Abstract
Statistics courses are included in almost all social science undergraduate programs, given the recognized importance that statistical training has for professionals in this field. However, the majority of students in this field do not have strong mathematical training, and they do not show an inclination for quantitative methods [1], [2]. There is a common belief that their attitudes towards Statistics are mostly negative. Since attitudes are recognised as an integral part of the learning of any educational content [3], social science students’ negative attitudes could lead to difficulties in acquiring statistical skills and in using Statistics correctly in their professional future [4]. For those students who have more negative attitudes, these difficulties would be greater. If, for instance, women have attitudes towards Statistics that are more negative than men, female students would find that the difficulties mentioned above would be greater. This arouses the interest of analyzing the differences in attitudes by students’ characteristics, such as gender.

In the teaching of Statistics, the desired outcomes in an introductory Statistics course are related to students’ learning, students’ persistence, and students’ attitudes and beliefs [5]. The learning outcomes are the ones most generally considered, but the other outcomes are also important since they will affect whether or not students will appropriately use statistical skills, ideas, and techniques. The learners’ attitudes toward Statistics will also influence their statistical thinking, both outside the classroom and when applying it to other courses. Positive attitudes also encourage students to take Statistics courses at a higher level [6], [7], and a negative attitude towards a Statistics course will be an obstacle to learning the course content efficiently [4]. Students’ attitudes influence their performance, beliefs, and behaviour in class, especially in terms of motivation and achievement [8]. It is therefore essential to monitor and attempt to improve the attitudes of students towards Statistics [8]. In this sense, different instruments have been developed to evaluate students’ attitudes towards Statistics; the Survey of Attitudes Toward Statistics (SATS©) [9] is probably the best known, and most validated [10]. Extensive work supports the reliability, validity, and multi-dimensionality of their scores and constructs [10]–[15], and researchers in Statistics education have been using this instrument to assess students’ attitudes across various educational settings, interventions, and instructional approaches [16]–[21]. The SATS© [9], [22] was at first composed of 28 items (SATS – 28©) assessing four attitudes toward Statistics dimensions: value, difficulty, affect, and cognitive competence.
updated survey (SATS – 36©) includes 36 items for assessing six dimensions of attitudes toward Statistics: value, difficulty, interest, affect, cognitive competence, and effort.

Although the common belief is that the students’ attitudes toward Statistics are negative, when the measurement instruments are applied some research works confirm the negative belief regarding students’ attitudes—[23]–[25], for instance,—but others reveal that the attitudes are slightly positive [3], [26]–[32].

The literature on educational gender differences reveals that gender inequalities in education have significantly changed in recent decades. In Western countries, women enrolled in undergraduate university studies outpace men. However, some differences persist. This is the case of preferences for different study subjects. Many research works observe gender differences in beliefs about enjoying studying different fields and differences in preferences [33], [34]. In this sense, the evidence provided by previous studies on the subject shows that women's choice for science, technology, engineering, and mathematics (STEM) subjects is lower than for men [33]–[38] and the gender differences in choice of major have recently been at the center of hot debate on the reasons behind women's underrepresentation in science and engineering [39].

Regarding gender differences in attitudes towards Statistics, [4] measure advertising students’ attitudes towards Statistics, and their results seemed to suggest a difference between men and women in their overall attitude, with women being generally more positive on most dimensions. However, women report being significantly more anxious about Statistics. Particularly, women reveal feeling more anxious than men towards their ability in Statistics. This finding agrees with [40], who obtain that women tend to have more anxiety about Math and Statistics than men. On the other hand, [4] findings seem to indicate that women turn their anxiety into a positive by being more apt to seek help from their instructor and ask questions in class. As a result, women may perform better in Statistics class than men. Other studies in the literature reported no differences between genders concerning their attitude towards Statistics [41]–[48]. Other studies reported that men expressed more positive attitudes towards Statistics than a woman [49]–[52]; these differences usually were small.

Considering these antecedents, this work addresses the analysis of gender differences in attitudes towards Statistics of social sciences undergraduate students, using a survey administered to students of social science degrees in the University of the Balearic Islands.

The survey instrument included SATS-36© [9], widely used and applied in Statistics education studies, along with some questions regarding demographic and academic characteristics of the respondents, such as gender, previous achievement in Mathematics and problems when studying Mathematics and/or Statistics.

Results show that students’ assessments of the attitudinal components are positive, except for Difficulty and Affect. The relationship between the six attitudinal factors and the demographic and academic characteristics of students has also been investigated. Gender differences are identified in four of the six components of the SATS©. Women show lower mean scores in Affect, Value, and Difficulty, and higher mean scores in Effort. From the results there emerge recommendations for teaching and learning, as well as for the improvement of attitudes towards Statistics in Social Science degrees, taking into account gender differences. Statistics lecturers should be aware of gender differences to avoid women more negative attitudes towards Statistics to turn into more significant deficiencies in learning and acquiring statistical skills and in a poorer use of Statistics in their future professional life.

2 METHODOLOGY

The target population was composed of the students enrolled in the introductory Statistics courses of six social sciences degrees (Tourism, Economics, Business Administration, Business Administration, and Tourism, Business Administration and Law, and Economics and Tourism) in the University of the Balearic Islands, in 2019. Seven hundred seventy students were enrolled in these introductory Statistics courses.

Based on the previous literature review, a self-administered questionnaire was designed. The questionnaire had the following sections: the first section contained four general questions regarding whether the student had studied Statistics previously, and asked about his/her previous perceptions and perceived problems when studying Statistics or Mathematics; the second section included the SATS-36 © scale items [22]; the third section included questions regarding the motivations for
choosing the degree in which they were enrolled; and the fourth was made up of demographic and classification questions.

The survey was administered on the first day of the course when the first sessions of each subject begin. Half an hour before the introduction to the subject of Statistics, two researchers who were not going to be the lecturers in Statistics asked the students to answer the questionnaire. The subjects were asked for their collaboration and were requested to provide sincere answers. They were also informed that the procedure was going to be completely anonymous. All students present in the classroom answered the questionnaire, and a total of 526 questionnaires were obtained.

To analyze students’ answers, a data mining technique was applied to the two open questions included at the beginning of the questionnaire, related to the students’ feelings and perceptions about the subject of Statistics. For the other questions, consisting of multiple choice and Likert scale questions, descriptive and test statistics were calculated. Firstly, individual items and components of the SATS-36© were analyzed, following the instructions indicated on the web page of the survey [22]. Mean scores for the individual items were obtained, along with descriptive statistics for the six attitudinal components. Secondly, a reliability analysis was also carried out for the six attitudinal components, using Cronbach’s alpha. Thirdly, differences in attitudinal component scores, which depended on students’ gender, were analysed. When the Kolmogorov-Smirnov test of normality indicated that normal distribution could be assumed for the components, parametric tests (t-test and ANOVA) were used to test those differences. If not, non-parametric tests (Mann-Whitney U test and Kruskal-Wallis test) were calculated.

3 RESULTS

3.1 Description of the sample

The survey instrument was administered to introductory Statistics students just before they started the course, and a total of 526 questionnaires were obtained. 37.8% were students of Tourism, 11.8% of Economics, 31.9% of Business Administration, 8.6% of Business Administration and Tourism, 6.3% of Business Administration and Law, and 3.6% of Economics and Tourism. Most of the respondents were women, 54.3%, and the average age was 19.6 years. 10.9% were repeating the subject. Most parts of the respondents were not working (60.2%) or worked sporadically (18.1%). 76.5% of the students that answered the questionnaire had been enrolled in the area of social sciences (76%) in their secondary education. Students who considered themselves to have a bad relationship with Statistics were a minority (13.2%), 45.6% considered their relationship to be good or very good; 38.3% described it as slightly bad. Problems related to the study of Statistics seemed to be the lack of understanding (27.4% of the respondents) and inability to understand, pose, or solve, statistical problems (21%). Those who stated that they had no problems made up only 6.4% of the students. The majority of the respondents define their past performance in Mathematics as within the average (43.6%).

3.2 Qualitative data analysis

The questionnaire included two open questions such as: How do you describe your relationship with statistical or math subjects? and What are the main problems you have when studying Statistics and/or Mathematics? To analyse the sentiment of the sentences declared, the libraries specialized on data mining and sentiment analysis were used (tm, tidyverse, tidytext, glue, string, sentimentr) and those declarations were compared to different lexicons.

The results show 42.6% (221) positives, 16.2% (84) negative and 41.2% (214) neutral sentences to the first questions (n=519). The results from the first questions show a frequency analysis of the word “effort” that appeared 155 times (correlated to: “level” (0.41), “marks” (0.36), “pass” (0.20)); the word “marks” 109 times (correlated to: “low” (0.40), “effort” (0.36), “pass” (0.34)), and the word “level” 70 times (correlated to “effort” (0.41), “marks” (0.34), “high” (0.32)).

In relation to the second question the students write 24.4% (119) negative sentences, 27.3% (133) positive and 48.3% neutral (n=519). Specifically, the frequency analysis shows that words such as “understand” appear 76 times (and was correlated to “because” (0.26), “ask” (0.18), “things” (0.16)), the word “problems” appear 59 times (“use” (0.24), “methodology” (0.24), “long” (0.20), “understanding” (0.17)); “formulas” 47 times (“learn” (0.34), “apply” (0.28), “remember” (0.28), “apply” (0.25)), the word “exercises” 44 times (“practice” (0.28), “home” (0.22), “solved” (0.20)); “lack” 44 times
3.3 Assessment of attitudes toward Statistics of Social Science students

Table 1 reports the mean scores of the sample for the 36 items of the SATS© and the six attitudinal components of this scale. Following the indications in [22], responses to the negatively-worded items have been reversed, in order to allow a correct interpretation of the results. Therefore, the higher the value of the items’ scores, the more favourable the students’ attitudes [3], [17].

The most of the items (24) obtain a positive mean score from the respondents (above 4, the value indicating neutrality in the 7-point Likert scale), indicating that attitudes toward Statistics are not as negative as it is commonly believed, in line with the results obtained by [3], [6], [12], [17], [28]–[32], [53]–[57]. The majority of the items with a negative assessment are those related to the belief that Statistics is a demanding discipline and to the sense of insecurity that Statistics courses generate in the students. This positive view of students’ attitudes towards Statistics is also observed when calculating the means of the SATS-36 components. Effort, Interest, Value and Cognitive Competence mean scores are positive; Affect obtain a mean score that can be considered neutral, and the only negative score is for Difficulty. According to these findings, it seems that students do not like Statistics and that they consider it to be a difficult discipline. On the other hand, they are willing to invest effort and are interested in learning this subject, maybe because they are aware of its value for their academic and professional careers, and they also see themselves capable of learning Statistics. These results agree with those obtained in a previous study focused solely on tourism students [20].

Reliability analysis of the SATS© scale shows a high level, with a Cronbach’s alpha of 0.882 for all items, and it was also good for each of the components: 0.787 for Affect, 0.700 for Cognitive Competence, 0.781 for Value, 0.614 for Difficulty, 0.783 for Interest and 0.786 for Effort.

Table 1. Mean scores for the attitudes’ items and components of the SATS-36.

<table>
<thead>
<tr>
<th>Components and items</th>
<th>Mean</th>
<th>Components and items</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Affect</strong></td>
<td></td>
<td><strong>Cognitive Competence</strong></td>
<td></td>
</tr>
<tr>
<td>3. I will like statistics</td>
<td>4.42</td>
<td>5. I will have trouble understanding Statistics because of how I think</td>
<td>4.51</td>
</tr>
<tr>
<td>*4. I will feel insecure when I have to do Statistics problems</td>
<td>3.78</td>
<td>*11. I will have no idea of what is going on in this Statistics course</td>
<td>5.16</td>
</tr>
<tr>
<td>*15. I will get frustrated going over Statistics tests in class</td>
<td>4.13</td>
<td>*26. I will make a lot of math errors in Statistics</td>
<td>3.79</td>
</tr>
<tr>
<td>*18. I will be under stress during Statistics classes</td>
<td>3.78</td>
<td>31. I can learn statistics</td>
<td>5.86</td>
</tr>
<tr>
<td>19. I will enjoy taking Statistics courses</td>
<td>4.03</td>
<td>32. I will understand Statistics equations</td>
<td>4.84</td>
</tr>
<tr>
<td>*28. I am scared by Statistics</td>
<td>4.11</td>
<td>*35. I will find it difficult to understand statistical concepts</td>
<td>3.92</td>
</tr>
<tr>
<td><strong>Value</strong></td>
<td></td>
<td><strong>Difficulty</strong></td>
<td></td>
</tr>
<tr>
<td>*7. Statistics is worthless</td>
<td>5.92</td>
<td>6. Statistics formulas are easy to understand</td>
<td>4.00</td>
</tr>
<tr>
<td>9. Statistics should be a required part of my professional training</td>
<td>4.49</td>
<td>*8. Statistics is a complicated subject</td>
<td>3.60</td>
</tr>
<tr>
<td>10. Statistical skills will make me more employable</td>
<td>4.53</td>
<td>22. Statistics is a subject quickly learned by most people</td>
<td>3.39</td>
</tr>
<tr>
<td>*13. Statistics is not useful to the typical professional</td>
<td>5.25</td>
<td>*24. Learning Statistics requires a great deal of discipline</td>
<td>3.19</td>
</tr>
<tr>
<td>*16. Statistical thinking is not applicable in my life outside my job</td>
<td>4.81</td>
<td>*30. Statistics involves massive computations</td>
<td>2.80</td>
</tr>
<tr>
<td>17. I use statistics in my everyday life</td>
<td>3.36</td>
<td>*34. Statistics is highly technical</td>
<td>3.44</td>
</tr>
<tr>
<td>*21. Statistics conclusions are rarely presented in everyday life</td>
<td>4.91</td>
<td>*36. Most people have to learn a new way of thinking to do Statistics</td>
<td>3.98</td>
</tr>
</tbody>
</table>
3.4 Gender differences in attitudes towards Statistics assessment.

Differences regarding students’ attitudes toward Statistics between men and women were analysed. For this purpose, the existence of differences in the SATS-36 components means scores among males and females were tested.

The Kolmogorov-Smirnov test of normality indicates that only for the Value component can the normal distribution be assumed. For this component, to test the existence of differences in attitudes depending on student’s characteristics, a parametric test (t-test) was used for this component; a non-parametric test (Mann-Whitney U test) was employed for the other components that cannot be considered normally distributed (Affect, Cognitive Competence, Difficulty, Interest, and Effort). Table 2 presents mean score of each component for men and Women, indicating in which cases the differences among both groups are statistically significant.

### Table 2. Mean scores by gender of the components of the SATS-36.

<table>
<thead>
<tr>
<th>Component</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Affect</td>
<td>4.21</td>
<td>3.88</td>
</tr>
<tr>
<td>Cognitive Competence</td>
<td>4.74</td>
<td>4.62</td>
</tr>
<tr>
<td>Value</td>
<td>4.88</td>
<td>4.74</td>
</tr>
<tr>
<td>Difficulty</td>
<td>3.58</td>
<td>3.40</td>
</tr>
<tr>
<td>Interest</td>
<td>4.90</td>
<td>5.01</td>
</tr>
<tr>
<td>Effort</td>
<td>5.63</td>
<td>6.21</td>
</tr>
</tbody>
</table>

* significant at 10%, ** significant at 5%, *** significant at 1%.

Significant differences are observed in four of the six components: Affect, Value, Difficulty and Effort. Women reported mean scores lower than men in Affect, Value and Difficulty. On the other hand, women showed a more positive attitude than men regarding the Effort component. Since the Affect components includes the items related to anxiety and stress, these findings agree with [4] who obtained that women reported to be significantly more anxious about Statistics than men. However, women seem to be willing to invest more effort in learning Statistics, maybe because as [4] stated, women turn their anxiety into a positive and try to overcome with effort the fear of this subject.

4 CONCLUSIONS

It is widely recognised that attitudes are a key factor in the learning process. Since previous research has shown that negative attitudes can become an obstacle to effective learning [4], it is important to monitor and try to improve them. It is also necessary to analyse which students’ characteristics are related to their attitudes, to identify which students are likely to have more negative attitudes and, therefore, have more difficulties for learning a subject. This work has analyzed social science students’ attitudes towards Statistics, focusing on their gender differences.
The common belief of most Statistics lecturers is that students’ attitudes toward this field are negative [24]. However, the findings obtained in this research do not agree with this belief in the case of social science students. On the one hand, the qualitative analysis shows that only a minority of the answers to the open questions are negative. On the other hand, of the six attitudinal components analysed, four obtain positive mean scores (Cognitive Competence, Value, Interest and Effort), one a neutral mean score (Affect) and one a negative mean score (Difficulty). Results seem to indicate that the majority of social science students do not like Statistics, and they consider that it is a difficult discipline. However, they appreciate its value for their professional future, are interested in learning Statistics, feel capable of learning this discipline and are willing to invest the effort to learn and pass the course. These findings are in line with previous research works that have shown that when attitudinal measurement instruments are applied, students do not reveal negative attitudes toward Statistics, at least not for all the attitudinal components. The lecturers’ efforts should work towards improving aspects related to the two components which received the lowest mean scores (Affect and Difficulty). In this sense, recommendations for the teaching of Statistics are directed towards focussing on statistical thinking, using real-world data and examples, introducing technology, active teaching methodologies, such as working with projects [58]–[67].

The literature on educational gender differences indicates that women seem to have a lower inclination towards STEM subjects [33]–[38]. In the particular case of the relationship between gender and attitudes towards Statistics, gender differences have also been detected. Some works reveal that women report being significantly more anxious about Statistics than men [4], [40]. The results of this work corroborate the existence of gender differences in relation to attitudes toward Statistics for social science students. Women reported higher mean scores than men for the Effort component, but lower mean scores for Affect, Value, and Difficulty. Therefore, since negative attitudes can imply greater learning difficulties, lecturers should be alert to these gender differences and try to take measures to counteract them.

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