Mathematical Statistician and Engineering Applications
ISSN: 2094-0343
2326-9865

# The Battle of Sexes in Statistics Courses: Evidence from the Employment of e-Education

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**Article Info**
**Page Number: 6543-6550**
**Publication Issue:**
**Vol. 71 No. 4 (2022)**

**Article History**
**Article Received: 25** March 2022
**Revised: 30** April 2022
**Accepted: 15** June 2022

Abstract
The employment of IT technology within the scope of education is an almost universal reality which has come to include, probably, all tertiary education institutions across the world. The present survey discusses the technical and psychological difficulties, stemming in parts from the application of e-education tools, experienced by tertiary education students with regards to statistics courses in Greece and further questions the notion of male predominance concerning statistics subjects, which is still an open research topic in cognitive psychology as well as education. The corresponding questionnaire was addressed to 160 pre-graduate students, who up to the time of the survey (i.e., the spring semester of 2022), have undertaken at least one course with contents in statistics, in various departments at the University of Piraeus. The survey finds that (i) gender differences do not seem to play a role in the perception of students regarding the statistical notions and contents (ii) male students seem to perform better than female students in statistics courses and (iii) the students face moderate difficulties relating to the use of statistical software and/or e-education platforms, regardless of gender.

**Keywords:** e-Education, gender differences, mathematics aptitude, statistics education.

## I. INTRODUCTION

The world of education counts several decades of debate and ongoing research regarding the aptitude for quantitative subjects and its relation to gender. The more "traditional" school of thought has claimed that male students outperform their female counterparts in subjects with quantitative contents including mathematics, statistics, science and technology. Such claims are often associated with the notion that girls are more socially oriented and boys are more object oriented, which however, [1] has argued to be one of the "unfounded beliefs about sex differences." Another strand of research focuses on the performance on standardized tests of mathematical reasoning (i.e., SAT-M, GRE). According to [2] and [3] women score lower than men on the math section of the standardized tests undertaken for admissions to colleges and graduate schools, whereas [4] reports that boys score higher than girls but also argues that boys and girls take equally demanding math classes in high school, wherein girls get better grades.

Furthermore, several more recent studies showcase that very few cognitive measures support the notion of sex differences. In this line, [5] provides a review of experimental studies which find no difference in the primary abilities for mathematics and thus, concludes that mathematical and scientific reasoning relate to a set of biologically based cognitive capacities that are equally shared between males and females. On the contrary, the meta-analysis of [6] reports that males on average express considerably more interest than females in engineering and somewhat more interest in science and mathematics. This study argues that sex differences in occupational interests account for the entirety of the gender gap in engineering and much of the gender gap in science and mathematics. Finally, [7] adopts a more holistic perspective and argues that STEM gender gaps are shaped to a large extent by a variety of factors that go well beyond those commonly mentioned, that is, workplace discrimination, sex preferences, within-sex variability, socialization, culture and include biology as well.

The previous body of literature has led to mixed, and to some extent, inconclusive results as regards the predominance of males in quantitative subjects. Such results need to be revisited, particularly under the implications of the Covid-19 pandemic and the restrictions that followed thereafter. The pandemic reached Greece in February 2020, leading to the lockdown of schools and academic institutions across the country. As a result, exclusively e-learning modules substituted the classroom lectures in Greek schools and universities, thus raising the challenges of highly technical courses such as statistics. The implications of employing exclusively e-learning modes and practices, with regards to quantitative courses, were striking and affected both students and educators in many different levels. Among them, the hypothesis of gender-based aptitude for quantitative subjects such as mathematics and statistics raised again. The physical interaction between educator and students, which is intrinsic to the face-to-face teaching process and in many cases remedies misconceptions on the students' part was eliminated. This necessitated the students to adjust their attitude toward the teaching process and employ traits of personal initiative and self-discipline, in order to cope up with the various mental challenges of the courses. On this basis, highly technical contents including those of statistics are becoming more difficult to be mastered and thus, the individual's aptitude for quantitative notions much more critical. It is therefore essential for the academic community to understand the interrelation between gender and aptitude for quantitative subjects.

The present survey explores the discrepancy between the views of male and female students regarding the statistics courses in tertiary education in Greece, during the Covid-19 pandemic. We consider a period during which e-education modes were exclusively in use, which allows us to observe the outcomes of e-learning practices explicitly. Subsequently, the survey questions the hypothesis of gender-based aptitude for statistics. The specific study adds to the strand of literature focusing on gender differences and education and places emphasis on the implementation of e-education and its implications with regards to the various learning objectives.

## II. E-EDUCATION

Technology is quickly becoming the main driving force in the modern economy. Therefore, schools and universities are striving to prepare students for a dynamic and technology-driven labor market. In this context, statistics courses have adopted the use of computer resources including statistical software tools as well as electronic platforms which support the education process. These resources provide a new means of interaction, which complements the conventional classroom instruction and facilitates the learning process. Moreover, they enrich the students' experiences with the various forms of technology, which is very important for their academic and career aspirations. Reference [8] notes that the contact of pupils and students with technology as well as the use of computers in academic institutions for teaching purposes, is indispensable when considering the advantages of their application. Furthermore, [9] argues that innovation is necessary in the teaching process both for the present and for the future of education, to help students, reach their full potential. In this respect, the various tools of e-education are expected to play an increasingly critical role in the teaching process, given that they provide an area which is rather appealing, particularly to the younger generations. Thus, the application of IT tools for education purposes has provided a very promising research field, engaging the academic community into the study of the various aspects stemming from the interaction between educators and students via the e-education means.

Empirical research has devoted considerable effort investigating the effects of applying technology for education purposes and comparing the outcomes with those of conventional teaching. Reference [10] finds that technology-aided teaching bears only minor positive benefits in terms of student performance when compared to conventional teaching approaches. In the same line, [11] concludes that there is no significant difference between students who use means of technology within the scope of learning and students undertaking solely conventional education approaches. Nevertheless, the same study argues that students, tend to be satisfied with the lessons that incorporate multimedia, and consider the interaction between themselves as a positive aspect which benefits the overall learning process. On the contrary, [8] demonstrates that technology brings substantial positive impacts on the students' ability to conduct scientific research as well as to collaborate with each other. Similar conclusions are reached in [12] The specific study was conducted in Canada and considered the teaching of physics courses. The results demonstrated that the students who use computers tend to outperform the students who do not, in the final tests.

## III. THE SURVEY

A questionnaire consisting of 40 questions was addressed to 160 students of various departments at the University of Piraeus. The survey took place during the spring semester of 2022 and involved students who have undertaken at least one course with statistical contents by that time. For the sake of brevity, we do not present the results of the questionnaire in its entirety. Instead, we focus on the most important of these questions seeking (i) to demonstrate the main differences between the male- and female-perspectives regarding the statistics courses

and (ii) to examine whether aptitude for statistics courses relates to gender.

## IV. THE RESULTS

We obtained 160 responses to the questionnaire. It is worth noting that the female participants were almost twice as many as the male participants (i.e., 104 female participants and 54 male participants), whereas two participants choose not to disclose their gender. The first question we discuss addresses the participants' familiarity with the notions of statistics, prior to their attendance in a higher education statistics course. We present the results of this question in Fig. 1.

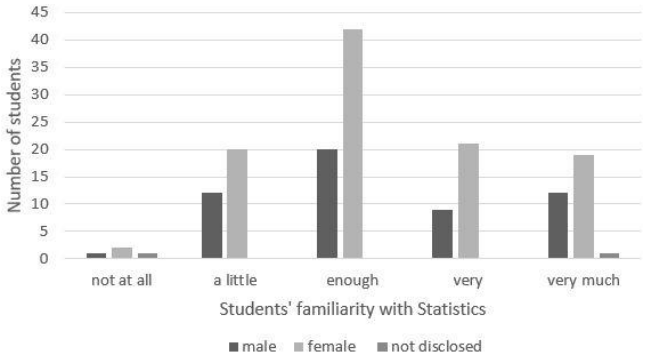


**Fig. 1.** Familiarity of the participants with Statistics.

These results indicate that the participants possessed sufficient knowledge in the contents of the courses even before attending them. This outcome is valid both for male and for female participants of the survey.

The second question considers the psychological impacts and more precisely the anxiety caused to student by the nature of the courses in statistics. Such courses, more often than not, become highly technical and tend to involve their own language, notation, etc. Thus, it is not uncommon students to experience them as a source of anxiety. The results of the second question are illustrated in Fig. 2.

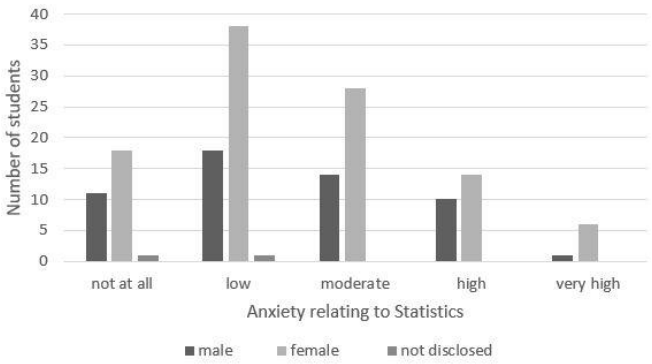


**Fig. 2.** Anxiety relating to Statistics courses.

The results now showcase that anxiety relating to the statistics courses is an issue for approximately half the participants regardless of gender (i.e., 48 females and 25 males), which indicates no major difference between the genders.

The next question generalizes the previous one and seeks to determine the anxiety levels of the students attending mathematics courses. The two subjects, that is, mathematics and statistics are closely related and display certain characteristics in common. Amongst these, they both require abstract thinking, precision, logical sequence and structure, generalization and classification, rigor as well as the adoption of appropriate notation. It is therefore reasonable one to expect that students may exhibit similar reactions with regards to their anxiety levels when they attend courses in mathematics and statistics. We present the answers regarding the third question in Fig. 3.

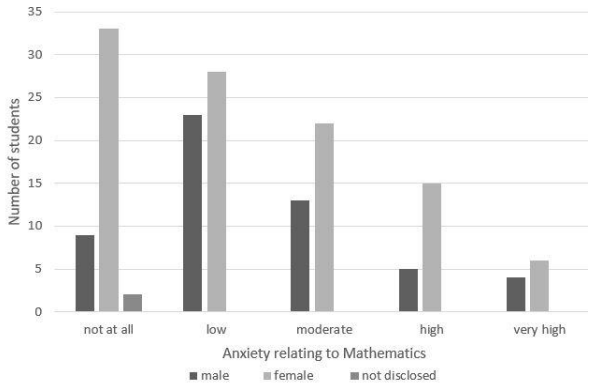


**Fig. 3.** Anxiety relating to Mathematics courses.

Initial inspection of these results highlights that a substantial number of students (i.e., 43 females and 22) experience at least moderate levels of anxiety relating to the mathematics courses. Once again, there does not seem to exist main difference relating to gender.

The forth question considers the students' attitude toward the employment of IT-tools for education purposes. More presicely, the students are asked to express the discomfort they experienced due to difficulties relating to the use of either statistical software tools or e-education platforms. We summarize the corresponding results in Fig. 4.

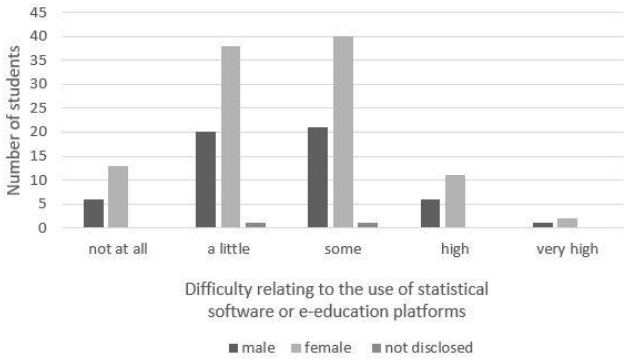


**Fig. 4**. Difficulty relating to the use of statistical softare or e-education platforms.

These results reveal that 53 female and 28 male students face at least some difficulty with the use of statistical software tools or e-education platforms. Given the sub-sample sizes, there does not seem to exist a substantial difference between the genders.

Subsequently, we question whether there is a difference relating to gender in the performance of students in the final exam of the course they attended. To this end, the students are asked to state the grade they achieved. We illustrate these results in Fig. 5.

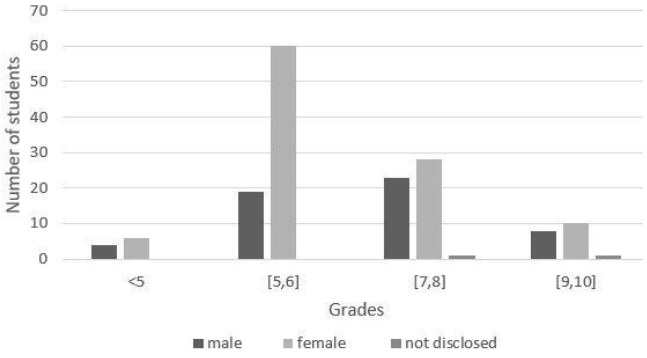


**Fig. 5.** Grade distribution of the participants.

Our results now illustrate that male students seem to outperform their female counteraprts. More precisely, 31 out of 54 male students achieve a grade of at least 7, whereas only 38 out of 104 female students achieve a similar performance. This outcome is consistent with [13] which reviews national trend studies, college admissions examinations and Advanced Placement tests and concludes that males tend to outperfom females on standardized measures in the US and with [14] which examines the relationship between mathematics participation and mathematics achievement in Flemish secondary schools and argues that boys' better performance in mathematics is related to their higher participation in the specific courses. Finally, we observe a general tendency of the students, both males and females, who to a lerge extent declare low or no anxiety relating to statistics and achieve at least a passing grade. This finding is in line with [15] which emphasizes on the prior-to-the-class attitudes and beliefs of the students as a factor that can facilitate or impede the learning process and the application of statistics.

## CONCLUSION

The present study provides primary data from various departments at the University of Piraeus as well as a descriptive statistics-based analysis seeking to shed light into the technical and psychological difficulties experienced by tertiary education students, concerning the statistics courses. In addition, we question whether the claims of male-advantage regarding the quantitative subjects are relevant. Our study complements the statistics education literature, especially with regards to the Greek academic institutions, wherein such works are limited. A strand for future research includes addressing the questionnaire to more academic institutions and obtaining a more general view of the students' perspective upon the subject.

**Acknowledgment**

This paper is an output of the science project KIDEDU funded by the Research Center of the University of Piraeus.

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