A COMMITTED WEBQUEST IN STATISTICS

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Abstract

Statistics in Industrial Design Engineering is a subject of the second semester of the first course. The number of my students in this subject is nearly 200 students, 120 of them are new students (there are two groups). This subject is included in a project for the adaptation of the Bologna Declaration in Spain. This subject should cover the basic concepts in Statistics that students will need in following subjects: Descriptive Statistics, Probability and Inference, in 137 hours, 60 of them are in the classroom or laboratory. In order to make students work the most basic concepts (sampling and description of data) and thinking skills, I have designed a webquest [1] where they are critical citizens. It is a long webquest, which students can develop in ten weeks (without considering three weeks of holidays that they have during the second semester) outside the classroom, in a team of 4 students. In Engineering, unfortunately, there are usually few female students. However, the number of female students is similar to the male students in Industrial Design Engineering. The webquest starts with a video of the great series "Against all odds: inside Statistics" [2], the chapter 3, Describing Distributions, where an illustrative example shows how a city government used statistical methods to correct inequity between men's and women's salaries, in the eighties, in USA. Students should investigate the wage gap in the present, making and analyzing a small survey, and using the official data of the INE (Spanish Institute of Statistics, http://www.ine.es), where they should collect among other variables: the number of hours devoted to work at home. This is a coeducative webquest, where students should investigate also a brilliant woman that using Statistics managed to save a lot of lives: Florence Nightingale. The rest of activities in the webquest considers also subjects that are on everyone's lips, such as climate change through ecological footprints, and points where they can find Statistics in their daily life, for example in clinical analysis, bad use of Statistics in the media, or making a complaint to the city government because bad estimations in water consumption mean paying more in the invoice (this is based on a real history where thanks to Statistics the money was given back to the citizen). In the webquest, there are also research activities for seeing the importance of Statistics in Industrial Design, in particular in Ergonomics. They are devoted to the description of relationships: regression line and principal component analysis through the accommodation of pilots in aircraft design [3].

The students are working in this webquest during this semester, I will collect data about their experience and opinion in order to improve and modify this webquest for the next year.

Keywords: Webquest, Coeducation, Statistics in Engineering.

1 INTRODUCTION

Firstly, I will comment some reasons that lead me to design a webquest. As noted in the abstract, this webquest is aimed at students of Statistics in Industrial Design Engineering. The number of students is very high. I have 180 students in total (120 new students each year), divided into two groups, one in the morning and one in the afternoon. This subject is an introduction to statistics in engineering, with the following contents: Descriptive statistics, Sampling, Probability and Statistical Inference. There are 137 hours, 60 of them are in the classroom or laboratory.

Students must enroll for this mandatory subject. It is a first-year course, taught in second semester. Students can access this engineering, from any Bachelor option, from artistic Bachelor, humanities and social sciences, and scientific (technological and natural sciences and health). The percentage of students who do not come from the technology option is about 30 or 40% depending on the answers provided by students in various courses.

In the first cases, students are not very in favor of mathematics. On the other hand, a large group of students come with the preconceived idea that statistics is not useful in Industrial Design, and therefore a priori they are not very motivated or interested. It is always a challenge to teach a subject, when many students are not a priori interested, and in particular is a challenge to teach statistics to

non-specialists [4]. Throughout the course, through the use of problems applied to industrial design field and the use of their own data [5], I try to remove this prejudice. This point will also be reflected in the webquest, where in addition to considering activities applied to industrial design, they will also see how statistics appears in their daily life, and in social problems of great interest. In fact, the webquest is entitled "Statistics daily." I follow a similar tactic as Phua explained in [6].

According to the American Statistical Society (ASA) and American Mathematical Association (MAA), which created a committee to study the teaching of introductory statistics [7], there are three key recommendations [8]: 1) helping to think as statistics, 2) provide more data and concepts, and less theory and formulas, and 3) encourage active learning. There are also many authors who recommend learning statistics by doing statistics [9], and using cooperative learning [10,11].

The last reason that led me to make a webquest, has a social aspect: to make students to become aware and to reflect on various present problems, including discrimination, environmental problems and climate change, etc. I also wanted to promote critical thinking with their own results and from others, including those in the media. And finally, I wanted to work various skills through teamwork, fundamental to a future engineer: as taking decisions with teammates, sharing the work evenly, meeting the agreed deadlines, and resolving conflicts that occur in the group. For the latter, I supplied them the document "Coping with Hitchhikers and Couch Potatoes on Teams" [12], to guide them how to manage conflictive situations, as it is likely to occur [13]. In this regard, however, I have not found serious problems, possibly because in the first semester, in another course, they already worked in groups. Therefore, in this second semester, they did not repeat the group if they had had conflicts in the first semester (a couple of students commented me this situation). In addition, the webquest was voluntarily, since it didn't appear in the official program of the subject, which should be given almost a year before starting classes. With the webquest, students can obtain one point more, provided that they have at least 4.5 (0 to 10). Initially, 23 groups were formed, participating the half part of the enrolled students.

2 WHAT IS A WEBQUEST?

Dodge, the webquest's father, defined a webquest originally as [1, 14]: "an inquiry-oriented activity in which some or all of the information that learners interact with comes from resources on the internet, optionally supplemented with videoconferencing".

Webquests can be short or long term, according to if they are designed to be completed in less than 3 sessions or not. In a long term webquest, the instructional goal is extending and refining knowledge [15]. They have the following structure [16]: Introduction, Task, Process, Resources, Evaluation and Conclusions. In the introduction, that presents the webquest, we can motivate the students. In the task appears what the goal is. In the process, we will clearly specify the steps to achieve the objective. Resources are available for students. The evaluation will specify how to evaluate the work in the webquest. In the last stage, the conclusion, we will remember what has been learned, encouraging its use in other contexts. Recently, there have also miniwebquests, only with Introduction, Task and Evaluation.

The most common formats of a WebQuest task [17] are: 1) retelling, 2) compilation, 3) mystery, 4) journalistic, 5) design, 6) creative product, 7) consensus building, 8) Persuasion 9) self -knowledge, 10) analytical, 11) judgment, and 12) scientific tasks.

It is important that the task is motivating and interesting for students, which represents a real life task. The webquest is mostly used in groups. In a webquest, we do not want that students simply copy / paste the information that they can find, but they must go through a process of investigation and processing of information obtained.

In [18], we can find a guide on how to develop a quality webquest, indicating which the most common errors in each of the sections of a webquest are, and giving suggestions to enhance its effectiveness.

2.1 Webquests for Statistics in Spanish

The number of available webquest is increasing every day, just do a Google search. However, if we restrict ourselves to search for webquests in mathematics, in particular in statistics, this number goes down drastically, in both Spanish and English. If you also consider webquests for Statistics at the university level, they are negligible, and even more if we look for Spanish webquest of Statistics at university level, despite an introduction to statistics is a common subject in many degrees.

Falcón et al. [19] made an analysis on the WebQuest about Statistics and Probability in Spanish, but focusing primarily on secondary education. In that work, they also present how to create webquests on Statistics and Probability. Huertas and Tenorio presented one of the few webquest on Statistics at the university level in [20], for students of the degree in Business Administration. In that webquest, students should seek official data on the website of the National Statistics Institute (INE) and the Andalusian Institute of Statistics (IEA), and perform a descriptive study with data. These authors also developed another webquest, this time for high school students (4th ESO), dedicated to women in the history of mathematics [21], one of the few coeducational webquest in mathematics.

In the following links, you can find some databases that collect, among other areas, webquests on Statistics in Spanish, but mostly not for university level:

1) http://www.estadisticaparatodos.es/webquest/webquest.html
2) http://www.phpwebquest.org/wq25/procesa_index_todas.php
3) http://www.aula21.net/tercera/otrasbiliotecas.htm
4) http://www.webquestcat.cat/

3 A COMMITED WEBQUEST

3.1 Introducing the webquest to the students

It is the first time I design a webquest. The first day of class, when I introduce the subject, was also the first time that my students heard the word webquest. As I expected that the students would say "webqué" (as in the article by Adell [22], it is a Spanish pun that means “web, pardon?”), I proposed them for homework finding out what a webquest is. This first homework could be regarded as a treasure hunt task [23, 24]. They play the role of a detective or a hacker as Lisbeth Salander, and have to solve several questions about the information and resources of the subject [25] that they have in the aulavirtual (Moodle platform at my university) of the subject. This task ends with an activity where they have to find out through the IP, who opened all resources of the subject from the United States. When we discuss this task in the following class, I try to make them reflect on two points: first, the importance of collecting information on the users, where they come from, what they open, ultimately, to compile statistics on our website to use it later for site improvements, etc. Secondly, having in mind that websites can be opened to the whole world and any file loaded on the web (photos, videos, etc.) may be watched by anyone.

Note that the vast majority of my students have internet at home or student residence. However, there are available free computers and notebooks in the college, with free internet access at the university.

3.2 Webquest: Estadística en el día a día (Statistics daily)

In order to make students work the most basic concepts (sampling and description of data) and thinking skills, I have designed a webquest where they are critical citizens. It is a long webquest, which students can develop in ten weeks (without considering three weeks of holidays that they have during the second semester) outside the classroom, in a team of 4 students. In Fig. 1 we can see the first page of the webquest title “Estadística en el día a día”, where a famous woman Florence Nightingale is quoted.

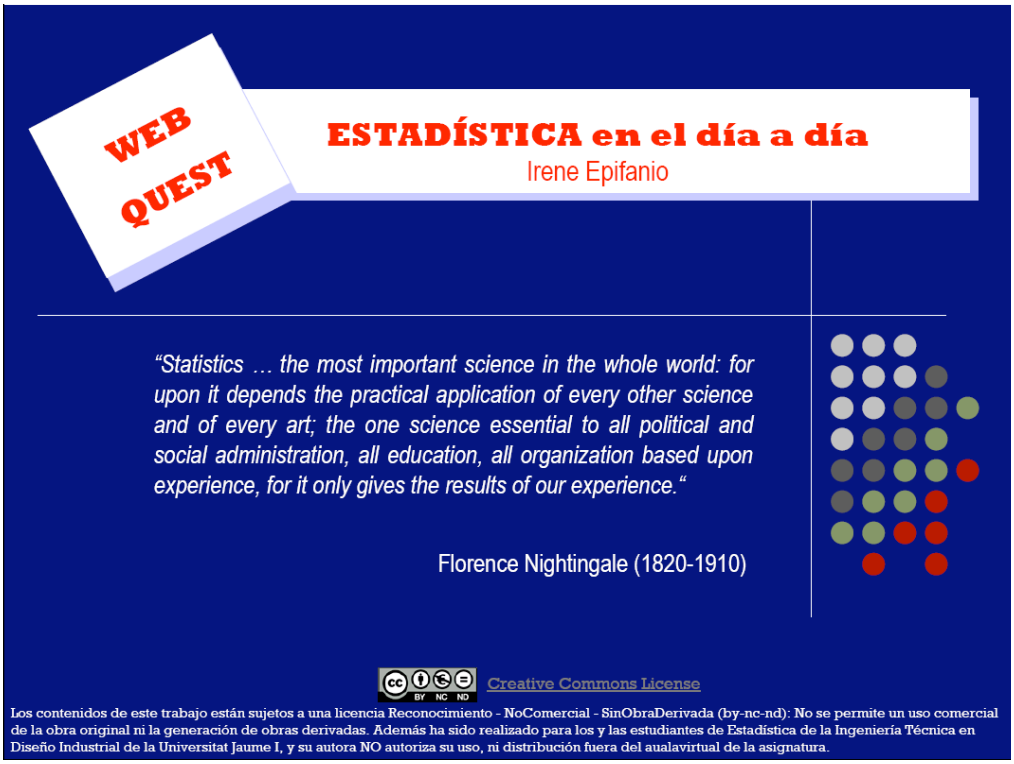

Fig. 1. The first page of the webquest.

In the introduction, I indicate that the basics concepts of the subject will be considered. They should be very clear, for the rest of the course topics. They will also discover how Statistics can help (even the most basic) in close and daily problems of real life and in Industrial Design (Ergonomics, Industrial Design Methodologies, Emotional Design, etc.). Furthermore, we need a basic knowledge of statistics to be a critical citizen and to be able to participate effectively in public argument based on figures and data, inherent to democracy.

The task can be seen in Figure 2. Students form a group of four persons, for developing a series of activities using the resources listed. They will make a collective work that has to be delivered through aulavirtual by uploading of files, as indicated in each activity. Finally, they have to make an individual activity and filled out a questionnaire about the teamwork. Let us see each activity.

3.2.1 Activity 1: Trabajo en equipo (Teamwork)

This activity is the formation of the group. They should form a group, whose components have similar objectives (with the same desire to work, although they were not their best friends). They need to name the team, and choose between team members to a person acting as spokesperson, who will be responsible for communicating with the teacher and loading to aulavirtual the team tasks on the dates indicated. As if it was a project, they have to draw up preliminary plans (allocation of tasks among members, and dates to review the material, etc., in advance of deliveries marked). The time for this first task was two weeks at most. In this way, I could see if they had performed an unbalanced distribution of tasks, and I could tell them that this should be corrected.

I created a forum for students who could not attend classes (usually students repeating a year) and wanted to form a group. In this way, they could contact between them.

The presentation of some of the groups was really original. For example, a group introduced them in the style of the Ocean's Eleven movie, and others like a football team TV presentation in a Champions League match.

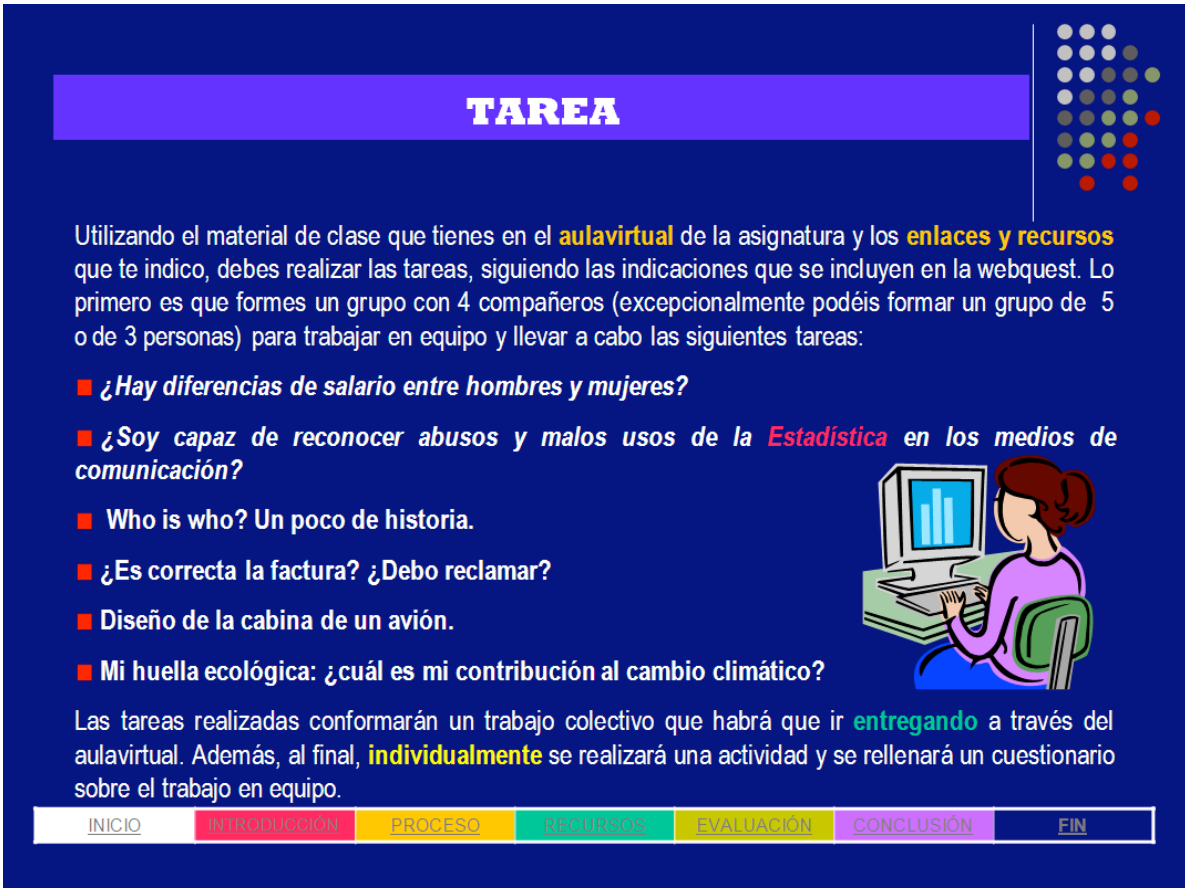

Fig. 2. Task module for the webquest

3.2.2 *Activity 2: ¿Hay diferencias de salario entre hombres y mujeres? Is there a wage gap between men and women?*

In Engineering, unfortunately, there are usually few female students. However, the number of female students is similar to the male students in Industrial Design Engineering, around 50%. This activity has a large coeducational component. An excellent collection of resources on coeducation be found in [26].

The activity starts with a video of the great series “Against all odds: inside Statistics” [2], the chapter 3, Describing Distributions, where an illustrative example shows how a city government used statistical methods to correct inequity between men’s and women’s salaries, in the eighties, in USA. Students should investigate the wage gap in the present, making and analyzing a small survey, and using the official data of the INE (Spanish Institute of Statistics, http://www.ine.es), where they should collect among other variables: the number of hours devoted to work at home. Data recollected in this survey must be supplied as much to the fifth week (actually, it's been six weeks since the beginning of the webquest because they have a week of holidays). As obviously they do not have the resources to perform the INE survey, one of the questions is to indicate how it should be done if they had adequate resources.

In addition to the survey, they must find out who is Lilly Ledbetter, and what the Fair Pay Act is in USA. For the European Union, I give them a link of the European Parliament where the matter was discussed, and they must find out why it is claimed on 22nd February as the International Day of Pay Equity.

With the analysis of their data and the investigations conducted, they must write their conclusions.

In the first story of the video, mean, median, and five-number summary are introduced. The second story of the video deals with the problem of the composition of food, essential for proper nutrition. In this story, boxplots are introduced. To reinforce the idea of random variable and simultaneously highlight the importance of a balanced diet at the expense of junk food, a second section of the webquest activity, is dedicated to a nutrient that is often heard in the ads: the fiber. In addition, to seek what fiber is, they should also check the amounts of fiber (in 100g.) for five different foods of plant

origin (foods of animal origin do not contain any fiber) from various sources. They will see that do not match to each other (and in some cases vary widely) and comment the reasons for these differences. In addition, they will reflect on the lack of information on the number of samples from the amount of fiber is estimated (in some sources is only one!), and the lack of a measure of variation in the vast majority of databases on food.

The last story of the video shows a musical urine analysis of data, and the standard deviation. Following this story, I give them a clinical analysis in English (they can also work a foreign language) from Jane Doe (unknown woman) to find out which is the reference range, and how to calculate and perform various interpretive issues. In this way they can see that the statistics also appear in medicine.

3.2.3 Activity 3: ¿Soy capaz de reconocer abusos y malos usos de la Estadística en los medios de comunicación? Am I able to recognize abuse and misuse of statistics in the media?

Unfortunately, many people who practice journalism have not ever received any statistics course, and yet they dare to report figures that occasionally offer in a careless manner, which leaves citizens vulnerable to journalistic sensationalism, political demagoguery or commercial fraud. The students should read the section (1.3) for Abuses of Statistics in Triola's book [27], and look for examples (it is enough to pay some attention reading, listening or watching news or advertisements, they are more common than desirable) where a misuse of statistics appears. They should incorporate the examples to the work, identifying the source (and date) where this example was located and indicating why it has abused of statistics and suggesting why or how it should be presented.

3.2.4 Activity 4: Who is who? Un poco de historia. A bit of history.

This is a coeducative [28] webquest, where students should investigate also a brilliant woman that using Statistics managed to save a lot of lives: Florence Nightingale. The website of the Royal Spanish Mathematical Society has a section devoted to Women and Mathematics [29], which is worth consulting. In this activity, they also have to perform an activity about regression on a problem of ergonomics, to estimate the mean and standard deviation of the length of the forearm for adult men in Valencia (the Spanish region where it is located our university) in the second half of the nineteenth century, when Florence Nightingale and Sir Francis Galton lived, who introduced the concept of regression line.

3.2.5 Activity 5: ¿Es correcta la factura? ¿Debo reclamar? Is the invoice correct? Should I complain?

This activity is based on a real history that happened in Valencia, where thanks to Statistics the money was given back to the citizen. Students must study the water invoices of a family, identify bad consumption estimates that the company carried out, which meant paying more in the invoice. They have to write a complaint to the council and the supplier to give their money back, based on the tables constructed and the findings made on the charges that change depending on the consumption of two months.

3.2.6 Activity 6: Diseño de la cabina de un avión. A crew station design.

This is a research activity for seeing the importance of Statistics in Industrial Design, in particular in Ergonomics. In this activity, they have to use principal component analysis, an advanced statistical technique, which is has not explained on classroom, through the accommodation of pilots in aircraft design [3]. With this problem students can see that combining percentiles of different variables, as too usual in Ergonomics, is not appropriate if one want to cover a certain percentage of population.

3.2.7 Actividad 7: Mi huella ecológica: ¿cuál es mi contribución al cambio climático? My ecological footprint: what is my contribution to the climate change?

This activity should be performed by all group members, and submit individually with their user in the aualvirtual. If one group member does not make this activity, the group will not be assessed, in this way if a group member is not working, the rest of the group will have no choice but to inform about this fact. A strategy as in [13] can be also considered, where they must make an extension of the project and is valued differently if all group members succeed or not.

In this activity, they should determine what the ecological footprint is and what their footprint is. They must estimate the weight of waste per week for several weeks, divided into different categories: paper

and cardboard, glass, organic, containers and packages, oil and others. They have to make graphical and numerical descriptions of these data. They can make other estimates and discuss the recommendations by using the following web http://www.vidasostenible.org/CIUDADANOS/A1.ASP.

Finally, in this activity they must answer a short questionnaire about the performance of their group.

3.2.8 Resources, Evaluation and Conclusion

In many activities, students have links that they can use, but not in all activities are available. I decided it because they're college students, and they must also begin to be able to look for on the web and select which or not meet the target.

For their assessment, the group will receive the same score based on the criteria listed in the webquest in detail, but here I only include the titles: time delivery, completeness, proper statistical content, appropriate and precise use of language and no spelling mistakes, originality, presentation, teamwork, autonomy at work (reading comprehension), and good use of the internet.

The conclusion will be presented in Section 4.

3.3 Evaluating the WebQuest

To assess the webquest I am going to pass an anonymous survey of students on June 17, after completing the course, the day when they have to do a test. Being anonymous they can be expressed freely. In addition, it can be answered by students that did not want to participate, to understand their motives. This survey aimed to learn the strengths and weaknesses of the webquest, and student opinion on this initiative.

On the other hand, any webquest can be evaluated, as explained in [30], in several aspects: Overall Aesthetics, Introduction, Task, Process, Resources, and Evaluation. I have designed the webquest trying to considering the maximum scores in each category, but obviously this is my opinion. I am not the best person to judge my own work.

4 CONCLUSIONS

This section contains the conclusions, also included in the webquest. I hope the webquest has served the students to learn not only statistics but also reflect on several important issues nowadays, such as discrimination, environmental care and climate change, etc. And of course, I hope that has served to encourage critical thinking with their own results and from others, including those in the media. Finally, I hope they have enjoyed the benefits of working in team. If it has not been the case, at least the small-scale negative experiences (such as this work), can help them in managing other more important conflict situations.

I hope this webquest can serve with the necessary adjustments, or at least serve as inspiration for other teachers. Although it has been designed for first-year university students of engineering, it could be adapted to introductory statistics courses from other degrees, even for secondary school if the level and number of activities are decreased. For example, in Activity 2 about wages, they also collect the education level for each person: it is a good exercise so that students could see for themselves what to expect if they do not study and complete their formation, because of the high school dropout rate in the Spanish educational system.

I still do not know the students' opinion about the webquest. I will collect their opinion on 17th June, the day of the exam. However, I have appreciated the interest of many students through their questions and comments, and some of them have told me explicitly that they are enjoying doing this work.

It is a great effort to find and use examples and problems that may arouse the interest of students, and even more if our degree does not match the degree where we teach, but I think it is worth. With empathy (putting yourself in the student place) and trying to connect to their interest, teaching can been improved. At least it is seems that from my teaching evaluations that students carried out over the years.

ACKNOWLEDGEMENTS

This work was partially supported by financial help of Unitat de Suport Educatiu de la Universitat Jaume I. I would also thank the teachers of the course (Nuria Solsona and Carlos Lomas) “Claves

didácticas para incorporar la perspectiva de género a las asignaturas" (Educational keys for including gender perspective in the subjects) held in 2009 at the Universitat Jaume I. I also thank very much the support of Miguel Ángel García.

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