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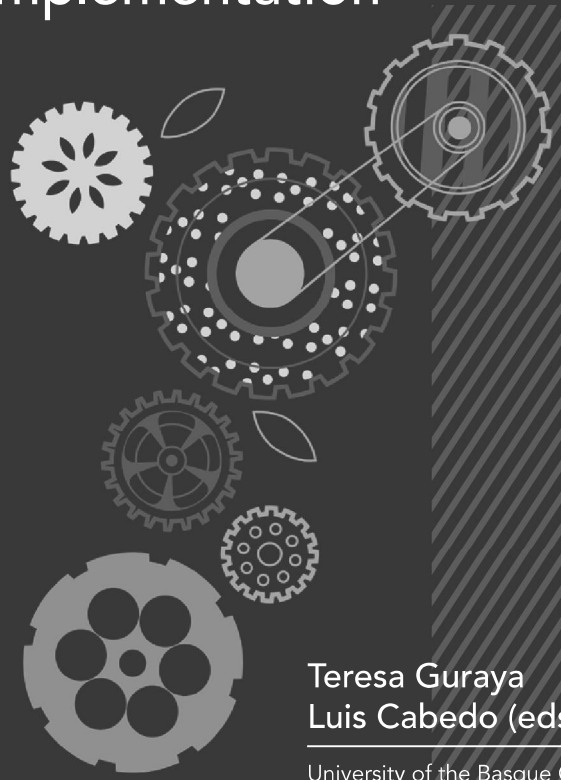
**ENGINEERING EDUCATION**

FOR THE XXI CENTURY

# Engineering Education towards Sustainability: Approaches for Institutionalization and Teaching Implementation



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UJI UNIVERSITAT JAUME I

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# Writing of stem women's biographies in Wikipedia format, an opportunity to improve Cross-curricular Competencies

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ABSTRACT

The presence of women in careers and studies in the STEM fields (Science, Technology, Engineering and Mathematics) is very low. The reasons for this under-representation are diverse and include the scarcity of female role models in these disciplines. In this communication, we show an activity to provide female references to engineering students. The activity, developed in the degree in Chemical Engineering, consists of writing the biography of a STEM woman in Wikipedia format, and has been designed in such a way that it also serves to connect the subjects of Physics and Technical English. In addition, this task aims to improve cross-curricular competencies such as information management capacity, written communication in native and foreign languages and critical thinking.

The results of this task have been satisfactory. On the one hand, the students have increased their knowledge about female contributions to Physics and Chemical Engineering and, on the other hand, there has been an improvement in cross-curricular competencies.





## Women in STEM

Spanish women are majority among university students, but they continue to be a minority in STEM careers (Science, Technology, Engineering and Mathematics). Despite the good professional prospects than STEM careers offer, women remain significantly underrepresented in these sectors (MICINN, 2018). This issue is becoming a growing concern due to the impact that the lack of diversity in the development of technologies may have in our daily life, or the inequality that this lack of presence may create in a highly technological society.

There are different reasons for this lack of interest, because girls are influenced by several social, cultural and economic factors, and the effect cannot be reduced to a single factor (Freire, Ruiz-Garcia & Oliver, 2018). Among the different reasons of this gender gap are the lower visibility of women working in STEM and the lack of female inspirational models. This gender gap is also in Wikipedia, where Google drives us when we do a search and where biographies about female scientists or engineers are scarce. Fortunately, there are projects like WikiProject Women Scientists that are changing this situation, or individual initiatives like the one promoted by physicist Jess Wade, who every day writes at least one Wikipedia page dedicated to a woman, a person of colour or an LGBTQ person in science in the hope of combating the lack of diversity (Wade & Zaringhalam, 2018).

Thus, we find that the students have little knowledge about the scientific or technological contributions of women. This knowledge, in many cases will not be increased after passing through the university, since there is a low level of mainstreaming of the gender perspective and scarcity of subjects in the undergraduate and postgraduate programs (Vergé & Cabruja, 2017). So, to make visible the contributions of women to science and technology, the students of first year of the Degree in Chemical Engineering of the University of Santiago de Compostela (USC) were asked to prepare the biography of a female scientist or technologist in Wikipedia and Galipedia format. This activity also serves to improve the skills of students since "the process of writing for Wikipedia covers all aspects of academic writing -originality, rigor, peer review, etc-" (Soler, Pavlovic & Font, 2018). Also, some of these biographies are only in English and this task is an opportunity to connect the subjects Physics and Technical English. This activity has been carried out through the virtual classroom of the subject in the platform Moodle, showing that the virtual classroom can be a place to improve equality.

## Objectives

The main objective of this project is to recover the stories of women scientists and engineers and their innovations. Thus, we show examples of women (current and past) in science and technology to students. In this way, in addition to improving their skills and abilities, we are also contributing to the development of potential women editors of Wikipedia

## Methodology

The project detailed in this report was carried out in the subjects of Physics and Technical English. These subjects are basic and compulsory and have an associated virtual class-

room in Moodle, which is used as a content archive, with links to videos or articles of interest, as forums, also to increase student participation. In these subjects, we try to improve cross-curricular competencies such as written communication, critical thinking and information skills of students.

In first-year subjects, we often have students with little knowledge of inventions or scientific contributions (Calvo, 2017). To correct this, we have proposed the following task, figure 1, to increase the visibility of women scientists and engineers related to Physics and Chemical Engineering. The task, of a voluntary nature, was carried out through the virtual classroom of the physics subject, using the workshop tool of the Moodle platform.

**Figure 1.** Description of the task in the workshop of 2018

**Description**

The following task tries to make visible women (scientists, engineers and inventors) in Wikipedia. This activity consists in the accomplishment of the biography of a scientist, engineer in wiki format.

Group 1 (A- Fe) corresponds to Hertha Marks Ayrton's biography.

Group 2 (Fr-Lo) corresponds to Mary Sherman Morgan's biography

Group 3 (Lu-Q) corresponds to Donna Strickland's biography

Group 4 (R-Z) corresponds to Frances Hamilton Arnold´s biography.

For that, first, search the Wikipedia name of the scientist or engineer and see in which languages appear her biography. Next, a biography will be drawn up for Galipedia from those existing in other languages and also using the information that you read in books, such as *Mujeres en Ciencia y Tecnología* (Claramunt and Claramunt, 2012) or *Mujeres conciencia* blog.

The launch of the workshop Scientists and Technologists in Galipedia, includes the following steps:

- The teacher selects the biographies and creates the workshop.
- Students present their own work and then receive a proposal from another student to be evaluated according to the rubric (Calvo & Sanmarco, 2017). Two grades are given that appear in the Grading Book: a grade for the student's own presentation and a grade for the quality of their peer evaluation skills.
- The teacher reviews the grades and publishes the final grade. This assignment contributes 0.25 points to the final grade in this subject.

At the same time, in the subject Technical English for Chemical Engineers, the students were introduced to the biographies the aforementioned female scientists and chemical engineers. The task that the students were asked to complete involved translating the Wikipedia biographies of these inspirational female engineers from English to Galician, English to





Spanish, and Spanish/Galician to English, depending on the group each particular student was placed in, according to alphabetical order.

A class activity which really aided students' participation in this project, within the Technical English for chemical engineers in particular, was the undertaking of various listening exercises for example, Youtube videos relating to the lives of the women that the project focused on.

For the selection of the female scientists and engineers whose biographies the students are to prepare, different criteria have been taken into account, including the importance of their contributions in the scientific-technological field and the fact that the biography did not exist in the free encyclopaedia (in Galician or Spanish). Last year we gave priority to women inventors because for a long time, some of them have been forgotten and their inventions attributed to men (Calvo, 2018). This year, to celebrate that for the first time two scientists have won the Nobel Prize in Chemistry and Physics at the same time, we have proposed their biographies.

## Results

The participation of students in this activity has been higher during the 2016-17 academic year, in which 72% of the enrolled students participated, 61 students (33 men and 28 women), while in the years 2017-18 and 2078-19 the number of students was respectively 43 students (25 men and 18 women) and 46 students (30 men and 16 women). Probably, the difference in participation is due to the fact that the exams were advanced until December, which has caused the students to devote themselves during this month to their preparation and abandon other tasks.

During the first two years the students have produced biographies of eight female inspirational models such as Fabiola Gianotti, Maria Telkes, Maria Teresa Toral, Mae Jemison, Maud Menten, Irmgard Flügge-Lotz, Lisa Jackson and Ellen Swallow Richards (Calvo and Sanmarco, 2017; Calvo, 2018). This year the students wrote the biography of Nobel Laureate in Chemistry Frances Arnold, Nobel Laureate in Physics Donna Strickland, rocket fuel scientist Mary Sherman Morgan, and suffragette, engineer, mathematician, physicist, and inventor Hertha Ayrton. In figure 2, we show two examples of the biographies made by the students.

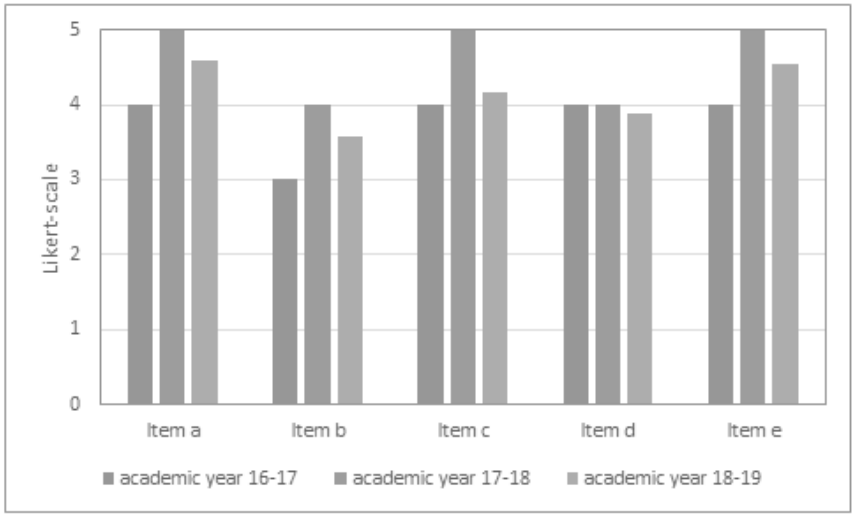
**Figure 2.** Examples of biographies elaborated by students

In order to know the opinion of the students about this activity we have used a simple questionnaire with five items of the Likert scale, where the range of the scale is 1= very disagree, 2= disagree, 3= somehow agree, 4= agree and 5= very agree. The five items were:

a. This activity helped me get to know women scientists related to Physics and Chemical Engineering.
b. This task helped me to improve my written communication.
c. I learned to write a biography in Wikipedia format.
d. I would like to publish the biography in Wikipedia.
e. I liked this activity.

Figure 3 shows the results of this survey in the three courses that were carried out. In view of the results, we can say that the activity is attractive to the students and that the objectives have been achieved, i. e., to provide female role models in science and engineering, and to familiarize the students with the Wikipedia edition.

**Figure 3.** Results of the student survey




## Conclusions

The activity that we present in this communication has served to make visible women who have contributed with their inventions and contributions to the advancement of science and technology, as well as connecting two first-year subjects (Physics and Technical English) of the degree of Chemical Engineering.





This activity has allowed us to develop some of the cross-curricular competencies that appear in the didactic guides of both subjects such as communication in written language, information management capacity, comprehension of texts in English and critical thinking.

This task has been highly valued by the students, who consider that it has helped them get to know scientists and engineers, improve written communication and familiarise themselves with the Wikipedia or Galipedia edition. In future courses, we will continue with this activity because it contributes to creating an atmosphere of equality in the classroom.

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