Exploring Gender Differences in Undergraduate Sports Science Students' Attitudes Toward Statistics

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Abstract: Due to the significance of statistics in science in general and in sports sciences in particular, statistics is incorporated into sports courses. The students at the University of Lahore are studying sport sciences, and this research intends to analyse attitudes towards the introductory statistics course as the principal predictor of success among these students. The Survey of Attitudes Towards Statistics (SATS) was utilized to collect attitudes, which were then evaluated using the instrument. The sample was self-administered and included both established predictors of attitudes and a novel predictor, specifically interest in statistics in daily life. The findings reveal that, from a gender perspective, males demonstrate more favourable attitudes towards statistics than females and possess higher self-confidence in their abilities compared to females. Gender and mathematics achievement in secondary education are crucial factors affecting affect and competence; however, age also impacts the latter. Gender and mathematics aptitude are significant indicators as well. Ultimately, no discernible gender discrepancy in academic achievement exists at the semester's conclusion. Various considerations make gender disparities in attitudes toward statistics realistically significant. Factors encompass women's experiences during a course, the probability of enrolling in an additional elective statistics course, and, in some instances, their ultimate performance in the course.
Keywords: *Statistics education, Students' attitudes, Sport curricula, Gender*

Introduction

Statistics are incorporated into the majority of higher education courses, underscoring the significance of quantification across various scientific fields. Crettaz von Roten and de Roten (2013) contend that the information society is defined by an excess of statistics, transcending the academic domain. It is imperative for the public to have basic statistical literacy, defined as "the ability to interpret, critically evaluate, and communicate about statistical information and messages" (Gal, 2002). Statistics should be taught in universities to prepare students to become future scientists and informed citizens. Universities bear responsibility for the advancement of their pupils.

Statistics can provoke anxiety, since students may fear inadequate performance in the course, perhaps detrimentally impacting their outcomes (Zimprich, 2012). Instructing statistics within social and human sciences presents a complex problem, since many students perceive the subject as irrelevant to their core interests. This is precise for multiple reasons.

The field of statistics education has markedly progressed in the last thirty years, focusing on clarifying differences in student performance. The aim of statistics education is to understand the variations in student performance. Among the myriad variants a significant number of research have concentrated on learners' attitudes about statistics as determinants of achievement. These attitudes specifically impact (1) the teaching and learning process, (2) students' statistical performance after classroom instruction, thereby influencing their achievement, and (3) students' decisions to enrolled in advanced statistics courses beyond the introductory level (Gal, Ginsburg, & Schau, 1997).

The Survey of Attitudes Towards Statistics (SATS) is extensively utilized to assess students' opinions. This instrument was initially created by Schau et al. (1995) with 28 items and then amended in 2003 to include 36 items (Schau, 2003). The instrument's validation was performed in several languages. A meta-analysis conducted by Emmioglu and Capa-Aydin (2012) demonstrated substantial relationships between the SATS subscales and success in the statistics course.

Various predictors of these attitudes have been established based on the course specifications and student profiles. Eichler and Zapata-Cardona (2016) noted that prior proficiency in statistics, regardless of whether it was obtained through online or conventional classroom instruction, or through classical or project-based approaches, was pertinent to the latter. Since statistics is "a branch of science rather than of mathematics" (Hand, 1998), its teaching must include a fundamental level of mathematical concepts. Previous mathematical knowledge is a substantial predictor of attitudes and performance in statistics courses, as evidenced by multiple research (Cladera, et al., 2019). This observation is a characteristic of students. Studies in mathematics education demonstrate that women have much lower self-confidence in mathematics than men. This holds true even when the mathematical skill of men and women is comparable in the majority of countries (Else-Quest, Hyde, & Linn, 2010). A correlation exists between gender and attitudes towards statistics among students in psychology (Chiesi & Primi, 2015), tourism (Cladera et al., 2019), and information and communication technology (Noraidah, et al., 2011). However, these inequalities were not found to be statistically significant among medical students (Milic et al. 2016).

Statistics are intrinsically connected to the realm of sports, rendering this circumstance very relevant. Statistics can be utilized to analyse an athlete's performance or team management (for instance, the development of specific methodologies like sabermetrics in baseball), to enhance the experience of sports spectators, or to facilitate self-monitoring for recreational athletes via personalized smart devices. The proximity of these two criteria offers a potential novel predictor of attitudes among sport sciences students, particularly regarding their interest in statistics in everyday life. This study sought to investigate the importance of students' interest in statistics in their daily lives as a predictor of their attitudes and the degree of accomplishment they would achieve at the course's conclusion. The research sought to evaluate the perspectives of sports science students on statistics from a gendered viewpoint.

Research Methodology

Attendees and Participants: This research enlisted participants from the Bachelor of Sport Sciences degree at the University of Lahore during their first statistics class in February 2024. Anonymity and voluntary participation were both required. This course was delivered in a traditional classroom setting. The instructor, with approximately 12 years of expertise in teaching introductory statistics, held a master's degree in mathematics, a doctorate in mathematics, and all three degrees.

Instrumentation: As stated by Whitaker et al. (2022), the SATS is the most frequently utilized instrument. It is available in two variations, consisting of either 28 or 36 items, the latter including two additional subscales. During confirmatory evaluations of the SATS-36, researchers determined that several questions should be eliminated (Persson et al., 2019).

The SATS has 28 items evaluated using a seven-point Likert scale, where one indicates strong disagreement and seven indicates strong agreement. Before constructing the four subscales—Affect, Competence, Value, and Difficulty—it was imperative to recode items containing negative language, as indicated by Gal et al. (1997). A higher score signifies that the student exhibits a more favourable disposition towards statistics, enhanced self-efficacy in their capacity to engage with the subject, a more personal appreciation for statistics, and views the curriculum as less challenging. Whitaker et al. (2022) emphasized the disputed interpretation of the subscale. Therefore, as a higher score reflects a more favourable attitude towards statistics, the subscale ought to have been labelled as the Facility of Easiness. The positive subscale scores range from 4.50 to 7.00, the neutral subscale scores range from 3.50 to 4.49, and the negative subscale scores range from 0 to 3.49. Research by Hilton, Schau, and Olsen (2004) established that the SATS measure demonstrates gender invariance. Cronbach's alpha, which evaluates the internal consistency of the SATS subscales, demonstrates that the scale is classified as either "minimally acceptable" or "very good," with a range of $\alpha = .66$ to $.89$ (DeVellis, 2003).

Statistics obtained from athletic performances or gathered through a connected smartwatch or application for measuring physical activity, along with two items concerning statistics on current events (students were asked to evaluate their interest in statistics related to the COVID-19 pandemic or electoral polling statistics within the country) (see Supplementary material for exact phrasing). Both items relate to statistics in current events. The additive scale demonstrates an "insufficient" degree of internal consistency, indicated by a coefficient $\alpha = .54$ (DeVellis, 2003).

Methodology: The questionnaire included sociodemographic information such as gender and age, the SATS instrument, the number of previous statistics courses, interest in statistics in everyday life, and the mathematics grade achieved in secondary school. All of these characteristics were included in the questionnaire. The data collection occurred in 2024, during the students' introductory statistics course.

Quantitative and Statistical Analysis: Following the completion of the descriptive statistics, a series of independent samples t-tests were performed to investigate the gender differences in question. A Welch test was utilized when the assumption of homogeneity of variances was breached, and a Mann-Whitney test was performed when the conditions of the t-test were unmet. Cohen's d and its 95% confidence interval were utilized to determine the magnitude of the t-test's effect. Measurements were performed to determine the Pearson correlations between the SATS subscales and other quantitative factors. Hierarchical regressions were performed to clarify the SATS subscales. Hierarchical regression is a method in which independent variables are introduced sequentially. Every stage of the procedure integrates independent variables of a comparable nature. Hierarchical regression is a distinct type of regression model. The sociodemographic factors were included in the early phase; performance in mathematics and preceding statistics courses was introduced in the succeeding phase; and interest in statistics in daily life was presented in the final phase.

Step three incorporated an interaction between gender and mathematical achievement to investigate whether men and women differ exclusively in their origins or also in the slopes of the independent variable, mathematical achievement. This was undertaken to more thoroughly investigate the influence of gender. A second model was completed utilizing adjustments made during the third phase of the prior model.

Data Analysis and Results

A sample size of 130 individuals is necessary to do a multiple regression analysis including five independent variables, with a power of 0.80, a type I error rate of 0.05, and a medium effect size (Cohen, 1992). A significance level of 0.05 was chosen. All analyses were performed utilizing SPSS (version 25).

Table 1

Demographic and Educational Characteristics of the Sample (n = 130)

Variable	Total	Men (n = 96)	Women (n = 34)	p
Gender	–	96 (73.8%)	34 (26.2%)	–
Age (M ± SD)	23.15 ± 3.10	23.18 ± 3.01	23.05 ± 3.35	0.807[b]
Previous Statistics Course				0.190[a]
No	78 (60%)	58 (60.4%)	20 (58.8%)	
Yes	52 (40%)	38 (39.6%)	14 (41.2%)	
Achievement in Mathematics	4.65 ± 0.83	4.68 ± 0.84	4.59 ± 0.80	0.540[b]

Note. *p <.05. (a) Chi-square test. (b) t-test for independent samples.

The sample consists predominantly of men, reflecting typical gender proportions in sport sciences programs. Table 1 presents the demographic and educational characteristics of the sample of 130 participants, consisting of 96 men (73.8%) and 34 women (26.2%).

The age distribution is consistent across genders, with no significant differences. The mean age of participants was 23.15 years (SD = 3.10), with men averaging 23.18 years (SD = 3.01) and women averaging 23.05 years (SD = 3.35). A t-test revealed no significant difference in age between men and women, $t(128) = 0.25$, $p = .807$.

No significant differences were found in prior statistics course participation by gender. Both men and women scored similarly in mathematics, with no significant differences observed. Regarding prior exposure to statistics, 60% of participants (n = 78) had not taken a statistics course, while

40% (n = 52) had previous experience. A chi-square test showed no significant association between gender and prior statistics course participation, $\chi^2(1, N = 130) = 0.16$, $p = .190$.

For achievement in mathematics, the overall mean score was 4.65 (SD = 0.83). Men scored slightly higher (M = 4.68, SD = 0.84) compared to women (M = 4.59, SD = 0.80). However, a t-test indicated no significant difference in mathematics achievement between genders, $t(128) = 0.62$, $p = .540$. This data suggests that the sample is demographically balanced and exhibits no significant differences in key educational characteristics between genders.

Table 2

Pearson correlations between SATS subscales and other variables (n = 130)

Variable	1	2	3	4	5	6	7
1. Affect	–						
2. Competence	.83***	–					
3. Value	.45***	.46***	–				
4. Difficulty	.52***	.62***	.28**	–			
5. Age	-.08	-.16*	-.17*	-.13	–		
6. Achievement in Mathematics	.55***	.50***	.31**	.33**	.11	–	
7. Interest in Statistics	-.02	-.03	.26**	-.18*	-.07	-.06	–

Note. *p <.05, **p <.01, ***p <.001.

The table displays the Pearson correlation coefficients between the SATS subscales (Affect, Competence, Value, and Difficulty) and additional variables (Age, Achievement in Mathematics, and Interest in Statistics). The correlations indicate the strength and direction of relationships among these variables for a sample size of 130 participants.

A very strong positive correlation exists between Affect and Competence ($r = .83$, $p < .001$), indicating that participants with more positive feelings about statistics tend to feel more confident in their statistical abilities. Value correlates positively with both Affect ($r = .45$, $p < .001$) and Competence ($r = .46$, $p < .001$), showing that participants who value statistics more tend to feel more positive and confident about the subject. Difficulty is positively correlated with Affect ($r = .52$, $p < .001$) and Competence ($r = .62$, $p < .001$), suggesting that participants who perceive statistics as easier are more likely to have positive attitudes and greater confidence.

Age shows weak negative correlations with competence ($r = -.16$, $p < .05$) and Value ($r = -.17$, $p < .05$), indicating that older participants tend to report slightly lower confidence and value for statistics. Achievement in Mathematics has strong positive correlations with Affect ($r = .55$, $p < .001$) and Competence ($r = .50$, $p < .001$). This suggests that participants with higher mathematical achievement tend to have more positive feelings and confidence in their ability to learn statistics. Achievement is also positively correlated with Value ($r = .31$, $p < .01$) and Difficulty ($r = .33$, $p < .01$), indicating that participants with stronger mathematical backgrounds are more likely to value statistics and perceive it as easier. Interest in Statistics correlates positively with Value ($r = .26$, $p < .01$), showing that participants with greater interest in statistics tend to value the subject more. A weak negative correlation exists between Interest in Statistics and Difficulty ($r = -.18$, $p < .05$), suggesting that participants with higher interest perceive statistics as slightly easier.

Table 3
Descriptive Statistics and Internal Consistency of Subscales, Total and Among Gender (n = 130)

Variable	**Cronbach α**	**Total (M ± SD)**	**Men (M ± SD)**	**Women (M ± SD)**	**p**	**d [95% CI]**
Affect	0.83	4.32 ± 1.19	4.50 ± 1.08	3.85 ± 1.35	.017*	0.55 [0.11; 1.00]
Competence	0.85	4.68 ± 1.17	4.88 ± 1.02	4.15 ± 1.39	.039*	0.63 [0.20; 1.07]
Value	0.9	4.73 ± 0.98	4.79 ± 1.00	4.63 ± 0.89	0.392	0.17 [-0.28; 0.61]
Difficulty	0.68	3.38 ± 0.74	3.43 ± 0.73	3.25 ± 0.78	0.29	0.25 [-0.20; 0.69]

Note. *p <.05, **p <.01, ***p <.001.

The descriptive statistics and internal consistency of the SATS subscales for the overall sample and by gender (n = 130) provide significant insights into students' views about statistics. The internal consistency for all subscales varied from satisfactory to outstanding, with Cronbach's α values ranging from 0.68 (Difficulty) to 0.90 (Value), signifying dependable measures. The mean score for Affect in the overall sample was 4.32 (SD = 1.19). Men had substantially elevated scores (M = 4.50, SD = 1.08) in contrast to women (M = 3.85, SD = 1.35), with a medium effect size (d = 0.55, 95% CI [0.11, 1.00]), indicating that men harbor more favorable sentiments toward statistics than women ($p = .017$).

The whole sample mean for competence was 4.68 (SD = 1.17). Men achieved a substantially higher score (M = 4.88, SD = 1.02) compared to women (M = 4.15, SD = 1.39), with a medium effect size (d = 0.63, 95% CI [0.20, 1.07]). This suggests that males demonstrate higher confidence in their statistical skills than women ($p = .039$). No notable gender differences were detected for the Value subscale, which exhibited an overall mean of 4.73 (SD = 0.98). Men achieved a marginally higher score (M = 4.79, SD = 1.00) compared to women (M = 4.63, SD = 0.89); however, this difference was not statistically significant (p = .392), exhibiting a small effect size (d = 0.17, 95% CI [-0.28, 0.61]).

Correspondingly, the aggregate mean score for Difficulty was 3.38 (SD = 0.74). Men had slightly elevated scores (M = 3.43, SD = 0.73) relative to women (M = 3.25, SD = 0.78); however, the difference was not statistically significant (p = .290), with a minor effect size (d = 0.25, 95% CI [-0.20, 0.69]). The findings indicate notable gender disparities in Affect and Competence, with males demonstrating more positive emotions and enhanced confidence in their statistical skills relative to women. Nonetheless, no substantial variations were observed for Value or Difficulty, indicating that these views are less affected by gender. These findings highlight the necessity for focused measures to tackle gender differences in statistical attitudes, especially in cultivating confidence and positive sentiments among women.

Table 4

Hierarchical regression results for Affect and Competence

Predictor	Affect					Competence				
	B	SE	β	R^2	ΔR^2	B	SE	β	R^2	ΔR^2
Step 1				0.08	.08*				0.12	.12**
Constant	5.72	1.08				6.7	0.96			
Gender	-0.69	0.31	-.25*			-0.78	0.29	-.29**		
Age	-0.05	0.04	-0.14			-0.08	0.04	-0.21		
Step 2				0.33	.25***				0.32	.20***
Constant	6.55	0.95				7.17	0.93			
Gender	-0.61	0.27	-.22*			-0.7	0.26	-.26***		
Age	-0.07	0.04	-0.19			-0.09	0.04	-.25**		
Previous Statistics course	-0.32	0.24	-0.13			-0.1	0.24	-0.04		
Achievement in Mathematics	0.68	0.14	.47***			0.62	0.14	.44***		
Step 3				0.34	0.001				0.35	0.03
Constant	6.59	0.95				7.26	0.92			
Gender	-0.59	0.27	-.21*			-0.7	0.26	-.26**		
Age	-0.07	0.04	-0.19			-0.09	0.04	-.25**		
Previous Statistics course	-0.33	0.24	-0.13			-0.12	0.23	-0.04		
Achievement in Mathematics	0.61	0.16	.42***			0.49	0.16	.34**		
Interaction Achievement in Mathematics by Gender	0.31	0.35	0.1			0.62	0.33	0.2		

Note. *p <.05, **p <.01, ***p <.001.

Table 4 displays hierarchical regression analysis for the determinants of Affect and Competence, which are two subscales of the SATS. The models comprised three steps: (1) Gender and Age, (2) incorporation of Prior Statistics Course and Proficiency in Mathematics, and (3) the integration of the interplay between Proficiency in Mathematics and Gender. Results are shown as unstandardized regression coefficients (B), standard errors (SE), standardized coefficients (β), R^2 values, and changes in R^2 (ΔR^2).

Initially, Gender and Age accounted for 8% of the variation in Affect ($R^2 = 0.08$, $\Delta R^2 = 0.08$, $p < .05$) and 12% of the variance in Competence ($R^2 = 0.12$, $\Delta R^2 = 0.12$, $p < .01$). Gender was a notable predictor ($B = -0.69$, $\beta = -0.25$, $p < .05$), suggesting that women had significantly lower Affect ratings than men. Age was not a significant predictor ($p > .05$). Gender was again significant ($B = -0.78$, $\beta = -0.29$, $p < .01$), indicating that women reported diminished Competence. Age exhibited a tendency towards significance ($B = -0.08$, $\beta = -0.21$, $p > .05$).

In the second phase, incorporating Previous Statistics Course and Achievement in Mathematics markedly enhanced the explained variance for both Affect ($R^2 = 0.33$, $\Delta R^2 = 0.25$, $p < .001$) and Competence ($R^2 = 0.32$, $\Delta R^2 = 0.20$, $p < .001$).

Mathematical achievement was identified as the most significant predictor ($B = 0.68$, $\beta = 0.47$, $p < .001$), suggesting that greater proficiency in mathematics correlates with more favorable attitudes toward statistics. Gender was a significant predictor ($B = -0.61$, $\beta = -0.22$, $p < .05$), although Previous Statistics Course and Age were not significant predictors ($p > .05$).

Mathematics achievement was the most significant predictor ($B = 0.62$, $\beta = 0.44$, $p < .001$). Gender was significant ($B = -0.70$, $\beta = -0.26$, $p < .01$), while Age exhibited a significant negative correlation ($B = -0.09$, $\beta = -0.25$, $p < .01$). The prior Statistics Course did not serve as a significant predictor ($p > .05$).

In the third phase, the interaction term (Achievement in Mathematics × Gender) did not significantly enhance the explained variation for either Affect ($R^2 = 0.34$, $\Delta R^2 = 0.001$, $p > .05$) or Competence ($R^2 = 0.35$, $\Delta R^2 = 0.03$, $p > .05$). Mathematics achievement was a notable predictor ($B = 0.61$, $\beta = 0.42$, $p < .001$), and gender was also significant ($B = -0.59$, $\beta = -0.21$, $p < .05$). Age and prior enrollment in a statistics course were not significant factors. The interaction term was not statistically significant ($p > .05$).

Mathematics achievement was the most significant predictor ($B = 0.49$, $\beta = 0.34$, $p < .01$). Gender ($B = -0.70$, $\beta = -0.26$, $p < .01$) and Age ($B = -0.09$, $\beta = -0.25$, $p < .01$) continued to exhibit statistical significance. The prior Statistics Course and the interaction term were not statistically significant ($p > .05$). The hierarchical regression analysis indicated that Gender and Achievement in Mathematics were reliable predictors of both Affect and Competence. Women exhibited markedly lower scores on both subscales in comparison to men, although elevated mathematical achievement was highly correlated with more favorable views and increased confidence. The interaction between mathematical achievement and gender did not significantly influence the models, indicating that the impact of mathematical achievement on affect and competence was uniform across genders. These findings highlight the significance of tackling gender gaps and the impact of mathematical background on perceptions of statistics.

Discussion

This study aimed to analyze the introductory statistics course in sport sciences through a gender lens. We examined students' perceptions of statistics, their interest in its application in daily life, and their performance in statistics at the semester's conclusion.

The findings suggest that the instructor of an introductory statistics course can anticipate that sport science students would exhibit predominantly positive attitudes; specifically, these students perceive themselves as competent and appreciate the subject matter, while concurrently harboring a real apprehension regarding the course's difficulties. Researchers have identified a consistent pattern of views across numerous prior investigations, such as in psychology (Hood, Creed, & Neumann, 2012) and in medicine (Hannigan et al., 2014).

Significant gender disparities in attitudes underscore the necessity of a gender viewpoint. Men exhibited greater positive emotions and higher confidence in their abilities compared to women. This outcome aligns with the existing research. In management, the same two disparities identified in this study were observed, along with an additional difference: women reported greater difficulty in the course. In contrast, only one difference was noted in information and communication technology. Chiesi and Primi (2015) observed variations in emotion, competence, and difficulty while studying psychology in Italy, whereas Zimprich (2012) identified a difference solely in difficulty within the same situation in Switzerland. In both psychology research, women regarded statistics as more challenging than men did.

At the conclusion of the semester, we noted no substantial gender disparity in statistical performance, consistent with the findings of Chiesi and Primi (2015) and Zimprich (2012).

Given that Emmioglu and Capa-Aydin (2012) emphasized the relationship between attitudes and success in statistics, how can one account for the observed gender disparities in attitudes while achievement remains consistent across genders? Diverse interpretations may be articulated regarding the literature. Schram's meta-analysis indicated that gender disparities in achievement are influenced by course characteristics (course type, grading methods), with no gender inequalities observed in courses featuring a final examination (Schram, 1996). Haley, Johnson, and Kuennen (2007) discovered that "gender alone is not a significant contributor to student performance in introductory business statistics"; however, there exists an interaction between student and professor gender: "Students taught by a professor of the opposite gender perform significantly worse than those taught by a professor of the same gender." Brooks (1985) attributed women's success in statistics to their greater conscientiousness and propensity to seek assistance more frequently.

This study's results can be attributed to the teaching methodology's shift from formulas and demonstrations to a problem-driven approach (i.e., data-driven learning), the influence of the final examination, or the genders of the professor and teaching assistant. This study did not enable us to distinguish between these potential impacts; therefore, we advocate for further research on this matter.

Conclusion

This research is the first effort to examine the viewpoints of sport sciences students concerning statistics before the commencement of their first term. The research, employing a gender lens, underscores notable gender disparities in views about statistics. The disparities are substantial as they influence women's experiences during course participation (process consideration) and the probability of enrolling in an extra elective statistics course (access consideration; Gal et al., 1997). In conclusion, these inequalities in attitudes are substantial since they may lead to differences in student accomplishment based on the teaching approach adopted by the instructor. Readers must acknowledge the study's limitations prior to assessing the results. This research examines a single course at a Swiss institution specializing in sports science. The validity of the outcomes for athletic pupils on a national or international scale remains uncertain. Nonetheless, this study was underpowered (achieved power = .76) and requires replication with a larger cohort of students. The exploratory interest instrument exhibits inadequate internal consistency. Consequently, subsequent research should develop and validate an improved scale.

The statistic with the greatest mean is value; hence, educators should underscore its significance and utilize authentic sports data to instruct students in sport sciences. Spiegelhalter's (2019) book, which prioritizes conceptual over technical challenges, may motivate educators to foster critical thinking around statistical communication.

An instructor must effectively handle class variety, including variations in educational backgrounds, sociocultural contexts, and learning styles. Gender attitudes are significant in statistical analysis. Regrettably, the gender disparity in cognitive ability may hinder women's engagement in the classroom, as they may exhibit reluctance to inquire or partake in hands-on activities due to feelings of insecurity. To enhance classroom dynamics, instructors must integrate women more significantly, particularly when they are a minority, as indicated in this study.

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