**Guides to
mainstreaming gender
in university teaching**

Computer Science

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Xarxa Vives
d'universitats

SUMARY

PRESENTATION

What is the gender perspective and what relevance does it have in teaching undergraduate and graduate programmes? When applied to a university setting, the gender perspective or gender mainstreaming is a comprehensive policy to promote gender equality and diversity in research, teaching and university management—all areas affected by different gender biases. As a cross-cutting strategy, it involves all policies taking into account the characteristics, needs and interests of both women and men, and distinguishing biological aspects (sex) from culturally and historically constructed social representations (norms, roles, stereotypes) of femininity and masculinity (gender) based on sexual difference.

The Xarxa Vives d'Universitats (XVU) (Vives Network of Universities) encourages a cohesive university community and reinforces the projection and the impact of academe in society by promoting the definition of common strategies, especially in the gender perspective scope of action. It should be highlighted that policies that do not take into account these different roles and diverse needs and are, therefore, gender-blind do not help to transform the unequal structure of gender relations. This also applies to university teaching, where we offer students a compendium of knowledge to understand the world and intervene in their future professional practice, providing sources of reference and academic authority and seeking to promote critical thinking.

Knowledge transfer in the classroom that is sensitive to sex and gender offers different benefits, both for teachers and for students. On the one hand, deepening the understanding of the needs and behaviours of the population as a whole avoids partial or biased interpretations—both theoretically and empirically—that occur when using man as a universal reference or when not taking into account the diversity of the female or male subject. In this way, incorporating gender perspective improves teaching quality and the social relevance of (re)produced knowledge, technologies and innovations.

On the other, providing students with new tools to identify stereotypes, social norms and gender roles helps to develop their critical thinking and skill acquisition that will enable them to avoid gender blindness in their future professional practice. Furthermore, the gender perspective allows teachers to pay attention to gender dynamics that occur in the learning environment and to adopt measures that ensure that the diversity of their students is addressed.

The document you are holding is the result of the biannual 2016-2017 work plan of the XVU Gender Equality Working Group, focused on gender perspective in university teaching and research. At an initial stage, the report entitled *La perspectiva de gènere en docència i recerca a les universitats de la Xarxa Vives: Situació actual i reptes de futur (2017) [Gender Perspective in Teaching and Research at Universities in the Vives Network: Current Status and Future Challenges]*, coordinated by Tània Verge Mestre (Pompeu Fabra University) and Teresa Cabruja Ubach (University of Girona), found that the effective incorporation of gender perspective in university teaching remained a pending challenge, despite the regulatory framework in force at European, national and regional levels of the XVU.

One of the main challenges identified in this report in order to overcome the lack of gender sensitivity in curricula on undergraduate and postgraduate programmes was the need to train teachers in this skill. In this vein, it pointed out the need for educational resources that help teachers provide gender-sensitive learning.

At the second stage, these guidelines for university teaching with a gender perspective has been prepared, under the coordination of Teresa Cabruja Ubach (University of Girona), M. José Rodríguez Jaume (University of Alicante) and Tània Verge Mestre (Pompeu Fabra University). Altogether, eleven guides have been developed—with between one to four guides for each field of knowledge—by expert lecturers and professors from different universities in applying a gender perspective in their disciplines:

ARTS AND HUMANITIES:

History: Mónica Moreno Seco (Universitat d'Alacant)

Art History: M. Lluïsa Faxedas Brujats (Universitat de Girona)

Philology and Linguistics: Montserrat Ribas Bisbal (Universitat Pompeu Fabra)

Philosophy: Sonia Reverter-Bañón (Universitat Jaume I)

SOCIAL AND LEGAL SCIENCES:

Law and Criminology: M. Concepción Torres Díaz (Universitat d'Alacant)

Sociology, Economics and Political Science: Rosa M. Ortiz Monera and Anna M. Morero Beltrán (Universitat de Barcelona)

Education and Pedagogy: Montserrat Rifà Valls (Universitat Autònoma de Barcelona)

SCIENCES:

Physics: Encina Calvo Iglesias (Universidade de Santiago de Compostela)

LIFE SCIENCES:

Medicine: M. Teresa Ruiz Cantero (Universitat d'Alacant)

Psychology: Esperanza Bosch Fiol and Salud Mantero Heredia (Universitat de les Illes Balears)

ENGINEERING:

Computer Science: Paloma Moreda Pozo (Universitat d'Alacant).

Learning to incorporate the gender perspective in subjects merely implies a reflection on the different elements that constitute the teaching-learning process based on sex and gender as key analytical variables. In order to review your subjects from this perspective, the guidelines for university teaching with a gender perspective provide recommendations and instructions that cover all the following elements: objectives; learning outcomes; content; examples and language used; selected sources; teaching methods and evaluation, and management of the learning environment. After all, incorporating the principle of gender equality is not just a matter of social justice but also teaching quality.

Teresa Cabruja Ubach, M. José Rodríguez Jaume
and Tània Verge Mestre, coordinators

1. INTRODUCTION

In this guide, Computer Science lecturer Paloma Moreda (University of Alacant) addresses the inclusion of the gender perspective in information and communications technology (or ICT). This field comprises STEM degrees (science, technology, engineering and mathematics), characterised by the underrepresentation of women students and professionals. The low participation of women in this sector leads to the hegemonic presence of androcentric and sexist values, in the knowledge delivered in lecture rooms as well as in the IT products and technologies currently available on the market. From an academic and scientific perspective, as pointed out in the guide, the inclusion of women and gender-sensitive approaches promotes scientific excellence, boosts the quality of STEM outcomes by aggregating creativity and reducing potential gender biases (given that women's expertise is taken into account), and promotes more robust, efficient and effective knowledge of and solutions to social problems.

As far as university teaching is concerned, gender blindness poses a threat to women technologists' entry to and retention in a sector governed by androcentric values. They will have to demonstrate their professional competence in a context in which most project leaders (scrum masters) and team members are men – in other words, women will have to prove their credibility, as professionals in these fields are expected to be men. Therefore, the guide focuses on how to incorporate the gender perspective into the modes of organisation, teaching methods and resources employed in the lecture room, without forgetting other aspects to consider in university teaching planning.

Paloma Moreda's specific proposals for adopting the gender perspective in teaching are based on the following subjects: Analysis and Specifications of Software Systems (University of Alacant's Bachelor's Degree in Computer Engineering) and Video Games I (University of Alacant's Bachelor's Degree in Multimedia Engineering). Her advice on how to design teaching in each subject is tailored to the specific context. In the first subject, the primary aim is to introduce the gender perspective as part of the methodology, practical activities and teaching resources in order to shed light on gender biases in the sector. A central point in the second subject is how curricula with a gender perspective can encourage critical thinking among students. This will help them avoid gender stereotypes when designing video games and their final products will become tools to bridge the gap between young girls and technology. The guide includes the Engineering Checklist, with 25 questions to incorporate sex and gender analysis into engineering as a basis for developing gendered innovations.

2. GENDER BLINDNESS AND ITS IMPLICATIONS

The percentage of women enrolled in bachelor's, first- and second-cycle degrees in Spain in the 2015-2016 academic year (latest data available) is 54.5%. Only 25.5% of these women enrolled in engineering and architecture degrees, the fields of study with the lowest percentage (INE, 2017: 15). In ICT engineering degrees, this percentage drops to 10% (RAI, 2016; UNESCO, 2017: 20). A similar pattern is observed in postgraduate degrees: in engineering studies, women are underrepresented, have a lower third-cycle degree completion rate (WHITE PAPER: 24), and fewer of them pursue a research career – in 2006, the number of women undertaking a postgraduate degree in engineering and technology fell to 33.1% (WHITE PAPER: 110). Women's underrepresentation in computer science bachelor's degrees is reflected in the number of women professionals and researchers. In 2010, women working in ICT accounted for 28.73% of the total (Blasco, 2013: 58); in 2015, while the number of companies and the business volume in the ICT sector had gradually increased, they represented 22.9% (INE, 2017).

These figures are even more remarkable from a diachronic perspective, as they are not in line with the historical trend. Until the 1980s, women's participation and interest in computer science were similar, in terms of percentages and increases, to those in other areas and among men. However, this changed with the emergence of personal computers and the advertising campaigns to promote their use at home, exclusively targeted at male audiences (Henn, 2014).

Over the last decades, considerable efforts have been made to increase women's presence in technology and engineering studies. Still, socioeconomic obstacles, the lack of female models, stereotyped social representations and girls' low self-perception about the self-effectiveness of their telecommunications and IT skills (Cheryan *et al.*, 2012; Cheryan *et al.*, 2017; ICILS, 2013: 103; UNESCO, 2017: 22) are all factors that explain why the percentage of boys wishing to pursue ICT or engineering careers is higher (2% and 22% of women, respectively) (PISA, 2015; PISA, 2017). In childhood, however, girls are interested in STEM subjects (RAI, 2016b).

According to UNESCO (2017: 15), promoting women's access to STEM careers is an imperative:

- From the **human rights perspective**, because all people are equal and should have equal opportunities, including to study and work in the field of their choice.

- From the **scientific perspective**, because the inclusion of women promotes scientific excellence and boosts the quality of STEM outcomes, as diverse perspectives aggregate creativity, reduce potential biases, and promote more robust knowledge and solutions. Recent reports highlight that more gender-balanced companies display better performance and that we bear the consequences of women's underrepresentation in engineering, with unsafe protective measures and discriminatory technology.

- From a **development perspective**, because if gender inequalities in STEM education and employment persist, existing gender equalities in status and income will be perpetuated, as short- and middle-term jobs require that men and women acquire knowledge associated with STEM.

Bachelor's degrees in computer engineering will equip degree holders with all the skills **scrum masters** need. The problems specific to female scrum masters will be:

(i) taking up a role always considered to be male, not female, and achieving the credibility required for that role.

(ii) directing and guiding the work of male collaborators while avoiding criteria and attitudes typically adopted by men.

(iii) overseeing relationships with clients, who normally expect scrum masters to be men.

(iv) creating a suitable environment in which female team members are on an equal footing with male team members.

(v) finding the balance between strategies based on sensitiveness and understanding, more common among women, and slightly more authoritarian strategies, typical of men, making sure that understanding is not confused with friendship or authoritarianism with despotism.

Furthermore, the video gaming industry features a strongly male-dominated job market. In fact, over the last 50 years, most video game inventors, developers and players have been men (Gendered Innovation). As women are excluded from the technology sector, the existing video gaming market is based on and reproduces androcentric values (most notably violence, activity, domination and rationality), as well as sexist practices (hyper-sexualised female characters) (Cabañes, 2009). A study by Gutiérrez (2004) highlights that out of a total of 1,824 video game characters analysed, 64% were male, 16% female, and 19% non-human. There

is even more sexism in terms of gameplay: 73% of playable characters were male, compared to 12% female. In this context, the main problems facing female graduates wishing to pursue a professional career in video games are:

(i) learning how to get rid of learned stereotypes that reflect an exclusively male perspective. This explains why male characters greatly outnumber female characters and the latter, when present, usually play subordinate roles, for instance the "damsel in distress" archetype.

(ii) making others understand that developments by and for women are necessary in the video gaming industry.

(iii) making their male developer colleagues acknowledge the value of female-targeted video games.

(iv) achieving enough credibility to lead developing teams when the video game in development incorporates the gender perspective.

3. GENERAL PROPOSALS FOR INCORPORATING THE GENDER PERSPECTIVE INTO TEACHING

Computer science and related professional careers are today characterised by male-dominated structures. As a result, all models in the fields of development and research are men (androcentric vision), whereas leading women who have been and are important in this discipline, and who could set models for many girls and women if given more prominence, are ignored. Key women in the history of computer science, social advancement and progress who are hardly recognised include **Elizabeth Hawk**, inventor of the kitchen in 1867; **Josephine Cochranen**, inventor of the dishwasher in 1886; **Florence Parpart**, inventor of the fridge in 1914; **Mary Kenneth Keller**, the first female lecturer hired at Dartmouth College's Computer Science Department, in the United States, in 1958, and who developed the BASIC programming language (even though this language is exclusively credited to John G. Kemeny and Thomas E. Kurtz); **Ada Lovelace**, developer of what is regarded as the first computer program; **Grace Murray**, who together with her team created UNIVAC-I in 1951, considered to be the first large-scale digital computer and creator of the first compiler; **Margaret Hamilton**, director of the Software Engineering Division of the MIT Instrumentation Laboratory, where the navigation software for the Apollo space programme, which allowed Neil Armstrong to set foot on the Moon, was developed; **Erna Schneider**, creator of the computerised system for phone traffic; or **Radia Perlman**, who in 1983 invented the Spanningtree algorithm, without which we would be unable to use the internet.

The dominant approach and experiences in computer science are androcentric. Therefore, gender is usually associated with women, which results in gender-insensitive teaching that only adopts the gender approach in subjects perceived to deal with issues of interest to women. High-quality teaching in computer science cannot ignore the sex-gender system, as both biological differences (sex) and gender (the social construct approved by society on femininity and masculinity) will determine the success and failure of developments, the suitability of the responses given by the IT sector to social challenges and the pace of social progress, with computer science as a key factor. Not adopting the gender perspective in computer science leads to unsafe protective measures and discriminatory technology from which men and women do not benefit in the same way. Through some illustrative examples, computer science students can understand the sex-gender system and its relevance in the professional world.

- The first crash test dummy, used for decades, was based on the male body. The consequences are still visible today, with seat belts that do not fit pregnant women; as a result, car crashes are the main cause of foetal death related to trauma sustained by the mother.

- The first versions of machine translation systems such as Google Translate used the masculine pronoun even when the text clearly referred to a woman.

- The earliest voice recognition systems were designed for typical male voices and literally ignored female voices.

The incorporation of the gender perspective into teaching in engineering and ICT degrees involves reviewing not only the formal (explicit) curriculum, but also the teaching practices included in the hidden (implicit) curriculum. To that end, adjustments are needed in curricula and subject guides (explicit curriculum: skills, goals, activities and assessment), as well as in those actions requiring interaction in the classroom and with students (implicit curriculum: classwork, groupwork and tutoring). The latter features prominently in computer science degrees, since gender, as an analytical category, encompasses the **contextual dimension** (classrooms are socialisation agents in which gender inequalities are constructed) and the **relational dimension** (set of established interactions that outline the symmetric differential places and roles assigned to women and men). It should also be noted that environments with male overrepresentation discourage women's participation.

Bath (2009) has developed a systematic analysis of computational artefact design. This analysis has allowed her to identify four mechanisms through which gender bias is present in ICT, both structurally and symbolically:

- The 'gender-neutral' approach. A 'neutral' approach in technology makes women invisible, the result being that designers, without noticing, only take their own characteristics into account and exclude women, among other groups. For instance, in voice recognition systems that cannot recognise female voices.

- The gender differences approach. When technological innovation design focuses on gender differences, gender stereotypes and hierarchies are reinforced; for example, in many video games targeted at female audiences.

- The development of human-like machines that perpetuate gender rules and contribute to gender stereotypes. To eliminate this bias, it is necessary

to deconstruct the binary sex-gender system. Example: inclusion of designs based on the experience of users, both female and male.

- The use of biased algorithms, formal objects and conceptual approaches in computer science. Bath suggests recontextualising formal objects and questioning cases, ontologies and epistemologies in ICT research. Example: depending on the algorithmic model used, differences or similarities in brain activity between men and women are emphasised.

4. GOOD PRACTICES

4.1 Objectives

Generally speaking, the curricula of computer science degrees must set out **objectives** related to the promotion of equal opportunities between women and men; students should gain a view of the sex/gender system in line with equal opportunities and be aware of the obstacles facing women in engineering (ISONOMIA, 2010). Therefore, degrees should include as a **general objective** the "ability to promote a culture in favour of equal opportunities between men and women" as well as **general** competences in gender equality. To that end, changes should be introduced regarding two aspects of current curricula.

- On the one hand, there should be a Year 1 compulsory subject that (i) gives students an insight into the sex/gender system, considering equal opportunities and women's incentives and obstacles in engineering; (ii) sheds light on the knowledge produced by women in the field; and (iii) makes students able to solve problems in an inclusive way.

  Example: the subject Engineering, Society and University (available in engineering degrees at the Universitat de València). The second block of the subject gives an overview of engineering in different specialisations and, particularly, in each bachelor's degree (Computer, Multimedia, Industrial Electronics Engineering, etc.), focusing on the relationship between engineering and science, technology, the economy, society and the environment. The aim is to give students a taste of what engineering is like and encourage reflection on its impact on social development, always emphasising engineers' ethical and environmental commitment and the principles of equal opportunities, democratic values and a culture of peace.

- On the other hand, existing subject guides should be modified whenever necessary to add specific objectives for analysing and developing systems that take into account the behaviour and needs of male and female users. These objectives will enable students to identify androcentric biases in their discipline/profession and to work in egalitarian teams that incorporate women's perspective, experience and needs.

- Example: in subjects related to usability and accessibility in bachelor's degrees in multimedia engineering (for instance, the one offered by the UA), the existing objectives (see table 1, column 1) should be changed to (column 2):

CURRENTLY	WITH A GENDER PERSPECTIVE
Ability to design, develop, assess and ensure accessibility, ergonomics, usability and security of multimedia systems, services and applications, as well as of the information they manage.	Ability to design, develop, assess and ensure accessibility, ergonomics, usability and security of multimedia systems, services and applications, as well as of the information they manage, considering the needs, patterns of use and expectations of women and men.
Ability to work in a multidisciplinary group and a multilingual environment and to communicate, both orally and

in writing, knowledge, procedures, results and ideas related to information and communications technology, with a focus on the multimedia aspects of these technologies. | Ability to work in a multidisciplinary group and a multilingual environment and to communicate, both orally and

in writing, knowledge, procedures, results and ideas related to information and communications technology, with a focus on the multimedia aspects of these technologies, while promoting respect for diversity, equity and gender equality. |

4.2 Contents

Subject: Analysis and Specification of Software Systems. Year 3 compulsory subject of the Bachelor's Degree in Computer Engineering (UA). 6 credits (theoretical part: 3 credits, practical part: 3 credits). First semester.

In this subject, students will understand that paradigms and methodologies are needed in software engineering for developing and planning IT systems, as software development (analysis, database design and maintenance, programming of modules and components, integration of various technologies, etc.) can be very complex. The subject will provide basic knowledge on expert assessment and consulting for software quality requirements. The lesson breakdown is as follows:

Lesson 1. Introduction. Details: general objectives of the subject. Contents. Assessment system, description of scheduled activities.

Lesson 2. Analysis and specification of requirements. Details: determining requirements. Tools and techniques for finding requirements. Description of requirements. Software quality.

Lesson 3. Object-oriented analysis. Details: introduction to UML. Use case diagrams. Class diagrams. Object or instance diagram. Sequence diagram. Collaboration diagrams. Activity diagrams. State diagrams. Component diagrams. Implementation diagrams.

Lesson 4. Software development methodologies. Details: software life cycle. Traditional methodologies. Agile methodologies.

Lesson 5. Expert evaluation and consulting for quality assurance. Details: IT expert evaluation basics. Describing how IT expert evaluations should be conducted. IT system performance evaluation.

This subject is closely connected with the professional world, as students learn methodologies that will allow them to lead software projects. These include agile methodologies, whereby students work in groups and simulate the development of a project as if they were in a company. **Development team meetings** are a fundamental part of this process and must be held every day for progress monitoring and synchronisation purposes. These 15-minute meetings are the team's main communication channel. Team members share what they have done, what they are going to do and any obstacles they face. In these meetings, the *scrum master* role is essential – broadly speaking, the scrum master must guide the team's collaborative efforts and interface with clients.

The Bachelor's Degree in Multimedia Engineering will equip degree holders with all the skills **scrum masters** need. Given the problems that female scrum masters will face (see section 2), software development methodologies should be addressed in relevant subjects with a gender perspective. In this way, female degree holders will be ready for the challenges they will encounter in a strongly male-dominated field. The subject could include a module called "Agile methodologies with a gender perspective."

4.3 Subject: Video Games I

Year 4 optional subject of the Digital Creation and Entertainment pathway of the Bachelor's Degree in Multimedia Engineering (UA). 6 credits (theoretical part: 3 credits, practical part: 3 credits). First semester.

In this subject, students will further the knowledge and skills required to design and develop video games. Emphasis is placed on aspects related to artificial intelligence and network communication. The subject has a strong focus on technology, providing students with the basic tools they need to take part in the development of modern video games: using the internet, making proper use of resources to give real-time responses and developing algorithms to bring characters and autonomous entities to life. The lesson breakdown is as follows:

> **Lesson 1**. Low-level video game programming with limitations. Basic assembler.

> **Lesson 2**. Artificial intelligence. Differences between classical AI and video game AI. Designed AI. Machine learning.

> **Lesson 3**. Artificial intelligence techniques in video games. Finite-state machines. Fuzzy logic. Pathfinding. Neural networks. Genetic algorithms.

> **Lesson 4**. Network communications. Basic concepts of computer networks. Client/server and P2P architectures. Distributed information models in video games. Dead reckoning and other state predictions. Network middleware.

The current contents of the subject have not been critically reviewed from a gender perspective. This would allow us to avoid gender bias in the curriculum (formal and informal), bridge the gap between girls and technology (Funk and Buchman, 1996) and prepare female degree holders for the professional challenges they will encounter in a sector with a dominant sexist ideology (see section 2). The subject could start with a lesson on video games and gender.

4.4 Assessment

A model of university teaching focused on diversity and inclusiveness requires several assessment options when it comes to monitoring student progress and learning outcomes, with different types of tests according to students' needs and characteristics (Alvarado, 2010). Some students feel more comfortable with

traditional assessment systems, such as multiple-choice tests or open-response tests, while presentations can be more appropriate for others.

For instance, Database Administration and Management, a Year 4 subject of the Information Technology pathway of the Bachelor's Degree in Computer Engineering (UA), offers two assessment options: continuous assessment or final exam. Students can choose the option that suits them best, considering the theoretical and practical sessions they attend. In continuous assessment, attendance is required and assessment is based on four activity types: exercises, presentations, report and test.

- The exercises section (20% of the total mark) consists of short exercises that are carried out individually during practical or problem-solving sessions.

- Presentations (30%) require students to work in teams and present the basic aspects of their assignments. Clarity of contents and clarity of presentation are taken into account. Each presentation is the outcome of the group's research work on topics set at the start of the subject.

- The report (20%) is based on a group project carried out over three months, through which students must demonstrate their knowledge of the concepts learned in practical lessons.

- The final exam (30%) is an open-book, multiple-choice test that students take individually. The test covers concepts studied in practical and theoretical classes.

4.5 Modes of organisation and teaching methods

In engineering studies, there are many methods available for undertaking projects or tests, manipulating elements, conducting simulations and other intellectual skills related to the execution of real or simulated tasks. It would be best in these degrees to familiarise students with multiple styles that engineers should master and use in professional practice (Ventura, 2014). In engineering and computer science degrees, practical lab sessions are key in developing problem-solving and diagnosis skills (De Miguel, 2005). For example, in Database Fundamentals, a Year 1 subject of the Bachelor's Degree in Computer Engineering (UA), theoretical lessons are combined with individual or group problem-solving seminars, as well as with practical sessions where students are taught how to act.

Furthermore, collaborative learning contributes to the creative generation of new ideas, increases respect for diversity, promotes reading, speaking and

writing skills, and helps students develop social and job skills; all these aspects are extremely important in engineering. For this reason, promoting project-based learning in small teams is also essential in training engineering students (Herrero *et al.*, 2008). For instance, Virtual Reality is a Year 4 optional subject of the Bachelor's Degree in Multimedia Engineering (UA) where project-based learning is adopted. This subject introduces students to the basic principles of virtual reality and its applications through the development of a professional project.

Special attention should be paid to work placements, usually included in the curriculum through optional subjects. In the case of the University of Alacant, it is a 6-credit subject of the final year of the degree and students can choose the semester in which they wish to take it.

From the field of ICT research with a gender perspective, Bath (2009:1) proposes specific methods for technological design that reduce gender bias (de-gendering). The methods discussed in Bath's analysis and listed below can be integrated into teaching with a gender approach in ICT degrees:

- Involvement of potential users in the design process (cyclic user centred design).
- Design for skill.
- Design for technical empowerment.
- Design for experience.
- Reflective design.

It should be borne in mind, however, that all these strategies must be developed in an inclusive space that promotes communication and interaction. To achieve this, special attention should be paid to aspects of the hidden curriculum such as:

- Respecting others' right to speak so that all contributions have the same relevance.
- Setting up small work teams.
- Monitoring women's situation and role in work teams, as they will be in a clear minority.
- Analysing trends regarding the topic, in both women and men.
- In practical sessions, selecting topics that motivate and stimulate students.

- Developing examples, exercises and practical activities that bring gender inequalities to the fore.

In this sense, it is worthwhile highlighting the experiment conducted by García-Folgat *et al.* (2017) in the subject Software Engineering I (University of Salamanca). Specific activities and materials with a gender perspective were introduced. The activities were aimed at highlighting women's reality in the technological sector, which would prepare them for the challenges facing them and promote a critical vision of reality. With this in mind, the #usal17 Twitter tag and the virtual campus were used to provide information on the gender gap in the sector. Besides, the practical exercises proposed were related to a variety of gender issues. Remarkable points raised by the lecturers include (García-Folgat *et al.*, 2017: 629-630):

- Development of a web application that promotes STEM skills acquisition in primary and secondary education and breaks down stereotypes regarding the choice of university studies.

- Development of a job portal for women technologists.

- Development of a specific portal highlighting women technologists, containing initiatives, projects, associations, institutions and others to reduce the gender gap in the technological sector (final assignment of the subject). The assignment should be accompanied by a technical report including an introduction to the topic addressed. Optionally, the assignment would be presented in class.

5. TEACHING RESOURCES

The teaching resources traditionally employed in engineering are oral, written and visual.

Regarding oral and written communication, much work remains to be done on the use of inclusive vocabulary. It is obvious that indicating both genders in all cases is not the solution and should be avoided whenever possible, but it is equally obvious that that which has no name does not exist, according to George Steiner. For this reason, efforts should be made concerning the language we use, with a view to generating a space in which both men and women are present. Accordingly, the following should become standard practice:

- Where appropriate, using gender-neutral forms. Therefore, gender-specific pronouns (*he*/*she*, *him*/*her*, *his*/*hers*) should be avoided unless necessary. Some alternative options are plural nouns (*students*), plural pronouns (*they*, *them*, *their*) or indefinite pronouns (for instance, *all* or *every*). Gender-marked titles and names of professions, such as *chairman*, *chairwoman* or *air hostess*, are acceptable only if reference is made to a specific gender. Otherwise, *chair*, *chairperson* or *flight attendant* should be used.

- If both masculine and feminine forms are employed, alternating the order in which they appear to avoid implying that one of the sexes prevails over the other.

- Avoiding stereotypes or sexist terms and phrases.

As for visual communication, it is very important to include images in which men and women appear together so as to emphasise that both sexes perform various tasks, jobs, etc. In so doing, stereotyped images related to the traditional roles of men and women are avoided. Besides, the focus should be on women's tasks and achievements, rather than on their physical appearance, and double standards should be avoided in the treatment of men and women.

The importance and difficulty of this task become evident when we search the internet for pictures. For example, if we try to find pictures on Google with the search text *enginyeria informàtica* (Catalan for "computer engineering"), we will see that most of the first results provided are pictures of men. If we type *enginyer informàtic* (Catalan for "computer engineer", masculine singular form), we get links about computer engineering or computer engineers (what computer engineering is, what it is for or why become a computer engineer); when the search text is *enginyera informàtica* (Catalan for "computer engineer", feminine

singular), all results are related to engineering, with no information on women engineers. The pictures found when we enter the text *enginyer informàtic* (Catalan for "computer engineer", masculine singular) will usually show a man; if the search text is *enginyera informàtica* (Catalan for "computer engineer", feminine singular), the pictures will refer to engineering in general or show a man. For *enginyer camins* and *enginyera camins* (Catalan for "road engineer", masculine singular and feminine singular forms respectively) we will get job openings for men and information on road engineering for women. If we search for pictures, those for *enginyer* (Catalan for "engineer", masculine singular) are directly related to the profession, while almost all of those for *enginyera* (feminine singular) are close-ups of women who, on first glance, have nothing to do with road engineering (search performed on 15 November 2017).

6. TEACHING HOW TO CARRY OUT GENDER-SENSITIVE RESEARCH

The *Guía práctica para la inclusión de la perspectiva de género en los contenidos de la investigación* includes a specific section (6) that presents an eight-step methodology for incorporating the gender perspective into ICT research.

1. Rethinking priorities.

2. Rethinking theories and concepts.

3. Formulating research questions.

4. Analysing sex.

5. Analysing gender assumptions.

6. Analysing covariables.

7. Rethinking standards and reference models.

8. Participatory research.

This method and the questions it comprises are based on GENDERED INNOVATIONS IN SCIENCE, HEALTH & MEDICINE, ENGINEERING, AND ENVIRONMENT, which contains the Engineering Checklist. This list consists of 25 questions – grouped into 5 key dimensions – on how to incorporate sex and gender analysis into engineering as a basis for developing gendered innovations. The questions are transcribed below:

6.1 Key questions

1. Potential consumers of technology have different characteristics (gender identities, sex, age, ethnicity, profession, occupation, education, income, household and living arrangements, familiarity with and attitudes towards technologies, etc.). What role, if any, do sex and gender play with regard to the developing technology?

(A) DETERMINING THE RELEVANCE OF SEX

2. Are there basic anatomical and physiological differences between women and women that should be considered (e.g. in height, strength, range of motion, etc.)? (see Term: Sex; see Methods: Analysing Sex; Rethinking Standards and Reference Models).

3. Are there further anatomical and physiological differences between women and men that should be considered (e.g. in vision, hearing, voice pitch, sense of touch, smell, and taste, proprioceptors, muscular tension, temperature perception, etc.)?

(B) DETERMINING THE RELEVANCE OF GENDER

4. What are the potential application areas of the technology (e.g. professional life, leisure activities, home, etc.)? Do these contexts suggest different patterns of use by different groups of potential consumers (e.g. women and men)? See Term: Gender; see Method: Analysing Gender.

5. Might different groups of potential consumers (e.g. women and men) have different expectations regarding the interface? Do certain features of previous innovations reinforce existing gender inequalities, gender norms, or stereotypes? (see Reformulating Research Questions; Participatory Research and Design).

6. Might different groups of potential consumers (e.g. women and women) have different expectations regarding the exterior design?

7. Might different groups of potential consumers (e.g. women and women) have different expectations regarding the features and functions?

8. Is it more cost-effective to tailor the technology to specific groups (e.g. women and men) at early development stages or could it be inexpensively adapted in post-development?

9. Is there a risk of stereotyping or offending potential consumers through the exterior design (e.g. imposing role models, avatars, different forms of sexism, etc.)?

10. Is there a risk of excluding certain groups (e.g. women or men) through the technology design?

11. Would certain configurations reinforce existing social roles (e.g. gender separation in the work force; men associated with engineering and women with domestic technologies, for example)?

12. On the basis of the above, what are the relevant sex and/or gender variables for your business, and what do you need to know that you do not currently know or understand concerning sex and/or gender?

(C) DETERMINING THE TOOLS REQUIRED

13. Is it possible and/or necessary to establish a usability lab or to run ergonomic tests? What additional tools might you use for monitoring (questionnaires, workshops, etc.)?

14. Have you ensured diversity within test groups (in terms of age, sex, gender identity, height, etc.)?

15. Do you inform your customers about gender-tailoring in your technologies?

(D) DETERMINING THE POTENTIAL FOR INNOVATION

16. Can you think of any additional customer groups or application areas for your technology?

17. How much research would be necessary to identify these groups/markets?

18. Is your business model missing potential opportunities by not addressing sex and gender sufficiently? Where might sex and gender analysis open up new business opportunities through gendered innovation?

(E) PROCURING SEX AND GENDER EXPERTISE

19. Have you identified the particular gender expertise you require?

20. Do your internal and external teams include the needed gender expertise? If not, what efforts are your teams making to bring in gender specialists?

21. Do members of the target group(s) have particular expertise relevant to developing or applying the technology that should be incorporated into the innovation process?

22. What efforts is your team making to ensure that the diverse expertise, interests and needs of the target groups are incorporated into the design and development of the product? (see Participatory Research and Design).

23. Do certain groups hold knowledge (e.g. because of gendered divisions of labour) with the potential to prevent unwanted outcomes, such as increased gender bias or environmental damage?

24. What efforts is your team making to ensure that it learns from the inputs of external expertise concerning sex and gender, and builds relevant capabilities in-house?

25. Does your team understand how to incorporate gender expert knowledge and innovation criteria into existing design, engineering and quality methods such as Quality Function Deployment (QFD), Failure Mode Effect Analysis (FMEA), or Six Sigma?

This checklist is based on the Fraunhofer Discover Gender project, funded by the German Ministry of Research between 2004 and 2006.

7. REFERENCE RESOURCES

Gender-sensitive research requires similar solutions across different areas. To conduct inclusive research, researchers must receive specific training. To that end, it will be necessary to provide additional training in gender skills in technology and engineering. It is important to convey to students how gender knowledge can be productive in engineering and, consequently, in their professional practice – that is why projects incorporating gender should be analysed. In so doing, students will learn how to implement and incorporate gender-related aspects into technology and engineering. Some useful initiatives and resources in this regard are:

The Technical University of Berlin, in its GENDER PRO MINT programme, trains students in science and technology skills from multiple gender perspectives. This makes students integrate gender and diversity needs while developing scientific knowledge or technological advances. The programme consists of 5 modules (30 credits) in which students, for instance, see how engineering and gender are connected (introductory module) or learn how the concepts learned about gender can be applied to engineering through a case study (project module).

The *Guía práctica para la inclusión de la perspectiva de género en los contenidos de la investigación*, in its section 6, deals with how to incorporate the gender perspective into research. The guide is based on an eight-step methodology:

1. Rethinking priorities.

2. Rethinking theories and concepts.

3. Formulating research questions.

4. Analysing sex.

5. Analysing gender assumptions.

6. Analysing covariables.

7. Rethinking standards and reference models.

8. Participatory research.

These eight steps allow us to determine several aspects, including who benefits or does not benefit from research, potentially missed opportunities if the relevance of sex and gender is ignored, different needs for different groups, etc.

The basic premise of the **Gendered Innovations** project is that using methods for sex and gender analysis is necessary in order to create new knowledge. In other words, gender should be taken into account to add a valuable dimension to research. Therefore, one of the main objectives is to provide case studies that serve as specific examples of how analysing sex and gender leads to innovations in research. A portal has been created as a result of the project, providing access to several case studies in which the objective, method and innovations achieved are determined.

We can also mention books such as Cecilia Castaño's *Género, ciencia y tecnologías de información* (2014), a rigorous and accessible look at the complex relationship between women and technology from the gender perspective, based on the outcomes of different research projects and of the Gender and ICT Programme of the Universitat Oberta de Catalunya's (UOC) Internet Interdisciplinary Institute (IN3); or *Mujeres en ciencia y tecnología* (2012), a book by Rosa María Claramunt *et al.* that provides a balanced and realistic overview of the history of technology through women's contributions across different scientific disciplines, highlighting their importance and plurality.

Other useful materials and links:

- Diana project: http://www.inmujer.gob.es/areastematicas/socinfo/programas/diana.htm
- Association of Women Researchers and Technologists (AMIT): http://www.amit-es.org/
- Informática para tod@s ("Computer Science for All"): https://ipt.acm.org/
- Iniciativa 11 de febrero ("11 February Initiative"): https://11defebrero.org/
- Una estudiante de ingeniería en cada cole ("A Female Engineering Student in Every School"): http://hdl.handle.net/10347/15177
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- ACM-W: https://women.acm.org
- University of Granada's Technological Campus: http://cs4hs.ugr.es
- University of Alacant's GigaBytGirl Campus: https://web.ua.es/es/unidad-igualdad/secundando-la-igualdad/gigabytgirl/iii-campus-gigatebytgirl.html

- Tech&Ladies: http://techandladies.com
- Adalab (a social start-up): http://adalab.es
- R-Ladies Global: https://rladies.org/
- Women Techmakers: https://www.womentechmakers.com/

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Socio-economic barriers, the absence of female role models and the presence of stereotyped social representations make difficult to increase the presence of women in technology and engineering teaching.

The *Guide of Computer Science to mainstreaming gender in university teaching* offers proposals, examples of good practices, teaching resources and consultation tools that will allow to demasculinize this field and make visible female models to enhance women's access to degree studies in this field of knowledge.

Check out the guides from other disciplines at vives.org

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