Can Gender and Major Explain College Students' Performance in Business Statistics?

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ABSTRACT

Recent discussions in education, industry, and government have focused on the need for growth and diversity in STEM fields. STEM education and practice directly contribute to the economic vitality of a nation and benefit its citizens. Yet, STEM education and employment growth seem lopsided concerning both gender and diversity. While researchers have studied various dimensions of this phenomenon, this paper seeks to add to the knowledge base by analyzing the effects of gender and college major on performance and attitudes in statistics-related courses. T-tests, one-way analysis of variance, and multiple regression were used to investigate the effects of gender, major, and attitude on performance in business statistics courses. Results indicate that, in the business statistics course, there were no significant differences between the average score of male students and female students in 2 of 3 semesters. In the marketing research course, where similar statistical concepts as taught in the business statistics course were adopted, results were similar. However, there were differences in the students' scores when their academic majors were considered. Findings from this study can contribute to developing effective and innovative pedagogical methodologies to teach statistics and related subjects.

KEYWORDS

Gender, Major, Attitude, Perceived Statistics Worth, Business Statistics

INTRODUCTION

At the most basic level, general human welfare and a country's economic progress depend on how the nation manages its Science, Technology, Engineering, and Math (STEM) activities. Education in the STEM fields forms the basis of our understanding of the world and nature around us. It allows us to make and market products & services to enable comfortable lives. STEM is the foundation of discovery and also a critical source of competitiveness for an economy as it is inspirational and transformative. During the recent decades, the U.S. has been seen as the leader in innovations – the country that split the atom, landed humans on the moon and the rover craft on Mars, birthed the Internet and the GPS, decoded the human genome, and so on. All of these advancements in thinking gave the country the edge over the rest of the world. But to keep the innovative streak going, there is a need to foster and inspire later generations to explore STEM fields. If human advancement is a race, STEM is the impetus needed to finish first.

As the pace of inventions and innovations accelerates rapidly worldwide, a nation's ability to compete and draw talent depends on an effective STEM ecosystem in education (K-12 & post-secondary) to their employment in industry, government, and scientific establishments. As science and technology evolve, both producers and consumers need to be informed to utilize the

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advancements successfully. As with other fields, the emphasis on STEM is an evolving one. The industrial revolution and what it spawned can be considered the birth of the collective conscience of the importance of STEM. While it was not referred to as STEM in the past, humanity realized the importance of real-world problem solving, introducing efficient products and procedures, and serving the betterment of humanity. There were other "back to fundamentals" movements throughout history, including after introducing automobiles, WWII, the Sputnik moment, the successful moon landing, etc. (Gunn, 2017). The tech boom of the 1990s and 2000s and many of the successes of tech-based solutions and enterprises again revived interest in STEM that seems to be continuing till today. To some extent, STEM is driving the economy in the 21st century.

The call to education in STEM fields has affected both high schools and colleges. According to the National Science Foundation, the estimated size of the Science and Engineering (S&E) workforce is nearly 7 million in S&E occupations, and there are nearly 25 million citizens with an S&E college degree. STEM education is not just about studying in those areas but in a broader sense about moving away from a siloed approach of education and realizing the inter-dependency of content areas to acquire 21st-century skillsets in content (AI, cybersecurity, quantum science, advanced manufacturing, etc.), critical thinking, application-oriented problem solving, etc. (Barone, 2018).

The STEM issue is so important and strategic to the health of the U.S. economy that educational institutions at all levels (K-12, technical colleges, 4-year universities, etc.) along with the state/regional governments and the federal government have vested interest. There are close to 10 federal agencies (listing found at https://www.ed.gov/stem), including the White House, that have proposed initiatives and implementation plans as outlined in the "Progress Report on Federal Implementation of The STEM Education Strategic Plan" released by the Office of the Science and Technology Policy at The White House (U.S. Dept of Education, 2019). According to the National Science and Technology Council, the basic goals for STEM education are as follows: build strong foundations for STEM literacy; increase diversity, equity, and inclusion in STEM; and prepare the STEM workforce for the future (National Science and Technology Council, 2018). The report found at https://www.ed.gov/stem lists every federal department or agency with varying levels of involvement in accomplishing the goals.

Unlike the education systems of the past that centered on the 'sage-on-the-stage' or rote memorization approaches, STEM education involves a new paradigm and new thinking. It involves a robust foundational knowledge of fundamental concepts, interdisciplinary in nature, coupled with practical applications in scientific and business contexts to make connections between classroom learning and problems in real-life environments. This approach allows for developing problem-solving, critical thinking, analysis, higher-order synthesis, etc., along with traits such as inquisitiveness, perseverance, agility, cooperation, accountability, etc.

The STEM education ecosystem in the U.S. includes a confluence of institutions from K-12, technical schools, post-secondary university education, internships/apprenticeships, and other workforce development initiatives. Unlike in many countries, K-12 in the U.S. is mostly a state & county effort. Many of the larger higher education universities/institutions are also state-sponsored. The federal government, through funding, can play a critical role in fostering, supporting, and disseminating innovative efforts. While U.S. post-secondary or university education is the envy of the world, the same cannot be said of the quality of secondary schools. Unfortunately, even for those who are not seeking post-secondary education, STEM has become important for their career paths. Given the pace of technological advancement in both manufacturing and service sectors, there is probably no job that is "STEM-free." STEM literacy is essential to navigating the digitally connected world from the factory floor to the C-suites.

In recognizing the importance of STEM education, many states have established parallel STEM-focused formal education programs and systems. And many of these are tied to industries and businesses that have vested interest in greater involvement of students in specific areas. While STEM

has been gaining prominence in the American economy, more than 50 percent of Americans do not pursue a STEM degree because of the perceived difficulty of the subjects (Kennedy et al., 2018). The performance of American high school students in math has been stagnant based on the results of the Program for International Student Assessment (PISA) (Goldstein, 2019). At the same time, about 78 percent of high school graduates do not meet benchmark readiness for one or more college courses in math, science, reading, or English (The STEM Imperative, 2015). Other reports indicate slightly better performance. For instance, from 2006-2015, 15-year-olds in the U.S. scored below the global average in math skills but at or slightly above average in science skills (National Science and Technology Council, 2018).

Since the great recession, there has been an increase in STEM majors in university programs (Wright, 2016). The National Center of Education Statistics study found that the share of STEM degrees increased from 2010 to 2016 in almost every state while the share of humanities degrees was showing signs of decline (National Center for Education Statistics, 2019). The U.S. produces about 10 percent of the global science degrees at the bachelor's level, while India and China are producing 25 percent and 22 percent, respectively (Fayer et al., 2017). The U.S. Department of Commerce reports that those who earned STEM degrees tend to earn more whether or not they work in STEM-related occupations (U.S. Dept of Commerce, 2017). At the same time, STEM-skills personnel command higher wages compared to others who earned non-STEM degrees. In spite of the higher earnings capabilities in STEM fields, reports indicate that not all potential candidates are represented well in both STEM education and STEM jobs. The National Science Foundation report suggests that women, minorities, and persons with disabilities are significantly underrepresented (National Science Foundation, 2017). In another study by Microsoft and KRC Research, female interest in STEM wanes despite high priority given to them in schools and that girls lose interest in STEM as they get older. (Choney, 2018) At the same time, given their smaller proportion to the total population, Asians are overrepresented among STEM degree holders and the employed scientists and engineers.

The existing literature has shown mixed results regarding the effects of gender on students' academic performances. While math skills among boys and girls tend to be similar at the elementary and secondary school levels, the differences in attitudes toward the field result in more boys than girls pursuing careers in math-intensive fields in college (Theobald et al., 2020). In addition, O'Brien and Verma (2019) found a difference between how male and female students engage with business statistics courses at the college level, leading to a difference in their performance in such courses. When it comes to general statistics, there seems to be parity in the percentage of women and men employed (Sorrentino, 2015). According to the American Statistical Association, women entered the field either because of good role models, profession's collaborative environment, or an inclusive culture (American Statistical Association, 2015). To the best of our knowledge, there are no studies pertaining to such effects on performance in business statistics courses. Furthermore, there is a dearth of studies investigating the effects of majors on performance in and attitude toward Business Statistics. We hope to contribute to the existing literature by filling this void.

The remainder of the paper is organized as follows. A review of previous studies is carried out in section 2, literature review. The methodology used in the study and a detailed description and the characteristics of the sample data are presented in section 3, research methodology. The empirical results and findings are presented in section 4, results and findings. The last section presents the discussion and concludes the paper.

LITERATURE REVIEW

Given the gaps in jobs and diversity in STEM education and employment, it is crucial for academic, business, and governmental groups to work together to ensure that a steady pipeline of a diverse

student body is afforded opportunities to pursue STEM careers. Students from different backgrounds in the U.S. entering colleges express equal interest in STEM fields, but that does not translate to equal outcomes (Urton, 2020). While there might be some progress in a certain area, there is evidence that many of the students are falling behind in STEM (Phillips, 2017). A 2011 study by the U.S. Department of Commerce found that just one out of every seven engineering professionals is female. The gender gap in the STEM workforce correlates directly with the number of men and women involved in the academic communities in STEM (Phillips, 2017).

According to the National Center for Education Statistics, a higher percentage of bachelor's degrees were awarded to females than males in general (National Center for Education Statistics, 2019). Yet, within the STEM fields, women were awarded a lower percentage of degrees than men, which was true across all racial/ethnic groups. Women earn over half the bachelor's degrees in the U.S., yet they make up around 37 percent of STEM graduates (Wood, 2020). Similarly, women represent less than 20 percent of bachelor's in computer science. The numbers are not consistent across all STEM areas. For instance, half of all bachelor's degree earners in chemistry, math, and biology programs are women (Phillips, 2017). There has been some progress in understanding how certain learning techniques might narrow the gaps. For instance, "switching from passive techniques such as traditional lectures to inquiry-based active learning methods" benefits underrepresented groups in STEM education (Theobald et al., 2020). According to the authors, gaps in earning college degrees in STEM happen in part because the underrepresented groups tend to score lower in certain entry-level STEM courses resulting in many of them dropping out or switching majors (Urton, 2020). For instance, six years after beginning a STEM degree, 52 percent of Asian Americans and 43 percent of white students complete the degree, and most of these tend to be males.

Research has shown many impediments to the equitable participation of diverse groups in STEM education and employment. Systemic barriers such as implicit and explicit biases disincentivize underrepresented groups from entering STEM fields. (Rollins, 2020). A 2013 study found that discrimination was a major barrier for ethnic minority students pursuing STEM education (Grossman & Porche, 2014). Causes for the STEM gender gap are widely recognized as perceptual and the resultant stereotyping of the field. Sometimes lack of confidence in the subject tends to lower performance. Also, beliefs that math and science are masculine areas while humanities and the arts are feminine might play into the deselection of majors (Phillips, 2017). There is also a lack of visible female role models for younger girls to look up to in the STEM areas. Media and entertainment portrayals of women in certain areas have been positive in the case of roles in medical and law professions. Yet, there are few representations of women in engineering and computer programmer roles. These and other factors might lead younger women to move away from such areas into traditional ones.

College students have always viewed statistics as one of the hardest courses. According to Garfield and Ben-Zvi (2008), statistics is considered a difficult subject to learn due to the complexity of its concepts. We often find some students coming to class with a negative attitude toward the course or with the fear that they will not succeed, either because of a poor mathematical background or because of an emotional hangover attained from previous and somewhat traumatic exposure to quantitative courses (Bendig and Hughes, 1954). Those who are successful in business statistics attributed their performance to their mathematical background, their previous experience in quantitative courses, and their level of understanding of the usefulness of statistics. Students' positive attitudes toward statistics include their need to believe that they can understand and use statistics, think that statistics is useful both in their professional and personal lives, feel that statistics can be interesting, be willing to invest the effort needed to learn statistical thinking and skills, and realize that statistics is not too hard (Ramirez et al., 2012).

A student's attitude toward statistics is important as it has an impact on teaching and learning of the subject (Judi et al., 2011). It will impact their statistical thinking not only outside of the classroom but also in applications of statistics in other disciplines. Finney and Schraw (2003) documented that the difficulty students experience with statistics is not necessarily due to a lack of knowledge or poor ability but may be due to a lack of factors such as motivation for further learning, statistics self-efficacy, and attitude toward statistics. According to Perney and Ravid (1990), most college students believe that statistics is an obstacle in getting a degree. Gal and Ginsburg (1994) documented students often start statistics courses with a negative attitude toward the subject or end up developing one. In addition, students often decide to delay taking statistics as long as they can. Researchers have found that low performance in statistics courses often stems from a negative attitude toward the subject (Araki and Schultz, 1995; Elmore et al., 1993; Harvey et al., 1985; Schultz and Koshino, 1998; Roberts and Saxe, 1982; Waters et al.,1988; Wise, 1985). Mills (2004) showed that students in an introductory statistics course in the college of business at a southeastern university had more positive attitudes toward statistics, a finding that is consistent with the findings of Perney and Ravid (1990) and Waters et al., 1988.

There are many research articles analyzing the effect of gender on attitude toward statistics. Of these, most of the research (Araki and Schultz, 1995; Cashin and Elmore, 2005; Harvey et al., 1985) failed to document a statistically significant difference between the attitudes of male and female students toward statistics. However, contradictory to these findings, Waters et al., 1988 and Roberts and Saxe (1982) found that male students had more positive attitudes toward statistics than female students. Ashaari et al., 2011 have used a survey of the Attitudes Toward Statistics (SATS) developed by Schau (2003) to observe a student's attitude toward a statistics course. Their results showed that effective factor, cognitive capability, value, difficulty, interest, and students' effort were the six factors that contributed to the students' attitude toward statistics. Zamalia (2009) developed the profile of students taking statistics courses using only four components—affect, cognitive ability, value, and difficulty.

Tempelaar (2004) found a significant difference in students' understanding of measures of center based on gender among the first-year economics and business students who took the Quantitative Method course. Some additional studies pertinent to the effect of gender on students' performance and attitude include Chiesi and Prim (2015) and Oluwatelure (2015). Jamil and Mahmud (2019) found from a descriptive analysis of academic performance by gender that female students performed better than male students. However, they found that this difference was not significant statistically. Consistent with them, Louis & Mistele (2011) and Shkullaku (2013) also reported no statistically significant differences in academic performance between genders. However, Oluwatelure (2015), in their study of "Gender Differences in the Attitudes of Public Secondary Students in Science," reported that there was a statistically significant difference in performance between genders. Thus, the existing literature has shown mixed results regarding the effects of gender on students' academic performances. To the best of our knowledge, there are no studies pertaining to such effects on performance in business statistics courses. Furthermore, there is a shortage of studies investigating the effects of majors on performance in and attitude toward Business Statistics. The purpose of this study is to fill this void.

RESEARCH METHODOLOGY AND DATA

Our sample data in the present study consisted of 321 undergraduate students at a public university in the southeastern region of the U.S. The sample data come from students majoring in Accounting, Finance, Information Systems, Management, and Marketing in a college of business in the southern area of the United States. All of these students enrolled in either the business statistics course or the

marketing research course, or both during 2019. We decided to include the marketing research course in this study because approximately half of the content in the marketing research course involves statistics. Since passing the elementary statistics course is one of the prerequisites for all upper-level courses at this university, all sample students possessed general statistics knowledge before entering both business statistics and marketing research courses. Table 1 shows the characteristics of the sample data.

Table 1. Characteristics of the Sample Data

Description	Values	Frequency (%)
Gender	*Male*	*182 (56.70%)*
	Female	*139 (43.30%)*
Age	*18 – 25*	*296 (92.21%)*
	26 and over	*25 (7.78%)*
Major	*Accounting*	*33 (10.28%)*
	Finance	*28 (8.72%)*
	Information Systems	*20 (6.23%)*
	Management	*73 (22.74%)*
	Marketing	*167 (52.02%)*

Data on students' score were retrieved through the Learning Management System from both business statistics and marketing research courses, and data on students' attitude toward statistics, perceived statistics worth, and other demographic information were obtained through an online survey that the authors administered in both business statistics and marketing research courses over three semesters (spring 2019, summer 2019, and fall 2019). The surveys used to collect data in both business statistics and marketing research courses were identical. Students completed the survey in exchange for extra credit for the course that the survey was administered. Although the survey used to collect the data was an online survey, all students who participated in this study were asked to complete the survey during class time to minimize distractions. Because the data collection spanned over three semesters during 2019, some students could have taken both business statistics and marketing research courses during this period. Therefore, to prevent record duplication, the authors gave a brief introduction of the study and asked the students who had completed this survey either in the same semester or in the previous semester only to sign the consent form but not to engage in completing the survey.

We employed two instruments for this study. Both instruments were modified based on existing instruments. To measure students' attitudes toward statistics, we adopted the attitude toward the object scale developed by Oliver and Bearden (1985), who developed this scale based on Ajzen and Fishbein's (1980) original work. Our attitude toward statistics scale has 13 five-point semantic differential items and is characterized by several bi-polar descriptors presumed to measure students' overall evaluation of statistics, such as bad/good, undesirable/desirable, etc. For the second instrument, we modified the statistical anxiety rating scale or STARS (Cruise et al., 1985). The STARS is arguably the most used scale to assess statistics anxiety (Onwuegbuzie and Wilson 2003). The original STARS is a 51-item Likert-type scale with six dimensions, including the perceived statistics worth,

interpretation anxiety, test and class anxiety, computational self-concept, fear of asking for help, and fear of statistics instructor. However, based on the context of our current study and what we try to achieve, we believe that only perceived statistics worth dimension is relevant out of the six dimensions of the STARS. The perceived statistics worth dimension of the STARS that we employed in this study is a 16-item five-point Likert-type scale ranging from 1 ("Strongly Disagree") to 5 ("Strongly Agree"). With 16 items, the worth of statistics is the largest dimension of the STARS based on the number of scale items.

Student performance, their attitude, and perceived statistics worth are quantitative variables. "Gender" is a categorical variable with two categories— "male" and "female." The gender was re-coded as 0-1 dummy variables (male was coded as 1, and female was coded as 0, so the female is a reference category). Similarly, "Major " is a categorical predictor with five categories (Accounting, Finance, Information Systems, Management, Marketing). We used four dummy variables, Accounting, Finance, Information Systems, and Management, so that Marketing is a reference category. Thus, the dummy variable "Male" represents the difference in student performance between a male and a female student. Similarly, the dummy variable "Accounting" represents the difference in student performance between an accounting major and a marketing major. The choice of the reference category is arbitrary.

We used T-test to examine if there is a significant difference between male and female students, and one-way ANOVA to examine if there is a significant difference among different majors in terms of their performance, attitude toward statistics, and perceived statistics worth. Since these methodologies are widely used in the literature, these are not described in this paper.

As a common belief, we expect that male students perform better than their female counterparts in statistics-related courses. Since accounting and finance curricula involve more quantitative-related courses, we expect that accounting and finance students perform better in statistics-related courses than those majoring in information systems, management, and marketing. Prior studies (Araki and Schultz, 1995; Elmore et al., 1993; Harvey et al., 1985; Schultz and Koshino, 1998; Roberts and Saxe, 1982; Waters et al.,1988; Wise, 1985) have shown that attitude toward a subject has been a reliable positive predictor of the students' academic performance. Therefore, we expect a positive relationship between these two variables.

The scatterplots (not shown but available upon request to the authors) show an approximate general tendency to increase student performance with students' attitude and statistics worth. Thus, it is reasonable to fit a multiple linear regression model to estimate the student performance using the student attitude, gender, and academic major as the predictors. The multiple linear regression model is

$$Performance = \beta_0 + \beta_1 Attitude + \beta_2 Statistics\ Worth + \beta_3 Gender + \beta_4 Accounting + \beta_5 Finance + \beta_6 Information\ Systems + \beta_7 Management + \epsilon \qquad (1)$$

where $\beta_0, \beta_1, \dots, \beta_7$ are the parameters to be estimated and ϵ is the random error term.

EMPIRICAL FINDINGS

PART 1. DEPENDENT VARIABLE – STUDENTS' ACADEMIC PERFORMANCE

In this part, we examine the effect of gender and major on students' academic performance, i.e., students' scores. We used one-way ANOVA to test for differences in students' academic performance, i.e., total score out of 100 points across three semesters in business statistics and marketing research courses. The ANOVA results of the business statistics course suggest that the semester in which the

students took the course (spring – summer – fall) significantly influenced their performance in the business statistics course, F (2, 229) = 9.81, p = 0.000. The results imply differences in the range of students' abilities in the business statistics course each semester. A post hoc comparison using the Tukey test indicated that the students' average scores in the fall semester (M_{Fall} = 76.21, SD = 10.48) is significantly lower than those in the spring (M_{Spring} = 80.77, SD = 7.84) and summer (M_{Summer} = 82.65,SD = 8.05) semester. Consequently, we decided to conduct the subsequent tests involving students' scores in the business statistics course each semester separately.

Similarly, the ANOVA results of the marketing research course suggest that the semester in which the students took the course significantly influenced the grade in the marketing research course, F (2, 86) = 4.334, p = 0.016. The results imply that there are also differences in the range of students' abilities in the marketing research course each semester. Unfortunately, the Tukey post hoc test could not identify the semester in which the students' average scores differed significantly from others. The inconsistency between the results from the ANOVA test and those from the Tukey post hoc test is not uncommon. However, a close examination of the students' average scores each semester revealed that the students' average scores in the spring semester (M_{Spring} = 80.31, SD = 7.64) was noticeably lower than those in the summer (M_{Summer} = 85.02, SD = 3.35) and fall semesters (M_{Fall} = 84.25, SD = 4.82). Consequently, as we did with the business statistics course, we decided to conduct the subsequent tests involving students' scores in the marketing research course in each semester separately. The one-way ANOVA results are shown in Table 2.

Table 2. One-way ANOVA Results for Academic Performances Across Three Semesters in Both Courses

Business Statistics

Semester	N	Mean	SD	Minimum	Maximum
Spring 2019	*97*	*80.77*	*7.84*	*56.68*	*98.14*
Summer 2019	*48*	*82.65*	*8.05*	*64.74*	*96.82*
Fall 2019	*87*	*76.21*	*10.48*	*39.26*	*98.99*
***F*-value = 9.811**	*df = 229, 2*	*p-value = 0.000*			

Marketing Research

Semester	N	Mean	SD	Minimum	Maximum
Spring 2019	*50*	*80.31*	*7.64*	*65.69*	*97.07*
Summer 2019	*7*	*85.02*	*3.35*	*81.50*	*92.17*
Fall 2019	*32*	*84.25*	*4.82*	*74.33*	*94.67*
***F*-value = 4.334**	*df = 86, 2*	*p-value = 0.016*			

THE EFFECT OF GENDER ON ACADEMIC PERFORMANCE IN STATISTICS-RELATED COURSES

We used independent samples t-test to examine the differences in students' academic performance, i.e., the total score, between male and female students in both business statistics and marketing research courses each semester. The results from the t-tests are shown in Table 3. In the business statistics course, except for the Spring semester of 2019, where the average scores of female students (M_{Female} = 83.73, SD = 6.71) was significantly higher than that of male students (M_{Male}= 78.95, SD = 7.97), there were no significant differences between the average score of male students and that of female students in both summer and fall semesters of 2019. In the marketing research course, we did not find

any significant differences between the average score of male students and that of female students in any of the three semesters.

THE EFFECT OF ACADEMIC MAJOR ON ACADEMIC PERFORMANCE IN THE BUSINESS STATISTICS COURSE

We used One-way ANOVA to examine the differences in students' scores among different academic majors, i.e., Accounting, Finance, Information Systems, Management, and Marketing. Unfortunately, due to the lack of non-marketing students in the marketing research course each semester, we could only examine the effect of academic majors on students' scores in the business statistics course. The distribution of students from different academic majors in the business statistics course is shown in table 3.

Table 3. The T-Test Results for Academic Performances Between Males and Females in Both Courses

Business Statistics

Semester	Gender	N	Mean	SD	*t*-value	df	*p*-value
Spring 2019	*Male*	60	78.95	7.97	-3.046	95	0.003
	Female	37	83.73	6.71			
Summer 2019	*Male*	27	82.32	7.71	-0.314	46	0.755
	Female	21	83.06	8.65			
Fall 2019	*Male*	47	76.21	9.76	0.003	85	0.997
	Female	40	76.20	11.39			

Marketing Research

Semester	Gender	N	Mean	SD	*t*-value	df	*p*-value
Spring 2019	*Male*	25	78.75	7.55	-1.458	48	0.151
	Female	25	81.87	7.57			
Summer 2019	*Male*	4	85.54	4.63	0.441	5	0.678
	Female	3	84.33	0.50			
Fall 2019	*Male*	19	83.74	5.01	-0.723	30	0.475
	Female	13	85.00	4.61			

The results from one-way ANOVA revealed a significant effect of academic major on students' scores in the business statistics course, $F(4, 227) = 5.471$, $p = 0.000$. The results imply that there are differences in the students' scores based on their academic major. A post hoc Tukey test revealed that the average score of accounting students ($M_{Accounting} = 85.24$, $SD = 7.04$) was significantly higher than the rest. In contrast, the average scores of marketing students ($M_{Marketing} = 77.09$, $SD = 9.39$) were significantly lower than the rest. The one-way ANOVA results are shown in Table 5.

Table 4. Student (Business Statistics Only) Distribution Based on Academic Majors

Business Statistics

	Accounting	Finance	Information Systems	Management	Marketing	Total
Spring	*12*	*10*	*7*	*35*	*33*	*97*
Summer	*10*	*8*	*3*	*11*	*16*	*48*
Fall	*11*	*9*	*9*	*27*	*31*	*87*
Total	*33*	*27*	*19*	*73*	*80*	*232*

Table 5. One-way ANOVA Results for Academic Performances on Majors in Business Statistics

Business Statistic

Major	N	Mean	SD	Minimum	Maximum
Accounting	*33*	*85.24*	*7.04*	*67.99*	*96.82*
Finance	*27*	*81.77*	*7.93*	*67.38*	*96.93*
Information Systems	*19*	*79.30*	*8.10*	*65.98*	*95.42*
Management	*73*	*78.59*	*9.75*	*39.26*	*98.99*
Marketing	*80*	*77.09*	*9.39*	*56.96*	*98.14*
***F-value* = 5.465**	*df = 227, 4*		*p-value = 0.000*		

PART 2. DEPENDENT VARIABLE – ATTITUDE TOWARD STATISTICS AND ITS PERCEIVED VALUE

In part 1, we examined the effects of gender and major on students' academic performance, i.e., students' scores. In part 2, we examine the effect of gender and major on students' attitude toward statistics and its perceived value (worth).

THE EFFECT OF GENDER ON ATTITUDE TOWARD STATISTICS AND PERCEIVED WORTH

We used independent samples t-test to examine the differences between male and female students regarding their attitude toward statistics and perceived statistics worth. We first examined the effect of gender on both dependent variables in both the business statistics and marketing research courses combined and then in each course separately. In the combined scenario, the effect of gender is not significant on both attitude toward statistics (*p*-value = 0.111) and perceived statistics worth (*p*-value = 0.192). We found no significant effect of gender on both dependent variables when examining both the business statistics course and the marketing research course individually. The independent samples t-test results are shown in Table 6.

Table 6. Gender on Attitude Toward Statistics

Course	Gender	N	Mean	SD	*t*-value	df	*p*-value
Combined (N = 321)	*Male*	*182*	*3.79*	*0.67*	*1.598*	*319*	*0.111*
	Female	*139*	*3.66*	*0.79*			
Business Statistics (N = 232)	*Male*	*134*	*3.80*	*0.65*	*0.970*	*230*	*0.333*
	Female	*98*	*3.71*	*0.75*			
Marketing Research (N = 89)	*Male*	*48*	*3.74*	*0.71*	*1.348*	*87*	*0.181*
	Female	*41*	*3.52*	*0.86*			

Gender on the Perceived Statistics Worth

Semester	Gender	N	Mean	SD	*t*-value	df	*p*-value
Combined (N = 321)	*Male*	*182*	*3.76*	*0.84*	*1.307*	*319*	*0.192*
	Female	*139*	*3.64*	*0.85*			
Business Statistics (N = 232)	*Male*	*134*	*3.82*	*0.84*	*0.902*	*230*	*0.368*
	Female	*98*	*3.72*	*0.85*			
Marketing Research (N = 89)	*Male*	*48*	*3.59*	*0.71*	*0.880*	*87*	*0.381*
	Female	*41*	*3.43*	*0.84*			

THE EFFECT OF ACADEMIC MAJOR ON ATTITUDE TOWARD STATISTICS AND PERCEIVED STATISTICS WORTH

We used One-way ANOVA to examine the differences in students' attitudes toward statisticsand perceived statistics worth among different academic majors. The results from one-way ANOVA revealed significant effects of students' academic major on both attitude toward statistics, F (4, 316) = 2.724, p = 0.030, and perceived statistics worth, F (4, 316) = 2.738, p = 0.029. Unfortunately, the post hoc comparison using the Tukey test could not identify any majors that were significantly different from others in terms of both attitudes toward statistics and perceived statistics worth. However, upon close examination of the results, we observed a consistent pattern in both attitudes toward statistics and perceived statistics worth scenarios. In the first scenario, management and marketing majors appeared to report the lowest attitudes toward statistics (*M*Management = 3.62, *SD* = 0.71; $M_{\text{Marketing}}$ = 3.68, *SD* = 0.71) while information system and finance majors reported the highest attitude toward statistics ($M_{\text{Information Systems}}$ = 4.00, *SD* = 0.59; M_{Finance} = 4.02, *SD* = 0.63). As mentioned earlier, we observed a similar pattern in the perceived statistics worth. Both management and marketing majors reported the lowest perceived statistics worth, ($M_{\text{Management}}$ = 3.64, *SD* = 0.86; $M_{\text{Marketing}}$ = 3.62, *SD* = 0.82), while the information systems majors reported the highest perceived statistics worth ($M_{\text{Information Systems}}$ = 4.15, *SD* = 0.66). The one-way ANOVA results are shown in Table 7.

Table 7. Major on Attitude Toward Statistics (N = 321)

Major	N	Mean	SD	Minimum	Maximum
Accounting	*33*	*3.83*	*0.79*	*1.85*	*5.00*
Finance	*28*	*4.02*	*0.63*	*2.92*	*5.00*
Information Systems	*20*	*4.00*	*0.59*	*2.77*	*4.85*
Management	*73*	*3.62*	*0.71*	*1.38*	*5.00*
Marketing	*167*	*3.68*	*0.71*	*1.38*	*5.00*
***F*-value = 2.724**	*df = 316, 4*	*p-value = 0.030*			

Major on the Perceived Statistics Worth (N = 321)

Major	N	Mean	SD	Minimum	Maximum
Accounting	*33*	*3.81*	*0.92*	*1.54*	*5.00*
Finance	*28*	*3.96*	*0.90*	*1.23*	*5.00*
Information Systems	*20*	*4.15*	*0.66*	*2.31*	*5.00*
Management	*73*	*3.64*	*0.86*	*1.62*	*5.00*
Marketing	*167*	*3.62*	*0.82*	*1.00*	*5.00*
***F*-value = 2.738**	*df = 316, 4*	*p-value = 0.029*			

We fitted a multiple linear regression model using the students' score as the dependent variable and their attitude toward statistics, perceived statistics worth, gender, and academic major as independent variables. The categorical variable gender has two categories (male and female), and female is coded as the reference category. Similarly, the categorical variable academic major has five categories (Accounting, Finance, Information Systems, Management, and Marketing), and the marketing major is coded as the reference category. The results from the multiple regression model are shown in Table 8.

Table 8. Multiple Regression Results

Predictor	*b*	SE	*t*-value	*p*-value
Intercept	*75.16*	*2.64*	*28.43*	*.000*
Attitude toward statistics	*-0.45*	*0.92*	*-0.48*	*.629*
Perceived statistics worth	*1.98*	*0.84*	*2.36*	*<.05*
Gender (Male)	*-1.82*	*0.97*	*-1.88*	*.061*
Accounting	*5.02*	*1.63*	*3.09*	*<.05*
Finance	*2.21*	*1.75*	*1.26*	*.208*
Information Systems	*-0.01*	*2.03*	*-0.00*	*.997*
Management	*-1.04*	*1.19*	*-0.87*	*.383*
F-value = 3.9254, *p*-value = 0.0004, N = 321				

The results indicate that the multiple linear regression model is significant at the five percent level of significance (F (7,313) =3.94, p-value<0.000). The attitude toward statistics is not significant at the

five percent level of significance. This implies that students' attitude is not a useful predictor to predict their scores. On the other hand, the perceived statistics worth is significant at the five percent level of significance. This implies that students' perceived statistics worth is a useful predictor to predict their scores. The coefficient of slope for the statistics worth tells us that for one unit increase in statistics worth, the students' score increases on average by 1.98 points. Furthermore, gender is not a significant predictor at the five percent level of significance. This implies that their scores cannot be predicted using gender as a predictor. This is consistent with our results from the independent samples t-test earlier, where we found that there is not a significant difference between male and female students in terms of their scores. Finally, the results from multiple regression analysis suggest that there is a significant difference between the scores of accounting and marketing (*t*-value =3.09, *p*-value=0.0022). The coefficient of slope for Accounting tells us that, on average, we expect that the student score would be 5.02 points higher than for a student majoring in accounting than a student majoring in marketing. This result is consistent with the one-way ANOVA results earlier, which showed that a significant difference exists between at least one pair of the academic majors (F (4,316)=2.724, *p*-value=0.030). The coefficient of slope for other majors is not statistically significant.

CONCLUSIONS AND DISCUSSION

Building a nation on robust STEM foundations requires all members of society have equitable access to STEM education. The United States is likely to enjoy a wider lead in the future of advancement with broader participation from diverse groups in the STEM-powered education and employment systems. There is a growing body of research that indicates diversity is essential in retaining talent, increasing productivity, better decision making, and for the growth of better-performing businesses (Catalyst, 2020). As stated earlier in the paper, there are some impediments to the equitable participation of diverse groups in STEM education and employment.

While the STEM jobs are likely to grow, the projections for applicants entering the field are much lower and hence the skills gap. According to ACT, the testing service, the percentage of high school graduates interested in STEM has remained at under 50 percent from 2012 to 2017. Millions of jobs in the STEM field are projected to go unfilled due to a lack of applicants. At the same time, the number of STEM jobs is projected to grow by 13 percent between 2018 and 2027 compared to about 9 percent for non-STEM jobs, while a similar report states that STEM-related occupations are expected to grow by about 10 percent between 2014 and 2024. The job and salary figures for STEM fields are generally higher compared to other fields (Barone, 2019). Job reports in the past have indicated the inability of companies to find STEM-skilled workers, and much of this was attributed to increasing disparity in the job skills gap (Oberoi, 2016). Only one out of every seven engineering professionals is female, and this gender gap in the STEM workforce correlates directly with a lower number of women involved in the academic communities in STEM (Phillips, 2017). While higher numbers of bachelor's degrees are awarded to women, their representation in STEM degrees is much lower, and it holds across all racial/ethnic groups. (National Center for Education Statistics, 2019).

This paper has analyzed the effect of Gender and Major on performance and attitude in Business Statistics using independent samples t-test and one-way ANOVA. Our results indicate that, in the business statistics course, except for the Spring semester of 2019, there were no significant differences between the average score of male students and that of female students in both summer and fall semesters of 2019. In the marketing research course, we did not find any significant differences between the average score of male students and that of female students in any of the three semesters. The results from one-way ANOVA imply that there are differences in the students' scores based on their academic major. In addition, the effect of gender is not significant on both attitudes toward statistics and its perceived value. Our results further suggest the significant effects of students'

academic major on both attitudes toward statistics and its perceived value. However, the post hoc comparison using the Tukey test could not identify any majors that were significantly different from others in terms of both attitudes toward statistics and its perceived value.

In this study, we found that there is no significant difference between male and female students in terms of their performance in statistics-related courses. These results suggest that both male and female students have an equal chance to excel in statistics-related courses in business school. At least in our sample, these results demystify the common belief that male students tend to do better than female students in math-oriented subjects. Therefore, one of our actionable findings is that educators should encourage more female students to enter the STEM areas.

There are limitations to this study. Although the sample size was large enough, the sample was taken from students in an undergraduate program at a business school. It could also be interesting to conduct the analysis for similar data from graduate programs. Despite this limitation, this attempt has demonstrated a relationship between students' gender and major on performance and attitude in business statistics. This exploratory study, in conjunction with similar studies, can contribute to understanding gender and attitudinal issues among students in business statistics courses. The idea is to understand whether or not impediments exist and find strategies to mitigate issues seen in other STEM subjects.

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