Sciences

Guides to mainstreaming gender in university teaching

Physics

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Xarxa Vives d'universitats

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SUMARY

PRESENTATION

What is the gender perspective and how relevant is it in undergraduate and postgraduate teaching? Applied to university settings, the gender perspective or gender mainstreaming is a comprehensive policy for promoting gender equality and diversity in university research, teaching and management, areas that are affected by different gender biases. As a cross-cutting strategy, it means that all policies should consider the characteristics, needs and interests of both women and men, differentiating the biological aspects (sex) from the social representations (norms, roles, stereotypes) that are culturally and historically constructed on femininity and masculinity (gender) based on sexual difference.

The Vives Network of Universities (XVU) encourages cohesion within the university community and reinforces the influence and impact of universities on society by promoting the implementation of common strategies, particularly within the scope of the gender perspective. It should be noted that gender-blind policies that ignore these different roles and needs do not help in transforming the unequal structure of gender relations. This also applies to university teaching, through which we offer knowledge for students to understand and act in the world once they have become professionals, provide references and academic authority, and seek to develop their critical spirit.

A sex- and gender-sensitive knowledge transfer in the lecture room is beneficial to lecturers and students alike. On the one hand, by advancing our understanding of the needs and behaviours of the whole population, we avoid partial or biased interpretations, whether theoretical or empirical, which arise when men are regarded as the universal point of reference, or when gender diversity is not taken into account. Accordingly, incorporating the gender perspective improves teaching quality and the social relevance of the (re)produced knowledge, technologies and innovations.

On the other hand, providing students with new tools for identifying gender stereotypes, norms and social roles helps them develop their critical spirit and avoid gender blindness in their future professional careers. Moreover, the gender perspective allows teachers to pay attention to the gender dynamics that take place in the learning environment and adopt measures to properly address student diversity.

This document results from the 2016-2017 two-year plan of the XVU's Gender Equality Working Group, focused on the gender perspective in university teaching and research. In a first phase, the report *La perspectiva de gènere en docència i*

recerca a les universitats de la Xarxa Vives: Situació actual i reptes de futur (2017), coordinated by Tània Verge Mestre (Pompeu Fabra University) and Teresa Cabruja Ubach (University of Girona), noted that the gender perspective had not yet been effectively incorporated into university teaching, despite the regulatory framework in place at European and national level and across areas where the Vives Network is present.

One of the main challenges identified in the report regarding the lack of gender sensitiveness in undergraduate and postgraduate curricula was the need to train lecturers in this skill. In this vein, the report pointed out that lecturers needed teaching resources to deliver gender-sensitive teaching.

Consequently, in a second phase, the *Guides for university teaching with a gender perspective* have been produced, coordinated by Teresa Cabruja Ubach (University of Girona), M. José Rodríguez Jaume (University of Alacant) and Tània Verge Mestre (Pompeu Fabra University). In total, 11 guides have been prepared, including between one and four guides for each knowledge area. The guides have been drafted by women lecturers from different universities, who are experts in applying the gender perspective to their discipline:

ARTS AND HUMANITIES:

History: Mónica Moreno Seco (University of Alacant)

Art History: M. Lluïsa Faxedas Brujats (University of Girona)

Language Studies and Linguistics: Montserrat Ribas Bisbal (Pompeu Fabra University)

Philosophy: Sonia Reverter-Bañón (Universitat Jaume I)

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Sociology, Economics and Political Science: Rosa M. Ortiz Monera and Anna M. Morero Beltrán (University of 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 (University of Alacant)

Psychology: Esperanza Bosch Fiol and Salud Mantero Heredia (University of the Balearic Islands)

ENGINEERING:

Computer science: Paloma Moreda Pozo (University of Alacant)

Learning how to incorporate the gender perspective into the subjects we teach involves reflecting on the various elements that make up the teaching-learning process, with sex and gender as key analytical variables. To help you approach your subjects from this perspective, in the *Guides for university teaching with a gender perspective* you will find recommendations and indications covering all these aspects: objectives, learning outcomes, contents, examples and language to be used, selected references, teaching and assessment methods, and learning environment management. After all, incorporating the principle of gender equality is not only about social justice, but about teaching quality.

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

INTRODUCTION

This guide for the incorporation of the gender perspective in university teaching in physics presented by Encina Calvo Iglesias, professor at the Universidade de Santiago de Compostela (USC), provides guidelines and recommendations on how to avoid gender bias in all components of university teaching (formal and informal curriculum). What is unique about her proposal is that it is in an area and context (academic and professional) in which the presence of women is reduced (masculinised environments) and the formal curricular contents – at least in theory – do not give the impression that physics can be taught from a gender perspective.

Professor Encina Calvo outlines the objectives, contents, means of evaluation, organisational modalities, teaching methods and teaching resources with a clear strategy defined in her general proposals for incorporating the gender perspective (third section): to give visibility to female scientists in the discipline and eliminate the androcentric view that predominates in science, especially in the field of physics. Making female scientists more visible generates reference models for society and provides role models for young women going into science. To this end, throughout this guide, Professor Encina Calvo provides a series of examples and good practices – at both a national and international level – and suggests specific activities (in the classroom, in the forums of the virtual classroom and on social media) through which to incorporate the gender perspective into an ostensibly gender-neutral discipline.

As a point of reference, and as a didactic aid, the recommendations for the inclusion of the gender perspective made in this guide are in the Physics module which Professor Calvo currently teaches as part of the Bachelor's Degree in Chemical Engineering at the USC. The module is taken by students during the first year of their degree. This is a good time for them to do so, since, according to empirical evidence, during the first years of a university degree, students lack scientific prejudices, making it easier for them to reflect on the gender gap and sexism in science.

01. GENDER BLINDNESS AND ITS IMPLICATIONS

Women make up the majority of university students in Spain, but remain a minority in scientific and technical degrees – also known as STEM (science, technology, engineering and mathematics). In order to explain this discrepancy, we must take into account several factors. One is the influence, from an early age, of stereotypes (Bian, Leslie and Cimpian, 2017) which discourage women from pursuing certain degrees (Miller, Eagly and Linn, 2015). A second factor is that professional and academic opportunities for women in science continue to be inferior to those afforded to men. According to the report *Científicas en cifras 2015* (Female Scientists in Numbers 2015), only one in five management positions in scientific research (university chairs and management) are held by women. Despite the fact that women make up 39% of researchers, relatively few lead centres of excellence (López Sancho, 2017; Calderón, 2017). Perhaps the recent appointment of Rosa Menéndez to lead the CSIC – the first time a woman has headed the largest public research body in Spain – is a sign of progress towards a better balance between male and female scientists in the governing bodies of research centres and universities.

The shortage of women in STEM not only reduces women's opportunities to work and participate in the advances and decisions being made in the future of technology, but it also impacts on research and innovation, and, therefore, on society as a whole. Since "we know that the presence of women in science (like that of other groups) is not a sufficient condition for better science, but it is necessary" (García Dauder and Pérez Sedeño, 2017, via Marta Macho, 2017). The Gendered Innovations project shows the importance of including sex and gender in research and innovation, giving examples of how gender bias has caused damage to health, as well as loss of money and life, while holding back technological advances. For this reason, the EU's Horizon 2020 action plan sets out three gender goals: gender balance in research teams at all levels, gender balance in decision-making, and gender mainstreaming in research. These are all measures that the Helsinki Group on Gender in Research and Innovation recommends maintaining and reinforcing in the next Framework Programme, above all in evaluation, monitoring and capacity building.

Within the field of science, physics is the discipline with the lowest proportion of female students enrolled – around 30% according to the book *¿Por qué no hay más mujeres STEM? Se buscan ingenieras, físicas y tecnólogas* (Why Aren't there More STEM Women? Engineers, Physicists and Technologists Wanted).

In addition, the low representation of women in this discipline shrinks even more as we move higher up in the university system. For example, in the area of applied physics, which is the area with the highest female presence in Spain, 29% of university lecturers are women. However, this falls to just 17% in the professorial body. In other words, there are 39 female professors compared to 190 male professors in the same position (Spanish Ministry of Economy, Industry and Competitiveness, 2016). The uneven presence of women and men in the pictures used to illustrate scientific information published in the main state media outlets does not help either (González et al, 2017). The lack of role models and the invisibility of women in physics do not encourage female vocations. This is a vicious circle that we must break out of if we wish to attract more young people to the discipline. Gender Physics Day was held in Spain in 2017. Much discussion was made of the gender gap in physics and "numerous situations have been shown in which the sexist wall interposes in the professorial trajectory and lives of women scientists" (Salas, 2017). To improve this situation, a series of equality policies have been proposed. These include dissemination of data disaggregated by sex; implementation of equality plans; incentives and sanctions relating to equality; positive action measures related to maternity; parity in professional positions; equality of staff; and social dissemination of the contributions of female scientists.

02. GENERAL PROPOSALS FOR INCORPORATING THE GENDER PERSPECTIVE INTO TEACHING

In highly masculinised disciplines, like physics, a key strategy is to make female scientists more visible, and to eliminate the androcentric vision that predominates in science, particularly in the field of physics. By making women more visible, we are generating references for society and role models for young women, encouraging their interest in science. A number of actions have been developed as part of this strategy:

- Specific campaigns aimed at revaluing the contribution of female physicists to the discipline. Examples include the exhibition entitled *Investigadoras en la luz y tecnologías de la luz* (Female Researchers in Light and Light Technology); the *Calendario 2013 Investigadoras en Física Nuclear* (Female Researchers in Nuclear Physics 2013 Calendar); and the blog *Mujeres con ciencia* (Women with Science) of the UPV Chair of Scientific Culture, where we can also find the biographies of female scientists who have contributed to the advancement of physics.
- Follow the recommendations for bibliographic citation in academic papers by including the full names of female authors and not just their initials. This is to give visibility to the contribution of women to scientific knowledge, because "since our culture is androcentric, women's initials will be attributed to male identities" (Santos Guerra, 1997). "The relegation of women to positions of lower influence and prestige is produced by myriad daily practices, like, for example, the acceptance of androcentric style norms, such as those used in bibliographic references, where the names of women are omitted, contributing to their invisibility" (Torrado and González, 2017).
- When selecting manuals, "make sure to stay up to date with works written in your field that include the participation of women in the history and creation of knowledge, as well as in the non-stereotyping of activities and the use of non-sexist language" (Martínez Moscoso, 2012).
- Given that university manuals which show the contributions of women to science and technology are scarce – with some exceptions, such as *Matemáticas: Grao en Comercio* (Mathematics: Bachelor's Degree in Business) – it is advisable to include in the bibliographic references those that do. Examples include the university manuals *Mujeres en Ciencia y*

Tecnología (Women in Science and Technology) and *Mujeres Matemáticas: Las grandes desconocidas* (Women Mathematicians: The Great Unknown).

It is not easy to identify a subject within the field of physics in which to include differences between sex or gender or make a review of androcentrism. However, when it comes to the classroom, we can consider the following concepts:

- News related to discrimination against women in science. For example, "the Matilda effect", a term coined by historian Margaret W. Rossiter to denounce situations in which the research and discoveries of female scientists are relegated due to their gender. This happened to physicists Lise Meitner, Marietta Blau and Chien-Shiung Wu, as well as the astrophysicist Jocelyn Bell (Martínez Mazaga, 2014).
- The memoirs of physicist Mary K. Gaillard: "A highly recommended book that shows us in the first person what it meant for a woman to love theoretical physics 40 years ago. In fact, until today, no woman has held a permanent position in CERN's Department of Theoretical Physics, considered to be one of the most misogynistic strongholds in all of physics" (Villatoro, 2017).
- The article on sexism in science by neurobiologist Ben Barres, who, after making the transition from woman to man, recounted how her scientific achievements were perceived differently (Macho Stadler, 2014).
- The recent experiment by Moss-Racusin, the John and Jennifer study, which shows that men and women are not valued using the same criteria, even when an apparently quantitative and objective method is followed.
- The added obstacles that scientists of other races may encounter (Rosa and Mensah, 2016).
- The chapter "Understanding gender in science and technology", which reveals the barriers and disadvantages that women encounter in the scientific-technical field, even though their contribution and the gender perspective are both necessary for scientific advancement (Castaño and Webster, 2014).

These factors could be discussed in the classroom, in the forum of the virtual classroom or on social media. Moreover, there have been protest campaigns on Twitter, like #girlswithtoys, in response to the definition of *scientist* by

astrophysicist Shrinivas Kulkarni; and #DistractinglySexy, in reaction to the sexist remark by Nobel Prize winner Tim Hunt: “Three things happen when they are in the lab: you fall in love with them, they fall in love with you, and when you criticise them, they cry” (Macho, 2016).

03. PROPOSALS FOR INTRODUCING THE GENDER PERSPECTIVE IN PHYSICS

3.1 Objectives of the subject/module

The Physics module is taught in the first year of the Bachelor's Degree in Chemical Engineering of the Universidade de Santiago de Compostela (USC). It is compulsory and is worth 9 ECTS credits. The aim of this module is to provide students with a general introduction to physics, particularly to mechanics, thermodynamics and electromagnetism. It is intended, on the one hand, to promote the principles of physics, highlighting its limits of applicability, and, on the other, to develop in students the ability to analyse and solve problems. This is in addition to introducing students to the handling of laboratory material, helping them learn how to take and process experimental data, and prepare a scientific report appropriate to their level of expertise (therefore, it should not be exhaustive).

3.2 Contents of the subjects/modules

According to data from the 2015-16 academic year, the proportion of male students (52%) taking this degree slightly exceeds that of female students (48%). It is one of the engineering degrees with the highest proportion of female students. However, there is no explicit reference to any principle of equality or specific competence within the curriculum. This could be done by using the following CT12 competency:

> CT12. Skill in interpersonal relationships. Recognition of diversity and multiculturalism, as well as respect for fundamental rights and equality between men and women.

This is how it appears in various engineering subjects at the University of Salamanca, as can be seen in the *Analysis of the Subjects on Gender Taught at USAL*. However, references to the contributions of women in physics and engineering have been introduced into the syllabus of the subject and in the voluntary activities proposed to students (Calvo, 2017).

First-year students of a university degree "do not usually perceive inequality, mainly because assessment in the teaching system is similar for all… although they are receptive to the information and appear to lack scientific prejudice" (Carreiras, M. and López, C., 2016). For this reason, it is important to take advantage of this lack

of prejudice to reflect on the gender gap in these areas and on the sexism that still operates today in the selection and promotion processes of scientific personnel (Moss-Racusin *et al.*, 2012). There is a gender bias that scientists find it difficult to recognise because "In science we presume an objectivity, and an assessment method with very clear quality indicators, though it turns out that this is itself biased from the beginning" (Salas, 2017). We must make this bias visible so we can "know and understand what is taking place, in order to minimise the effect and react to it" (Rodríguez Baras, 2017).

This reflection can take place in the physical classroom or in the forum of the virtual classroom. It can even occur via social media, as in the module Software Engineering I of the University of Salamanca, in which "during the development of the subject, information is provided to students regarding gender issues – with special emphasis given to those relating to technology – via use of the hashtag #is1usal17 in Twitter" (García-Holgado *et al.*, 2017). These actions have already been successful as they "have changed students' perception of gender issues in the field of technology. All students who have delivered conclusions in their final project have acknowledged that they were not aware of the gender gap beyond the low number of women in the Bachelor's Degree in Computer Engineering" (García Holgado, 2017).

This reflection can be carried out through extracurricular activities. Castro (2016) shows us how, in the course of an activity on free software, students are introduced to the concept of gender perspective in the design and construction of software. This can also be done in the optional module Gender, Science and Technology, in which "the production of a glossary of terms and basic concepts is the thread that is followed through a range of topics, facilitating the debate between students and strengthening their implication in the subject" (Pardo, 2010). Another way of exploring this issue could be by means of an activity to integrate students from different disciplines, like the Human Ethology Seminar, in which leadership patterns are analysed (Gaytán, 2016). In addition, theatre could be used to reflect on and denounce the digital gender gap (Gil-Juárez *et al.*, 2015) or to learn more about the situation of women in science, with plays such as *Arcadia* and *Voices from the Well* (Mirás and Quinteiro, 2012) and *¿Son raras las mujeres de talento?* (*Are Talented Women Strange?*) (Macho, 2013).

The gender bias in our society can influence our perception of the dangerousness of hurricanes, and even affect the number of victims. This is because giving a hurricane a woman's name makes it sound less dangerous and causes people to take fewer precautions (Jung, 2014). This gender bias is also present in science

and physics. Although physics is defined as an objective and neutral science, the language and metaphors employed in it are not (McCullough, 2014, Götschel, 2014). As Götschel (2014) shows, the laws and concepts of physics have also been used to advocate for a hegemonic femininity in science. The lack of diversity in physics is clear enough from photos of the Solvay Conference. In the fifth, and most famous, edition, held in 1927, Marie Curie is the only woman present. In the 2011 edition of the conference there are just two women – Lisa Randall and Eva Silverstein – one fewer than in the 1933 edition of the conference. Recreating the famous 1927 images, as the Royal Italian Physics Society did this summer, with a photo of one man surrounded by female researchers, shows the importance of women in this discipline (Macho, 2017).

In centres where STEM-related degrees are taught, which tend to be masculinised, it is essential to incorporate references to the contribution of women to the advancement of these disciplines. "It is important to recognise those who went before us, or we will go the same way. There were many more than we know of" (López Sancho, 2017). To provide female references, a short biographical review of a renowned woman scientist or engineer can be included in the presentation of each topic. For example, the biography of astronomer Maria Mitchell can be presented during the study of gravitation (Calvo, 2015). Activities related to the transversal competencies can also be proposed. For example, to give visibility to the contribution of women to science in the Mathematics module of the Bachelor's Degree in Business and in the Physics module of the Bachelor's Degree in Chemical Engineering, students could be encouraged to carry out group work – something they may find appealing since it integrates some of their hobbies, such as reading or cinema (Calvo and Verdejo, 2017).

Recent studies have revealed a variety of examples of sexism and microaggressions in physics and astronomy (Barthelemy, McCormick and Henderson, 2016), reinforcing how important it is that departments and faculties work to eliminate such behaviours. The United States Delegation to the 6th International Conference on Women in Physics has created an online space for members of the physics community to explore the most common forms of biases and to share effective strategies for addressing them. In the US, scandals relating to sexual harassment of female scientists and students have caused a number of universities, colleges and large physics departments, like the one in MIT, to develop their own sexual harassment protocols (McCullough, 2016).

3.3 Subject assessment

Evaluation determines what and how students learn. It must therefore be a teaching tool that serves teaching staff as well as students to develop basically formative functions (Brown and Pickford, 2013). For each subject, teachers must rethink the assessment process, using procedures that make it possible to assess competencies, not just knowledge, while taking into account possible gender biases in tools and techniques of assessment. For example, a recent study carried out in Switzerland, Austria and Germany analysed how physics teachers evaluate their students (Hofer, 2014). The researcher asked 730 secondary school teachers to rate an exam response. The teachers thought they were testing real students, but they were actually taking part in a gender study. The questions and answers were exactly the same and the teachers could see the gender of the exam taker. The results of the study revealed a bias – even exhibited by female teachers – against female students, which diminished with greater experience (Hofer, 2014). Such a bias could be avoided altogether if student exam papers were identified by ID numbers instead of names and surnames (Conover, 2016).

Some tests, such as the widely recognised Force Concept Inventory, designed to determine students' understanding of basic concepts of Newtonian mechanics, have revealed gender disparities that favour male students (Madsen, McKagan and Sayre, 2013). One factor that could contribute to this disparity is the context of the questions that make up the test, since many involve stereotypically masculine activities, such as playing ice hockey, launching missiles or firing cannon balls (McCullough, 2004). Male students, due to their hobbies or their interest in certain games, could be more familiar with these types of situations and thus obtain better results in such questions (*Another Day in the Lab*, 2018; González-Espada, 2009). To avoid bias of this kind, it would be advisable to analyse the results of each question and, if there is a gender difference, delete or reformulate the question (Wilson, Wilson and Low, 2017). Another factor to keep in mind is the threat of stereotypes; emphasising feminine stereotypes before a test can condition the results and cause both men and women to react in a way that is expected of their sex (Fine, 2011). To reduce this effect, some studies suggest carrying out a written self-affirmation exercise, since, as shown in McCullough (2016), female students who completed such an exercise had better results in the standard physics test than those who did not (Kost-Smith, 2010).

Although evaluation has traditionally been carried out by teachers, experiences in recent years show that peer evaluation contributes to the improvement of students' critical faculties and ability to analyse. However, before proposing

a peer evaluation, it is necessary to assess how gender might affect the way in which students assess themselves and their classmates (Torres and Bengoechea, 2016), and take into account the tendency of women to underestimate their performances and that of other women (Ellis *et al.*, 2008).

3.4 Modes of organising teaching dynamics

In our society, women are more reluctant to speak in meetings. Those who do speak tend to be interrupted more, and their opinions are less frequently accepted by the group, so using participatory methods in the classroom could favour male students (Moure, 2014). One way to overcome this problem could be to adopt the strategies proposed by Mercedes Bengoechea in the *Guía de Recomendaciones para la inclusión de la perspectiva de género en la docencia universitaria: práctica (I)* (Guide of Recommendations for the Inclusion of the Gender Perspective in University Teaching: Practical I):

- "Create inclusive spaces of learning for both male and female students.
- Create organisational contexts in which girls can participate publicly, generating spaces for interaction where the self-esteem and wellbeing of women is fostered, without them having to give up their style of communication.
- Create spaces for female students to learn coping strategies for interaction, while learning about, and finding value in, the opportunities provided by their own style of communication."

The experience carried out in the Human Resources course at the Higher Technical School of Industrial Engineering of Universitat Politècnica de Catalunya-Barcelona Tech shows "the suitability of the activity of NASA, not only in understanding the benefits of group work, but in helping students comprehend the stereotypes of female and male communication, and allowing them to reflect on their own ways of interacting" (Gallardo, 2016).

Recent research has revealed that in the laboratory, female and male students tend to share equipment equally, but male students spend more time using computers, while female students spend more time on other activities (Day *et al.*, 2016). For this reason, the assignment of roles in laboratory groups should be supervised to ensure that all individuals carry out the same tasks and sexist stereotypes are not reinforced (Cantero, 2016).

3.5 Teaching methods

The adaptation of study plans to the European Higher Education Area has introduced changes in teaching methodologies, incorporating teaching strategies to involve students in their learning. These active methodologies include case analysis, problem-based learning (PBL), flipped classroom, team-based learning, learning and service (LAS), and so on. When adopting any of these methodologies it is important to consider which of them might be more suitable for introducing the gender perspective; for example, the LAS method – in which students apply what they learn in class to real-world situations by performing services to the community – could be used to develop egalitarian experiences (Fernández, 2016). According to recent research, active methodologies promote improvements in learning, but do not reduce the gender gap in physics. In order to reduce it, they suggest improving female students' sense of belonging and self-efficacy, reducing competition and emphasising collaboration (Karim, Maries and Singh, 2017). As McCullough (2016) points out, female students' self-confidence and self-efficacy is often different to, or lower than, that of male students in physics classes.

An effective way of improving this feeling of belonging among female students could be to host exhibitions, conferences and competitions (such as My Favourite Female Physicist at the University of Córdoba) on women in the world of physics. These contributions should also be made visible on the webpages of the centres where these degrees are taught. On the website of the Equality Commission of the Faculty of Physics of the University of Barcelona, for example, you can access the Women in Nuclear Physics Calendar, as well as the video of Jocelyn Bell's lecture on women in science. Also useful is the initiative of the United Kingdom's Institute of Physics (IOP), which has created the JUNO project to make departments more welcoming to women. There is a similar project in the USA. Finally, recent studies recommend developing mentoring campaigns, such as those of the Carnegie Mellon University in the United States and the Trondheim University of Science and Technology in Norway, aimed at retaining girls in computer science (Sainz *et al.*, 2017). This initiative is also being carried out at Spanish universities, in projects such as Mentoria M2m at the UPC or the TRIGGER project at UPM. Furthermore, the MatEsElla leadership programme – designed to promote science and business careers among bachelor's and master's degree mathematics students – has just been announced. However, it is important to keep in mind that mentoring could be counterproductive "if the scientist reproduces the culture of excellence by and for science" (Couso, 2017).

In many degrees in the fields of science and technology, physics is a compulsory module. Often in such degrees there are students who did not take the subject at high school for a number of reasons: the perceived difficulty of the subject, a lower average in the university entrance examinations compared to other subjects, or simply because the subject did not appeal to the student. Within this group there may be many female students. This does not just happen in Spain; in the UK, for example, physics is the fourth preferred subject among boys and only the nineteenth among girls (Couso, 2015). When planning teaching, we must bear in mind that in order to attract students, especially female students, "it is important to integrate a social focus in physics classes, seeking to motivate students by using examples from everyday life" (De la Nuez, Delgado and Calvo, 2017). It could also be useful to integrate methodologies like service learning in order to empower female students. For example, a project could be designed in which female students learn physics by preparing a workshop adapted to primary school students, thus helping to make women visible in the field of engineering (Calvo, 2016).

04. TEACHING RESOURCES

We currently have at our disposal a series of resources to help us correct, and avoid using, biased or discriminatory language. These tools include the non-sexist language guides developed by various universities (UA, UAB, UNED, USC, etc.) and computer applications that facilitate the linguistic revision of texts and offer alternatives for non-sexist uses of the language (Nombra en red, EXERIA, etc.). As well as using these tools to prepare our slides and documents, we should share them with, and encourage their use among, our students.

Most first-year physics manuals show an androcentric vision of the discipline. Men feature in the majority of the images and in the questions and problems, usually carrying out tasks that are considered masculine (Calvo, 2013). In the mechanics module, usually taught during the first semester, Newton's laws are often shown within a ballistic/military or a sports context, which could be subtly transmitting to female students the idea that physics is a man's discipline (McCullough, 2016). To transform this androcentric vision, women should be given prominence in the images and statements of problems. In the physics manual by Lea and Burke (2001), for example, we can find images of a woman lifting a weight and a female astronaut. As Götschel (2017) indicates, choosing atypical sports or genres for learning tasks is a way of challenging masculinity and opening a space for reflecting on normative examples. Contexts can also be changed: a female veterinarian shooting a tranquiliser dart at a monkey could be used instead of that of hunter with his rifle, for example. Toys like yo-yos could be used to explain the rotational movement of rigid bodies.

It would also be useful to show how physics can be applied in biology, medicine and the environment – disciplines that tend to appeal more to women – in areas such as fluids, surface phenomena, thermodynamics, acoustics, optics and radiations. In general, while female students display high levels of social activism, they often see physics as something abstract that has no applications in real life (Sax *et al.*, 2016). To change this perception it is important to reveal the physics behind many newspaper headlines, issues such as renewable energy or climate change in which women are playing an important role. Similarly, it is important to show the applications of thermodynamics in design for the 90% of the world's population that has limited access to essential commodities such as water. This can be done by analysing the construction of solar ovens, distillation-based water purification systems and boiling-based disinfection systems, and examining the effects of solar radiation on water. All these systems

can – thanks to their low cost – help populations in less-developed countries obtain healthy drinking water (Brocos, 2014).

In the area of cooking, teaching activities have been proposed for developing transversal skills, such as group work, and for acquiring knowledge about the physiochemical foundations of techniques used in cooking (Estévez, Zapico and DePalma, 2013). Such activities could also serve to place value on women's knowledge, as has been proved in the field of secondary education (Cantero, 2016; Sancho, Calero and Villena, 2017).

One way of providing more female role models for female students is to include a short biographical sketch of a renowned female scientist or engineer in the presentation of each new topic (Calvo, 2015). This method has already been employed in the teaching of mathematics (Verdejo, 2013). In the Physics module of the Bachelor's Degree in Chemical Engineering there are three areas where the contribution of women to science could be mentioned:

- In the slides on the first topic of the module – Introduction to Physics – there is a section about the contribution of women to the discipline. The section includes a photograph of the women who have won the Nobel Prize in physics: Marie Curie, Maria Goeppert-Mayer and – more recently – Donna Strickland. It also cites women who were unfairly overlooked, such as Lise Meitner, Chien-Shiung Wu and Jocelyn Bell.
- As part of the topic of particle dynamics, in the Science in the Salons section, the scientific contribution of the Marquise de Châteletet and her important role in the dissemination of Newton's work is commented on. The significance of Marie-Anne Pierrette Paulze, considered to be the mother of modern chemistry, is also made clear. The biographies of both of these women scientists appear in *Sabias,* by Adela Muñoz Paez, one of the books that appear in the bibliography of the subject.
- Finally, topic five refers to mathematician Sophie Kovalevsky, awarded the "Prix Bordin" by the Paris Academy of Sciences for best work on the rotation of a rigid body around a fixed point.

In addition to emphasising the scientific contributions of women, students were encouraged, during academic years 2016-17 and 2017-18, to write the biography of a female scientist or technologist in the format of a Wikipedia or Galipedia entry (Calvo and Sanmarco, 2017). The objective behind this was to improve students' informational competences, capacity for written expression and critical

sensibilities while, in turn, empowering female students, following the example of Professor De Wolfe from the History Department at the University of New England (De Wolfe, 2016).

05. TEACHING HOW TO CARRY OUT GENDER-SENSITIVE RESEARCH

The Spanish edition of the *Gender in Research* manual of the European Commission shows how research in areas of physics such as nanotechnology, energy and the environment are gender sensitive (Spanish Ministry of Innovation and Science, 2011). Other texts that can be of help in incorporating gender in research include the *Guía práctica para la inclusión de la perspectiva de género en los contenidos de la investigación* (Practical Guide for the Inclusion of the Gender Perspective in Research Content) (CIREM, 2012), and the booklet *Aplicación del Enfoque de Género en Proyectos TFG y* TFM (Application of the Gender Approach in Bachelor's and Masters' Theses) (Lobo, Bacigalupe and Fernández, 2015). In the latter we can see how some technical projects that might not seem to be gender sensitive, in fact are. It shows how, for example, in a bachelor's thesis, "The theoretical analysis on the Fenton reaction and reagents took into account the environmental consequences of the pollutant it was attempting to eliminate. However, at no point was a study carried out into the social impacts of the industries that created this pollutant, the possible pathologies that the elimination of said pollutant could have, or the use of water as the primary material for washing the pollutant before it returned to the rivers and aquifers" (Lobo, Bacigalupe and Fernández, 2015: 30). As shown by Arnáiz Franco *et al.* (2018) "through an inclusion of gender-sensitive content, the bachelor's thesis could become an effective tool for the prevention of occupational risks in the professional activity of engineering". These examples show that gender training is as necessary to tutoring a bachelor's or master's thesis as it is to writing one. And just as courses are provided to help improve students' ability to write, there should also be courses to teach students how to integrate the gender perspective into their work. In addition, as Laura Castro (2016) has pointed out, the inclusion of gender training could be the first step towards considering the gender perspective as a criterion for evaluation.

When proposing a bachelor's or master's thesis that incorporates the gender perspective in a crosscutting way during the various phases of the investigation we must bear in mind what Londa Schieberg said in a recent interview: "Not all proposals are likely to be analysed through the prism of sex and gender, such as theoretical physics or pure mathematics. This is for fields of study like robotics, environmental studies, health or medicine, areas where sex and gender analysis can have an impact" (Vicente Bernabeu, 2016). Nonetheless, all works should be written in non-sexist language and bibliographies should include the full

names of authors, not just their initials, to highlight the contribution of women to scientific knowledge. It would also be useful to emphasise the women who have contributed to these disciplines, underlining, for example, the important role of women in cosmology, particularly primordial magnetism of the universe (Ruiz Granados, 2017), or discussing the work of female pioneers, such as those on the page of the Specialised Group on Colloids and Interfaces of the Royal Spanish Society of Chemistry and the Royal Spanish Society of Physics.

The Bachelor's Degree in Physics at the USC includes subjects related to biology, medicine, or energies such as biophysics, medical physics, and physics of energies, which make it possible to discuss the examples that appear in the *Gender in Research* manual of the European Commission, like the fact that "the handling of iron oxide nanoparticles can cause health risks, the relevance of which may depend on sex" or that "perspectives of energy experts (primarily men) are seen as non-discriminatory and 'standard', while female perspectives are marginalised and externalised". To this end, the First Meeting on Women, Gender and Energy was held in Bilbao to protest the absence of women in the energy transformation plan in Spain.

If we analyse the prizes awarded for the introduction of the gender perspective in bachelor's and master's theses in a variety of universities (UAB, UVigo, US, UV, etc.) we can see that these calls have often lacked representation from the scientific-technological fields. Therefore, perhaps a specific competition should be proposed for centres that specialise in these disciplines. An example of this was the 1st Competition for Engineering and Rural Women at the Higher Polytechnic School of the USC, which rewarded works whose theme was the development of projects to improve women's living and labour conditions in rural areas. Another similar initiative is the Julie Hamackova Award at the University of Chemistry and Technology in Prague, designed to encourage research staff to incorporate gender analysis as an innovative part of their research. It would also be useful to include examples of bachelor's and master's theses that incorporate the gender perspective – especially those carried out in the field of ICT (García Delgado, 2016) or that have received an award (Jares, 2016) – in the UA's Digital Library of Teaching Resources with a Gender Perspective).

Another way to inspire students to carry out gender-sensitive research would be to include the Yellow Window checklist or the table of proposals for questions created by Lobo, Bacigalupe and Fernández (2015) in the contents of some

undergraduate subjects. At the UAB, the course Gender Perspective in Research is offered to PhD students, but it would be a good idea to offer it before. It could be provided as one of the gender-related subjects at the Universitat de València or the UJI. It would also be useful to offer students a course on incorporating the gender perspective into their bachelor's or master's thesis. Such a course could include the experiences of NGOs and institutions around cooperation that "have made great progress in incorporating the gender focus in development cooperation projects, since gender studies are often carried out on the populations that the development projects are directed at" (Lobo and Fernández, 2016). Also of interest is the Diversity in the Cultures of Physics experience, a summer school aimed at facilitating physics students' transition from masters to doctoral degrees, and opening up transnational prospects for their careers (Estrade, 2017).

One way to demonstrate the importance of collecting data disaggregated by sex and gender-sensitive data is by using research into the situation of women in physics. A global survey of 15,000 people involved in the discipline of physics reveals that women still do not have the same access to resources and career advancement opportunities as their male colleagues (Ivie and Tesfaye, 2012). As McCullough (2016) points out, this problem slows down women's career progression and makes women more likely to drop out of their STEM profession. The results of this survey also reveal that women generally have more domestic responsibilities, like doing housework. Similarly, it is shown that having a child has a negative impact on a woman's scientific career, while no such effect is observed on men's careers. Furthermore, according to a recent study published by the Pew Research Center, women who work in STEM "more frequently perceive discrimination and sexual harassment, and think that being a woman represents more of a disadvantage than an advantage to the success of their careers" (Pérez, 2018). Knowing these facts allows us to introduce corrective measures, such as providing courses on gender bias to teachers and research staff (Gvozdanović and Maes, 2018); and introducing positive action steps covering maternity, parity in professional positions, and so on, to contribute to equality in the field of physics.

06. PEDAGOGICAL RESOURCES

6.1 Printed or electronic books, reports, theses

Arnáiz-Franco, Carmen *et al.* (2018) "La inclusión de la perspectiva de género en estudios de ingeniería: El trabajo final de estudios como oportunidad." In: Rebollo-Catalán, Ángeles; Ruíz-Pinto, Estrella; Vega-Caro, Luisa. *La Universidad en clave de género*. Barcelona: Octaedro, 2018, pp. 81-110. ISBN: 978-84-17219-83-3.

Astrophysics Institute of the Canary Islands (2017). *Recomendaciones Gender Physics Day 2017*. Available at: http://www.iac.es/congreso/GIPD2017/media/conclusiones_recomendaciones_GiPD.pdf.

Cantero, Beatriz (2016). *Inclusión del género en la enseñanza de las ciencias*. PhD thesis. Available at: https://ddd.uab.cat/record/166152

Caprile, María; Vallés, Nuria and Palmen, Rachel (2012). *Guía práctica para la inclusión de la perspectiva de género en los contenidos de la investigación*. Barcelona: Fundación CIREM, 80. Available at: http://www.idi.mineco.gob.es/stfls/MICINN/Ministerio/FICHEROS/UMYC/Guia_practica_genero_en_las_investigaciones.pdf

Castaño, Cecilia and Webster, Juliet (2014). *Género, ciencia y tecnologías de la información*. Barcelona: Aresta. ISBN: 9788494145667.

Claramunt Vallespí, Rosa María and Claramunt Vallespí, Teresa (2012). *Mujeres en ciencia y tecnología*. Madrid: Editorial UNED. ISBN: 978-84-362-6421-0.

Ellis, Lee *et al.* (2008). *Sex Differences: Summarizing more than a century of scientific research*. Abingdon: Taylor & Francis. ISBN: 978-0805859591.

European Commission (2009). *Gender in Research*. Available at: https://www.yellowwindow.com/genderinresearch

Fine, Cordelia (2011). *Cuestión de sexos*. Barcelona: Roca Editorial.

Gvozdanović, Jadranka and Maes, Katrien (2018). *Implicit Bias in Academia: A challenge to the meritocratic principle and to women's careers - And what to do about it*. Available at: https://www.leru.org/publications/implicit-bias-in-academia-a-challenge-to-the-meritocratic-principle-and-to-womens-careers-and-what-to-do-about-it

Helsinki Group on Gender in Research and Innovation (2018). *Position paper on H2020 interim evaluation and preparation of FP9*. Available at: http://epws.org/helsinki-group-position-paper-h2020/

Lobo Igartua, Constanza; Bacigalupe de la Torre, Saioa and Fernández Cebrián, Sandra (2015). *Aplicación del enfoque de género en proyectos TFG y TFM*. Bilbao: Universidad del País Vasco editorial. Disponible a: https://euskadi.isf.es/wp-content/uploads/sites/31/2015/07/enfoque_genero.pdf.

MacCullough, Laura (2016). *Women and Physics*. San Rafael: Morgan & Claypool Publishers.

Martínez Moscoso, Dolores Marisa (2012). *Práctica docente con equidad de género. Una guía de trabajo*. Guadalajara: University of Guadalajara, Centre for Gender-Based Studies. Available at: http://www.publicaciones.cucsh.udg.mx/kiosko/2012/images/practica_docente.pdf

Sáinz, Milagros *et al.* (2017). *¿Por qué no hay más mujeres STEM? Se buscan ingenieras, físicas y tecnólogas*. Barcelona: Fundación Telefónica, Editorial Ariel. ISBN:978-84-08-17732-6. Available at: https://www.fundaciontelefonica.com/arte_cultura/publicaciones-listado/pagina-item-publicaciones/itempubli/590/

Spanish Ministry of Economy and Competitiveness (2016). *Científicas en cifras 2015*. Madrid: Women and Science Unit. Available at: http://www.idi.mineco.gob.es/stfls/MICINN/Ministerio/FICHEROS/Informe_Cientificas_en_Cifras_2015_ con_Anexo.pdf

Rodríguez-Jaume, María-José; Provencio, Herminia; Díez, Rocío; Establier, Helena; Ferrer, Belén; Mora, Rafael; Moreda, Paloma; Moreno-Seco, Mónica; La Parra-Casado, Daniel; Peñalver, Maribel; Pérez-del Hoyo, Raquel; Rosser, Ana; Sáiz, Maximiliano; Spairani, Silvia; Torres, María Concepción and Zubcoff, José (2017). *Apuntes para la igualdad. Tema I. Guía de recomendaciones para la inclusión de la perspectiva de género en la docencia universitaria: práctica (I)*. Available at: http://hdl.handle.net/10045/72075

University of Salamanca's Equality Unit (2017). *Análisis de las asignaturas sobre género impartidas por la USAL / Competencias en Materia de Igualdad de Género*. Available at: https://igualdadefectivablog.files.wordpress.com/2017/05/asignaturas-sobre-gecc81nero-impartidas-por-la-usal.pdf

Verdejo, Amelia (2017). *Mujeres matemáticas: las grandes desconocidas*. Vigo: Servizo de Publicacións Universidade de Vigo. ISBN: 978-84-8158-733-3.

6.2 Journal articles and conferences

Barthelemy, Ramón S.; McCormick, Melinda and Henderson, Charles (2016). "Gender discrimination in physics and astronomy: Graduate student experiences of sexism and gender microaggressions." *Physical Review Physics Education Research*, 12 (2), p. 020119.

Brocos, Pilar (2014). "Empregando a Física per introduir nunha enxeñaría us principis do 'deseño per a tots'." In: Membiela, P.; Casado, N. and Cebreiros, M. I. (eds.). *Experiencias e innovación docente no contexto actual da docencia uni- versitària*, pp. 691-695. Ourense: Educació Editora.

Calderón, María José (2017) "Día Internacional de la Mujer y la Niña en la Ciencia." *Revista Española de Física*, vol. 31 (1).

Calvo Iglesias, Encina (2013). "Perspectiva de género en la docencia de física." In: Membiela, Pedro; Casado, Natalia and Cebreiros, M. Isabel (eds.). *Experiencias de investigación e innovación en la enseñanza de las ciències*, pp. 513-517. Ourense: Educación Editora. Available at: https://web.ua.es/es/unidad-igualdad/docencia-igualdad/biblioteca/ciencias/perspectiva-de-genero-en-la-docencia-de-fisica.html

Calvo Iglesias, Encina (2015). "La ciencia sin mujeres llega a casa." In: Membiela, Pedro; Casado, Natalia and Cebreiros, M. Isabel (eds.). *La enseñanza de las ciencias: Desafíos y perspectivas*, pp. 55-59. Ourense: Educación Editora. Available at: http://hdl.handle.net/10347/13682

Calvo Iglesias, Encina (2016). "Una estudiante de ingeniería en cada cole." In: Santos Rego, Miguel Anxo; Sotelino Losada, Alexandre and Lorenzo Moledo, María del Mar. *Aprendizaje-Servicio e innovación en la universidad: actas VII Congreso Nacional y II Internacional de Aprendizaje-Servicio Universitario*, pp. 143-147. Santiago de Compostela: Universidade de Santiago de Compostela. Available at: http://hdl.handle.net/10347/15177.

Calvo Iglesias, Encina and Sanmarco Bande, M. Teresa (2017). "Científicas e Ingenieras en Wikipedia: Una reivindicación." In: Gutiérrez, Alfonso; García, Agustín and Collado, Rocío (eds.). *Actas del III Congreso de Educación Mediática y Competencia Digital Mayo-Junio 2017*, pp. 2553-58. Segovia: University of Valladolid. Available at: http://hdl.handle.net/10347/15812

Calvo Iglesias, Encina and Verdejo Rodríguez, Amelia (2017). "Literatura y cine para visibilizar a las científicas." *V Congreso Internacional de Docencia*

Universitaria CINDU 2017. Panorama de la docencia en la universidad. Vigo, 15-17 June 2017. Available at: http://hdl.handle.net/10347/16397.

Calvo Iglesias, Encina (2017). "Actividades para crear referentes femeninos en la Ingeniería." In: Cabedo, Luis and Guraya, Teresa (eds.). *First International Conference on Engineering Education for the XXI Century* - ICEE21C 2017, pp. 67-70. Bilbao: University of the Basque Country. Available at: http://hdl.handle.net/10347/15762

Day, James *et al.* (2016). "Gender gaps and gendered action in a first-year physics laboratory." *Physical Review Physics Education Research*, 12 (2), p. 020104.

Estévez, Carlos; Zapico, M. Helena and Depalma, Renée (2013). "Adaptándose a una nueva filosofía europea de educación universitaria: la experiencia 'Cocina a conciencia' y las competencias transversales para el grado en Química." *X Foro Iinternacional sobre Evaluación de la Calidad de la Investigación y de la Educación Superior (FECIES)*. Granada, 25-28 June 2013. Available at: http://www. ugr.es/~aepc/XFORO/FECIES2013.pdf

García-Holgado, Alicia *et al.* (2017). "Introducción de la perspectiva de género en la docencia de ingeniería del software." In: Sein-Echaluce Lacleta, M. L.; Fidalgo-Blanco, A. and García-Peñalvo, F. J. (eds.). *La innovación docente como misión del profesorado. Actas del IV Congreso Internacional sobre Aprendizaje, Innovación y Competitividad*, pp. 627-631. Saragossa: Servicio de Publicaciones Universidad de Zaragoza. Available at: https://repositorio.grial.eu/handle/ grial/1022

González-Espada, Wilson J. (2009). "Detecting gender bias through test item analysis." *The Physics Teacher*, 47 (3), pp. 175-179.

Götschel, Helene (2014). "No space for girliness in physics: understanding and overcoming the masculinity of physics." *Cultural Studies of Science Education*, 9 (2), pp. 531-537.

Hofer, Sarah I. (2015). "Studying gender bias in physics grading: The role of teaching experience and country." *International Journal of Science Education*, 37 (17), pp. 2879-2905.

Ivie, Rachel; Tesfaye, Casey Langer (2012). "Women in physics." *Phys. Today*, 65 (2), pp. 47.

Jung, Kiju *et al.* (2014). "Female hurricanes are deadlier than male hurricanes." *Proceedings of the National Academy of Sciences*, 111 (24), pp. 8782-8787.

Karim, Nafis I.; Maries, Alexandru and Singh, Chandralekha (2017). "Do evidence-based active-engagement courses reduce the gender gap in introductory physics?" *European Journal of Physics*.

Kost-Smith, Lauren E. *et al.* (2010). "Gender differences in physics 1: The impact of a self-affirmation intervention." *AIP Conference Proceedings*, pp. 197-200.

Lobo Igartua, Constanza and Fernández Cebrián, Sandra (2016). "Aplicación del enfoque de género en trabajos de investigación de alumnado universitario de ciencia y tecnología." *Ikastorratza*, *e-Revista de didáctica*, 17, p. 6.

McCullough, Laura (2004). "Gender, Context, and Physics Assessment." *Journal of International Women's Studies*, 5(4), pp. 20-30.

Madsen, Adrian; McKagan, Sarah B. and Sayre, Eleanor C. (2013). "Gender gap on concept inventories in physics: What is consistent, what is inconsistent, and what factors influence the gap?" *Physical Review Special Topics-Physics Education Research*, 9 (2), p. 020121.

Moss-Racusin, Corinne A. *et al.* (2012). "Science faculty's subtle gender biases favor male students." *Proceedings of the National Academy of Sciences*, 109 (41), pp. 16474-16479.

Rosa, Katemari and Mensah, Felicia Moore (2016). "Educational pathways of black women physicists: Stories of experiencing and overcoming obstacles in life." *Physical Review Physics Education Research*, 12 (2), pp. 020113.

Sax, Linda J. *et al.* (2016) "Women in physics: A comparison to science, technology, engineering, and math education over four decades." *Physical Review Physics Education Research*, 12 (2), p. 020108.

6.3 Web pages, research groups, associations and commissions

- AMIT. Association of Women Scientists and Technologists. Available at: http:// www.amit-es.org/
- Equality Commission of the Physics Faculty at the University of Barcelona.
- Available at: http://www.ub.edu/igualtatfisica/documents.html.
- Gender and ICT Group. *Researching Gender in the Network Society (GenTIC)*. Available at: http://gender-ict.net/

- Gender Bias in Physics: International Forum. Available at: https://gender-bias.compadre.org/resources/
- Gender Equality Network in the European Research Area. Gender and physics resources. Available at: https://genera-project.com/index.php/gender-and-physics-resources.
- Gendered Innovations in Science, Health & Medicine, Engineering, and Environment. Available at: http://genderedinnovations.stanford.edu/index.html
- Iniciativa 11 de Febrero (11 February Initiative). Available at: https://11defebrero.org/mujer-y- ciencia/
- Macho Stadler, Marta. *Mujeres con ciencia*. Available at: http://mujeresconciencia.com/
- Project Juno. Available at: http://www.iop.org/policy/diversity/initiatives/juno/index.html
- Toolbox Freie Universität Berlin. Available at: http://www.genderdiversitylehre.fu-berlin.de/en/toolbox/index.html.

6.4 Other electronic documents

- Anonymous (2018). "El inspector Gadget: problemas de física con sesgo de género." *Another Day in the Lab*. Available at: https://dayinlab.com/2018/01/12/ el-inspector-gadget-problemas-de-fisica-con-sesgo-de-genero/
- De la Nuez, Arabela; Delgado, Montserrat and Juan, José (2017). "El papel del profesorado: didáctica de la física con perspectiva de género." Lecture delivered at GIPD 2017. Available at: http://www.iac.es/congreso/GIPD2017/pages/ programa.php
- Conover, Emily. *Physics Grading Biased Against Women*. Available at: https://www.aps.org/publications/apsnews/201604/grading.cfm.
- Couso, Digna (2015). "Vocaciones científicas: Muchas soluciones y ninguna simple; ¿Qué podríamos hacer y no hacemos?." Available at: http://agenda.obrasocial.lacaixa.es/documents/10180/818570/Digna+Couso_Ponencia_CA/3233dbbf-944e-4e99-96ec-af2b64334cfd;jsessionid=5

- Couso, Digna (2017). "Equidad y comunicación social de la ciencia." *VI Congreso de Comunicación Social de la Ciencia*. Available at: https://youtu. be/edLZWp217nk?t=2622
- Equality Commission. University of Barcelona. *Calendario 2013 Investigadoras en física nuclear*. Available at: http://www.ub.edu/igualtatfisica/ images/UB_cal_13web.pdf
- Estrade, Marina (2017). "Diversity in the Cultures of Physics." Lecture delivered at GIPD 2017. Available at: http://www.iac.es/congreso/GIPD2017/pages/ programa.php
- González, Águeda and Torres, Néstor (2017). "Promoción de la igualdad de género en la Facultad de Ciencias de la Universidad de La Laguna." Available at: http://www.iac.es/congreso/GIPD2017/media/presentaciones/bloque3/B3_gleztorres_cienciasULL.pdf
- Götschel, Helene (2017). *Gender in STEM Research – Gender Research in STEM – Challenges in Physics*. Available at: http://www.acceleratingera.vu.lt/speakers/presentations
- López Sancho, Pilar (2017). "La brecha de género en las ciencias físicas." Available at: http://www.iac.es/congreso/GIPD2017/media/presentaciones/bloque1/B0_brecha_lopezsancho_CSIC.pdf
- Macho, Marta (2018). "Versionando una fotografia icònica." Mujeres con ciencia. Available at: https://mujeresconciencia.com/2018/01/02/versionando-una-fotografia-iconica/
- Pérez, Juan Ignacio (2017). "No es una percepción." Mujeres con ciencia. Available at: https://mujeresconciencia.com/2014/11/17/mujer-ciencia-y-discriminacion-del-efecto-mateo-matilda/
- Rodríguez Baras, Marina (2017). "John o Jennifer: Sesgos de género específicos en el ámbito científico." Lecture delivered at GIPD 2017. Available at: http://www.iac.es/congreso/GIPD2017/pages/programa.php
- Royal Spanish Society of Physics (2015). *Investigadoras en la luz y en las tecnologías de la luz*. Available at: http://www.luz2015.es/documen/20150925mujeres.pdf
- Ruiz Granados, Beatriz (2017). "Magnetismo primordial del universo: un ejemplo de investigación en cosmologia donde las mujeres tienen un

papel clave." Lecture delivered at GIPD 2017. Available at: http://www.iac.es/ congreso/GIPD2017/pages/programa.php

- Salas, Javier (2017). "A los científicos les cuesta mucho reconocer sus segos machistas." *El País*, 2017. Available at: https://elpais.com/elpais/2017/10/23/ciencia/1508750690_391155.html
- Sancho, Teresa; Calero, Vanesa and Villena, Unai (2017). "La ciencia que se esconde en los saberes de las mujeres." *Sorkin Saberes*. Available at: http://sorkinsaberes.org/sites/default/files/archivos/sorkin_guia_completa_cas. Pdf
- Vicente Bernabeu, José (2016). "Entrevista a Londa Schiebinger." Available at: https://metode.es/revistas-metode/monograficos/londa- schiebinger. html
- Villatoro, Francisco (2017). "Mary K. Gaillard: una mujer singular en una profesión poco femenina." *La ciencia de la mula Francis*. Available at: http://francis.naukas.com/2017/02/11/mary-k-gaillard-una-mujer-singular-en-una-profesion-poco-femenina/
- Wilson, Kate; Wilson, Anna and Low, David (2017). "Why it's important to examine how we teach and test physics to reduce gender bias." Phys. org. Available at: https://phys.org/news/2017-09-important-physics-gender-bias. html

7. FURTHER INFORMATION

Álvarez, Mari; Nuño, Teresa and Solsona, Nuria (2013). *Las científicas y su historia en el aula*. Madrid: Editorial Síntesis. ISBN: 9788497560573.

Bian, Lin; Leslie, Sarah-Jane and Cimpian, Andrei (2017). "Gender stereotypes about intellectual ability emerge early and influence children's interests." *Science*, 355 (6323), pp. 389-391.

Brown, Sally and Pickford, Ruth (2013). *Evaluación de habilidades y competencias en educación superior*. Madrid: Narcea Ediciones.

Cacace, Marina (2009). *PRAGES. Guidelines for Gender Equality Programmes in Science*. Available at: https://ec.europa.eu/research/swafs/pdf/pub_gender_equality/prages-guidelines_en.pdf

Carreira Otero, María and López González, Cándido (2016). "Una transgresión do- cente: integración de la perspectiva de género en la Escuela Técnica Superior de Arquitectura de A Coruña." In: Aguayo Lorenzo, Eva; López Díaz, Ana Jesús and González Penín, Anabel (eds.). *Perspectiva de xénero na docencia universitaria: IV Xornada Universitaria Galega en Xénero*. Santiago de Compostela: Servizo de Publicacións e Intercambio Científico da Universidade de Santiago de Compostela. Available at: http://ruc.udc.es/dspace/handle/2183/17453

Castro, Laura (2016). "O software libre como vehículo de introdución á perspectiva de xénero." In: Aguayo Lorenzo, Eva; López Díaz, Ana Jesús and González Penín, Anabel (eds.). *Perspectiva de xénero na docencia universitaria: IV Xornada Universitaria Galega en Xénero*. Santiago de Compostela: Servizo de Publicacións e Intercambio Científico da Universidade de Santiago de Compostela.

De Wolfe, Elizabeth (2016). "Making History, Empowering Students with Wikipedia." *Wiki Education*. Available at: https://wikiedu.org/blog/2016/06/22/make-history-empower-students/

Fernández, Raquel (2016). "El aprendizaje-servicio como innovación educativa para la implantación de la igualdad de género." In: Aguayo Lorenzo, Eva; López Díaz, Ana Jesús and González Penín, Anabel (eds.). *Perspectiva de xénero na docencia universitaria: IV Xornada Universitaria Galega en Xénero*. Santiago de Compostela: Servizo de Publicacións e Intercambio Científico da Universidade de Santiago de Compostela.

Gallardo-Gallardo, Eva (2016). "Interacción en las aulas de Ingeniería: más allá de los estereotipos de género en la comunicación." In: Aguayo Lorenzo, Eva; López Díaz, Ana Jesús and Penín, Anabel González (eds.). *Perspectiva de xénero na docencia universitaria: IV Xornada Universitaria Galega en Xénero*. Santiago de Compostela: Servizo de Publicacións e Intercambio Científico da Universidade de Santiago de Compostela. Available at: http://hdl.handle.net/2117/102951

Gallego Morón, Nazareth (2016). "Trencant el sostre de vidre: la lectura de la tesi doctoral com a moment clau." *Mètode*: *Revista de difusión de la Investigación*, 91, pp. 64-71.

García Dauder, Silvia and Pérez Sedeño, Eulalia (2017). *Las 'mentiras' científicas sobre las mujeres*. Madrid: Ed. de la Catarata, Colección Mayor. ISBN: 978-84-9097-265-6.

García Delgado, Alba (2016). *Una perspectiva de género en el perfil TIC*. Available at: https://upcommons.upc.edu/handle/2117/97993

García-Holgado, Alicia (2017). *Inclusión de la perspectiva de género en la asignatura de Ingeniería de Software I*. Available at: https://gredos.usal.es/jspui/bitstream/10366/135405/1/MID_16_084.pdf

Gaytán Guía, Susana (2016). "Estrategias para la introducción de la perspectiva de género en el curriculum de ciencias biológicas. Aproximación etológica a los patrones de liderazgo: una iniciativa didàctica." In: *Mujeres e investigación. Aportaciones interdisciplinares: VI Congreso Universitario Internacional Investigación y Género* (p. 328-340). Seville: SIEMUS (Interdisciplinary Seminar on Women's Studies of the University of Seville). Available at: https:// idus.us.es/xmlui/handle/11441/51818

Gil-Juárez, Adriana *et al.* (2015). "De la investigación mediante relatos de vida al teatro social: el caso de la brecha digital de género." *Universitas Psychologica*, 14 (4), pp. 1583-1598. Available at: http://revistas.javeriana.edu.co/index.php/revPsycho/article/view/10706

González García, Marta and Pérez Sedeñoa, Eulalia (2002). "Ciencia, tecnología y género." *Revista Iberoamericana de Ciencia, Tecnología, sociedad e innovación*, 2.

González, David; Mateu, Anna; Pons, Empar and Domínguez, Martí (2017). "Women Scientists as Decor: The Image of Scientists in Spanish Press Pictures." *Science Communication*, 39 (4), pp. 535-547.

Jares, Raquel (2017). *Proxecto piloto sobre o deseño dunha estratexia de incorporación da muller rural á vida professional*. Available at: http://forestales.uvigo.es/sites/default/files/POSTER-TFG%2017.pdf

Macho, Marta and Lorente, Eneko (2013). "¿Son raras las mujeres de talento?" *XVII Simposio de la Sociedad Española de Investigación en Educación Matemática*. Bilbao, September 2013.

Macho Stadler, Marta (2014). "Ben y su hermana Bárbara." *Mujeres con ciencia*. Available at: https://mujeresconciencia.com/2014/09/27/ben-y-su-hermana-barbara/

Macho Stadler, Marta (2016). Lecture "Mujeres y ciencia, ¿una ecuación imposible?" Available at: http://www.ehu.eus/~mtwmastm/AECI.pdf

Macho Stadler, Marta (2017). "Mujeres en disciplinas STEM: ¿para qué?" *Interacció*. Available at: http://interaccio.diba.cat/blogs/2017/09/04/mujeres-disciplinas-stem-para-que

Martínez Mazaga, Uxune (2014). "Mujer, ciencia y discriminación: del efecto Mateo a Matilda." *Mujeres con ciencia*. Available at: https://mujeresconciencia.com/2014/11/17/mujer-ciencia-y-discriminacion-del-efecto-mateo-matilda/

Miller, David I.; Eagly, Alice H. and Linn, Marcia C. (2015). "Women's representation in science predicts national gender-science stereotypes: Evidence from 66 nations." *Journal of Educational Psychology*, 107 (3), p. 631.

Mirás Calvo, Miguel A. and Quinteiro Sandomingo, Carmen (2012). "Matemáticas na Historia das matemáticas e no teatro Científico: experiencias docentes." In: *Unidade de Igualdade (ed.) I Xornada de Innovación en Xénero. Docencia e Investigación* (p. 203-207). Vigo: Universidade de Vigo. Available at: https://uvigo.gal/opencms/export/sites/uvigo/sites/default/uvigo/DOCUMENTOS/igualdade/Publicacixn_electrxnica_definitiva..pdf

Moure, Teresa (2014). "Experiencia docente: negociando o xénero na conversa." In: *Unidade de Igualdade. II Xornada de Innovación en Xénero. Docencia e Investigación, Andavira, Vigo* (p. 99-112). Available at: https://www.uvigo.gal/opencms/export/sites/uvigo/sites/default/uvigo/DOCUMENTOS/igualdade/Libro_de_actas_II_Xornada_de_Innovacixn_Educativa_en_Xxnero_con_portada_.pdf

Pardo, Patricia (2010). "El glossari com a eina per a l'aprenentatge en valors." In: *Jornada Dia d'Atenea*. Available at: http://upcommons.upc.edu/handle/2099/9186

Santos Guerra, Miguel Ángel (1996). "Currículum oculto y construcción del género en la escuela." *Kikiriki. Cooperación educativa*, 42-13, pp. 14-27.

Torrado Martín-Palomino, Esther and González Ramos, Ana M. (2017). "Redes de cooperación: una herramienta para minimizar las desigualdades de género en la ciencia." In: Iglesias Martínez, Marcos Jesús and Lozano Cabezas, Inés (coords.). "La (in)visibilidad de las mujeres en la Educación Superior: retos y desafíos en la Academia." *Feminismo/s*, 29, pp. 397-415.

Torres-Guijarro, Soledad and Bengoechea, Mercedes (2017). "Gender differential in self-assessment: a fact neglected in higher education peer and self-assessment techniques." *Higher Education Research & Development*, 36 (5), pp. 1072-1084.

Verdejo, Amelia. *Matemáticas en pie de Igualdad*. Available at: http://igualmat.uvigo.es/?lang=es

Verdejo, Amelia (2013). *Matemáticas: Grao en Comercio*. Vigo: Servizo de Publicacións Universidade de Vigo. ISBN 978-84-8158-611-4.

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