exempt from review by the Ethics Committee of the University of Alicante.

Informed Consent Statement: Informed consent was obtained from all participants in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to restrictions of third-party permission.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Differences in self-efficacy beliefs in gender knowledge/awareness by country and sex.

	Greece		Spain						
	M	*SD*	*M*	*SD*	*S. of V*	*F*	*p*	*Eta*	*Direction*
Gender terminology					Country	53.57	0.000 *	0.197	G > S
Female	5.05	1.12	3.83	1.37	Sex	0.06	0.806		
Male	5.05	1.11	3.90	0.84	C × S	0.05	0.825		
Gender legislation					Country	16.22	0.000 *	0.069	G > S
Female	3.95	1.50	2.98	1.41	Sex	0.05	0.817		
Male	3.76	1.49	3.08	1.26	C × S	0.50	0.478		
Equality vs. equity					Country	16.15	0.000 *	0.069	G > S
Female	4.78	1.13	4.06	1.51	Sex	0.93	0.336		
Male	4.62	1.26	3.87	1.13	C × S	0.01	0.929		
Gender roles					Country	0.26	0.609		
Female	4.34	1.49	4.26	1.21	Sex	3.42	0.066		
Male	3.99	1.52	3.87	1.13	C × S	0.01	0.937		
Gender discrimination					Country	1.51	0.221		
Female	4.78	1.01	4.55	1.44	Sex	0.31	0.580		
Male	4.67	1.31	4.46	1.07	C × S	0.00	0.996		
Gender parity					Country	34.38	0.000 *	0.136	G > S
Female	5.02	1.06	3.68	1.55	Sex	0.25	0.616		
Male	4.69	1.31	3.82	1.32	C × S	1.54	0.216		
Sex and gender					Country	1.40	0.238		
Female	4.32	1.72	4.81	1.44	Sex	0.42	0.516		
Male	4.40	1.61	4.44	1.33	C × S	1.05	0.308		
Gender inequalities					Country	6.45	0.012 *	0.029	G > S
Female	4.80	0.90	4.55	1.14	Sex	1.92	0.167		
Male	4.74	1.17	4.18	1.07	C × S	0.92	0.338		
Gender stereotypes					Country	2.69	0.102		
Female	4.34	1.24	4.17	1.32	Sex	0.06	0.802		
Male	4.42	1.29	4.00	1.12	C × S	0.48	0.490		

Scale range 1–6 (1 = Min., 6 = Max.); *df* (1, 218); * Significant at 5% or above; Eta squared: 0.01 (small), 0.06 (medium), 0.14 (large).

Table A2. Differences in self-efficacy beliefs in using a gender-responsive pedagogy by country and sex.

	Greece		Spain						
	M	*SD*	*M*	*SD*	*S. of V*	*F*	*p*	*Eta*	*Direction*
Providing equal opp.					Country	6.94	0.009 *	0.031	G > S
Female	4.88	1.03	3.85	1.23	Sex	0.13	0.715		
Male	4.26	1.45	4.33	1.03	C × S	9.13	0.003 *	0.040	$F_G > F_S$
Preventing G inequalities					Country	2.98	0.086		
Female	4.34	1.13	3.91	1.30	Sex	0.54	0.464		
Male	4.32	1.15	4.18	0.89	C × S	0.79	0.374		

Table A2. *Cont.*

	Greece		Spain						
	M	*SD*	*M*	*SD*	*S. of V*	*F*	*p*	*Eta*	*Direction*
Resp. learning styles					Country	5.31	0.022 *	0.024	G > S
Female	4.17	1.43	3.96	1.28	Sex	0.04	0.838		
Male	4.36	1.38	3.69	1.17	C × S	1.41	0.237		
Fostering gender col.					Country	0.50	0.481		
Female	4.76	1.32	4.66	0.79	Sex	0.03	0.870		
Male	4.75	1.20	4.62	1.09	C × S	0.01	0.913		
Lessons with a GP					Country	1.20	0.276		
Female	4.32	1.35	4.11	1.25	Sex	0.82	0.368		
Male	4.47	1.34	4.28	1.12	C × S	0.00	0.959		
Involving families					Country	1.57	0.212		
Female	3.71	1.57	4.23	1.16	Sex	1.05	0.307		
Male	4.19	1.44	4.15	1.20	C × S	2.05	0.153		
Conveying values					Country	1.04	0.309		
Female	4.27	1.45	4.72	1.08	Sex	0.00	0.962		
Male	4.55	1.30	4.46	1.19	C × S	2.24	0.136		
Collaborating colleagues					Country	2.11	0.148		
Female	4.39	1.20	4.74	0.99	Sex	0.84	0.360		
Male	4.32	1.48	4.49	1.02	C × S	0.26	0.614		
Educating G issues					Country	0.06	0.809		
Female	4.07	1.54	4.15	1.10	Sex	0.07	0.792		
Male	4.24	1.38	4.08	0.93	C × S	0.43	0.515		

Scale range 1–6 (1 = Min., 6 = Max.); *df* (1, 218); * Significant at 5% or above; Eta squared: 0.01 (small), 0.06 (medium), 0.14 (large).

Table A3. Differences in self-efficacy beliefs in developing gender-sensitive attitudes by country and sex.

	Greece		Spain						
	M	*SD*	*M*	*SD*	*S. of V*	*F*	*p*	*Eta*	*Direction*
Exercise G-S attitudes					Country	3.97	0.048 *	0.018	S > G
Female	4.15	1.67	5.23	0.96	Sex	2.78	0.097		
Male	5.18	1.10	4.77	1.04	C × S	19.37	0.000 *	0.082	$F_G < F_S$
Deconstruct G stereotypes					Country	1.24	0.267		
Female	3.98	1.57	4.89	1.03	Sex	6.10	0.014 *	0.027	M > F
Male	5.13	1.15	4.59	1.04	C × S	17.99	0.000 *	0.076	$F_G < F_S$
Critic against tolerance					Country	11.93	0.001 *	0.052	S > G
Female	3.88	1.63	5.34	0.84	Sex	2.79	0.097		
Male	5.02	1.28	4.79	1.13	C × S	22.26	0.000 *	0.093	$F_G < F_S$
Speak up ag injustice					Country	13.48	0.000 *	0.058	S > G
Female	3.27	1.76	4.68	0.93	Sex	0.69	0.408		
Male	4.11	1.53	4.18	1.19	C × S	10.92	0.001 *	0.048	$F_G < F_S$

Scale range 1–6 (1 = Min., 6 = Max.); *df* (1, 218); * Significant at 5% or above; Eta squared: 0.01 (small), 0.06 (medium), 0.14 (large).

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