Including gender perspective in a Computer Engineering Degree

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***Abstract*— The 2030 Agenda for Sustainable Development defines the need to guarantee an inclusive and equitable quality education for all people. This means that education systems should introduce the gender debate in different areas of education, from teacher training to the definition of subject knowledge, with the purpose of changing traditional roles and gender stereotypes. Incorporating the gender perspective in teaching involves reflecting on the different elements that make up the teaching- learning process from the point of view of the sex and gender variables. But, in addition, it means understanding in what context that teaching is taught and what competences must be offered to students. This paper presents a proposal for including the gender perspective in the teaching of a Software Engineering I subject included in the Computer Engineering Degree at the University of Valencia. The results show a clear impact on students, with large differences by gender, which corroborates the persistenceof the gender gap in the university field of Computer Science and opens new ways to continue working on proposals that helpclosing this gap.**

Keywords*— *Digital Gender Gap, STEM Gap, Software Engineering

INTRODUCTION

The low presence of women in STEM (Science, Technology, Engineering & Mathematics) degrees and especially in engineering and very particularly in ICT (less than 14% of women in Computer Engineering enrolled in Spain in the 2019-2020 academic year), is a structural and global problem, whose origin is found in the stereotypes that boys and girls receive from their childhood, determined by the sociocultural context [1].

To achieve a more egalitarian society, it must be considered that equitable access to ICT facilitates the participation of women in increasingly digital societies and in the global community. In fact, STEM and Digital gender equality are vital for the world to achieve the SDGs.

Closing the gender gaps would have positive effects on the potential development and economic growth of countries. In fact, gender diversity and, in general, the composition of diverse and interdisciplinary work teams has been shown to be fundamental for both research and innovation [2], and it has been shown that greater participation of women, not only in STEM fields, has a very positive impact on the global economy [3].

However, the gender problem is not only a question of numbers. Having a balanced presence of women and men in higher education does not automatically make university education gender sensitive.

Gender-sensitive teaching includes also paying attention to gender differences, both in the creation of the curriculum and in the conduct of the classroom. On the contrary, gender-blind curricula have the potential to increase the existing inequalities in society, to shift the subject matter towards one gender, to generate unequal opportunities for success or even to foster role stereotypes.

When talking about teaching in scientific and technical degrees, it is very common to find the perception that this type of subjects are alien to gender and, therefore, gender does not need to be considered within the subjects' design. In fact, in the more abstract and theoretical fields of science, the introduction of a gender perspective has been traditionally ignored under the assumption that scientific concepts, theories and methods are inherently neutral. However, the language, metaphors, analogies, and iconography used as support can offer a partial vision of reality and reinforce gender stereotypes.

Gender equality must also be expressed in all curricula at all levels of education. When considering including gender dimension in the development of study plans, it is necessary to consider not only teaching methods, but also interactions within the class.

In addition, (unconscious) gender bias profoundly affects the way professors rate their students, as reflected in diverse studies carried out in 2006 [4] and in 2015 [5]. Fortunately, these biases can be reduced by making teachers aware of the problem, as shown by the study [6] carried out in various European countries.

During the last six years, our Teaching Innovation Project (TIP) at the School of Engineering of the UV (ETSE-UV), has been focused on using active methodologies [8] to improve the learning process of software development subjects of students of different degrees of the ETSE-UV school and other STEM degrees.

However, active methodologies promote an improvement in learning, but do not inherently reduce the gender gap. To reduce it, our TIP has included new objectives for including gender perspective in the teaching of Software Engineering I subject of the Computer Engineering Degree of the ETSE-UV as a first step to include it in all the subjects of the TIP.

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Including the gender perspective in university teaching implies the implementation of a wide variety of measures to be taken by all the agents that intervene in the design of the study plans. This involves a critical and comprehensive review of the teaching-learning process, from the objectives to be developed to the evaluation system to be applied, through the selection of skills and learning outcomes to be acquired, the content to be included and how to develop the different activities, practices, exercises, etc.

Therefore, a holistic approach is needed, taking into account methodology aspects, emphasizing the improvement of the sense of belonging and self-efficacy, reducing competition, and emphasizing collaboration. Moreover, the actions developed must pay special attention to provide students with female role models, highlighting the importance of women in engineering and to clearly show the social applicability of Computing Engineering.

The rest of the article is divided into the following sections. In section II other related works are reviewed. In section 3 the methodology applied to include the gender dimension in the subject is explained. In section 4 the results of the implantation are analyzed. Finally, section 5 addresses the conclusions and future work.

Related Work

The inclusion of the gender perspective in university teaching has important benefits.

There are multiple studies and works that include recommendations on teaching with a gender perspective. Among the proposals made, it is worth highlighting those raised by UNESCO [9], [10], which includes recommendations that should be considered in all related publications (study plans and textbooks, learning materials and education legislation). The work of Maria Helena Esteves [11] is also very interesting, in which she carries out an in-depth analysis of the actions to be carried out, with concrete examples in the formulation of policies that promote equality in the classroom.

At the national level, some works are noteworthy such as the Guides of the Xarxa Vives, in particular the Computer Science Guide [12], the Portal of Teaching Resources with a Gender Perspective for University Teaching at the University of Alicante [13] that compiles specific resources for computer science and support materials to incorporate the gender perspective regardless of the area, or the Feminary Project [14], developed by the University of La Laguna in order to serve as a formal platform for the collaborative design of good practices in equality within the teaching-learning process.

In the specific case of Software Engineering, the works of Alicia García-Holgado stand out [15], [16], [17], [18] which show concrete measures of the application of the gender perspective linked to teaching innovation and have been taken into account when designing the methodology described in this paper.

Methdology

Context

The main objective of the TIP was to design strategies inside the Software Engineering I subject of the Computer Engineering degree of the University of Valencia (UV) that helps to incorporate gender perspective in the teaching, as a first step to introduce this dimension in the rest of the subjects in the TIP.

Participants

Software Engineering I is a compulsory subject that is taught in the second semester of the 2nd year of the Computer Engineering Degree at the School of Engineering of the University of Valencia.

The subject is taught using Flipped Classroom methodology [19], [20], [21] combined with Problem Based Learning [22], [23] and Project Based Learning [24], [25]. Thus, participating students work in small groups (4-6 persons) developing a software project just as they would develop in a real company. More information about the teaching strategies used in the subject can be found in [26]

In the 2020-2021 academic year, 54 students enrolled the subject, 13% were female (7) and 87% were male (47).

Program Description

The actions that have been introduced in the subject and that are proposed to gradually introduce in the rest of the teaching innovation project subjects include the following points:

1) Reviewing teaching guides: the teaching guide has been revised to include non-sexist language.

2) Reviewing teaching resources: presentations, selected texts, images or web pages have been reviewed to take into account the following considerations:

o Avoiding the use of unequal and discriminatory language. It is important to bear in mind that in Spanish, nouns and adjectives have gender, so that materials have been reviewed to include an inclusive vocabulary in addition to avoiding stereotypical or sexist contents.

o Including images of both men and women in the performance of their functions to highlight the presence of both genders. The images avoided transmitting stereotypes and traditional roles of men and women.

o Relating subject contents with examples from daily life so that they can see the applications of Engineering and Technology and the relationships with social applicability and the impact on the environment.

o Facilitating female role models, making visible women referents in STEM and whose work team is part of various people from the PID.

3) Reviewing bibliography: a gender-balanced presence of authors has been included and authors' first name has been included in the citation so that it is clearly reflected when the work was developed by a woman.

4) Reviewing teaching methodologies and practices from a gender perspective: we have reviewed how practices in the classroom were put in place, paying special attention to ensuring equal participation of female students.

5) Reviewing assessment systems: an evaluation system based on questionnaires and rubrics was used in order to limit the impact of unconscious biases. In addition, a weekly monitoring system based on questionnaires was used to ensure more control in this regard.

Specifically, to address point 3, this year the project to be developed by the students was directly related to the visibility of female referents in the STEM areas (Science, Technology,

Engineering, Mathematics). The students had to analyze, design, and implement software for the www.girls4stem.es project. Girls4STEM is a real project aimed at promoting STEM vocations throughout society, but especially among girls, at the University of Valencia [27], [28].

The development of this project was linked to the dissemination in the social network used in the subject (Twitter https://twitter.com/etseis1) of contents related to the digital gender gap and the gender perspective. Some examples of the publications made are presented in Fig. 1.

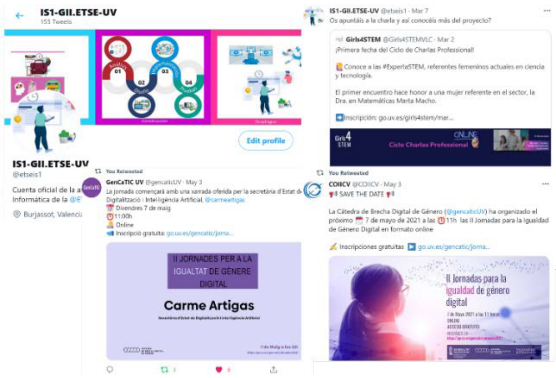

Fig. 1: Twitter account of the subject

Additionally, students were invited to participate in the activities organized by the project. Moreover, a special session in collaboration with the ETSE-UV was developed and students were encouraged to assist scheduling it during time class. This session was a Girls4STEM Professional Talk organized with the Masterclasses of the ETSE-UV, as can be seen in Fig. 2.

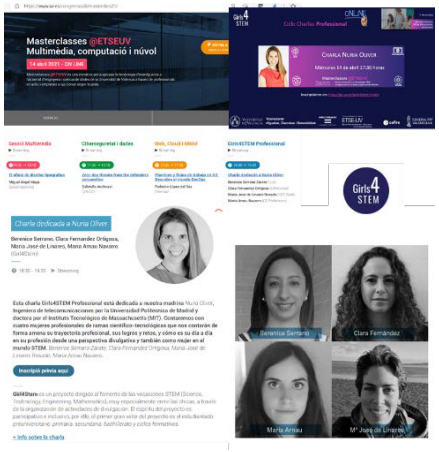

Fig. 2: Girls4STEM Professional Talk Special Masterclasses ETSE-UV

RESULTS AND DISCUSSION

In order to analyze the impact of the developed activities, a survey was designed. This task was presented to the subject students inside the Moodle environment of the UV (Aula Virtual), within the final questionnaire performed for the subject at the end of the semester.

Eight new gender-oriented questions, that can be seen in Fig. 1, were included in this survey, with a 5-item Likert scale (Strongly disagree, Disagree, Neutral, Agree, Totally agree). Students were able to answer the full survey, answer some questions or not answer them at all. It must be noticed that this survey was not blinded because we used it to analyze students' satisfaction with respect to their performance in the subject.

Q1	The gender gap is a fad.
Q2	The gender gap is not a problem that should be addressed in this subject.
Q3	Before taking the course, I did not know that there was a gender gap in the technology sector.
Q4	People studying technical careers should help reduce the gender gap in their sector.
Q5	The gender gap is a problem that only affects women.
Q6	The information about the gender gap shared on the subject's Twitter has helped me to better understand the gender problem in the technology sector.
Q7	The information received in the Girls4STEM talk has helped me to better understand the gender problem in the technology sector.
Q8	The software solutions proposed in the practical workshops can be a way of working to reduce the gender gap.

Fig. 3: Gender questions survey

Regarding the participation on the survey, 29 of the 54 students fulfilled the complete survey, 5 female and 24 male students. However, just 21 male students fulfilled the gender questions, meanwhile all the female students did it. This means that the female participation rate (71.4% for the full and the gender questionnaire) was higher than the male participation rate (51.0% for the full survey and 44.7% for the gender questions).

As can be observed in Fig. 4, which represent the median values obtained for each question for male (in green) and for female students (in purple), the students' perception regarding including gender perspective in the subject were very different depending on their gender.

Fig. 4: Mean values obtained for each question

If we analyze in depth the answers made by female (in Fig. 5) and male (in Fig. 6) students, it is quite obvious that female students had more positive perception than male students did. Female students were more aware about the digital gender gap and were much more in agreement with the information received during the course and the social impact of the software project developed.

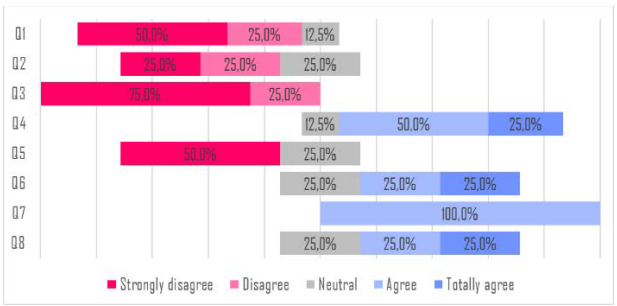

Fig. 5: Female answers distribution

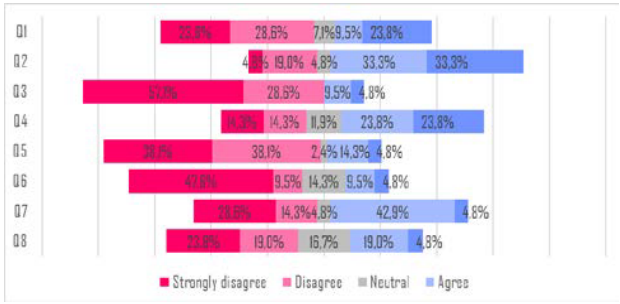

Fig. 6: Male answers distribution

CONCLUSIONS AND FUTURE WORK

In this paper we have presented a case study of a practical inclusion of gender perspective in a Computer Engineering subject. The evaluation results show high differences on gender perception of the activities performed, being more accepted in female students than among male students.

Even though the number of collected answers is not very high, especially the female answers, these results are coherent with those obtained in other similar studies [17], [18] . We consider that this demonstrates the lack of awareness of some of the students and indicates that we are moving in the right direction to close the gap.

The main limitation of this work is the lack of statistical results. We aimed to show a practical experience, not a sound result. Another limitation is that we need to explore how to generalize our procedure for other courses. As future work, the authors would like to repeat this experience in other subjects of the TIP and to collect more answers to the designed survey to validate the obtained results.

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