2006-510: A COMPARISON OF MALE AND FEMALE STUDENT ISSUES THAT AFFECT ENROLLMENT AND RETENTION IN ELECTRONICS AND COMPUTER ENGINEERING TECHNOLOGY PROGRAMS AT A FOR-PROFIT INSTITUTION

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A Comparison of Male and Female Student Issues that Affect Enrollment and Retention in Electronics Programs at a For-Profit Institution

Abstract

Women are underrepresented in the science, mathematics, engineering, and technology (SMET) work-force and in the undergraduate SMET programs at the colleges and universities in the United States of America. Studying the enrollment and retention issues of electronics students at a for-profit institution could improve the female enrollment and retention rates and help other colleges and universities increase their female student population which would help meet the future SMET work-force needs. The objective of this paper was to compare men and women in terms of self-confidence and self-efficacy as two of the dependent variables related to the enrollment and retention issues in electronics programs at a for-profit institution. The study used 2X3 factorial analysis of variance (ANOVA) and cell contrast tests in order to analyze the quantitative data.

Surveys were administered to 576 students in electronics programs at the for-profit institution's two campuses in the fall 2004 trimester. The response rate was 63.9%. For this paper, the survey instrument asked for information on self-confidence, self-efficacy, gender, program level, and age.

The research findings showed that there was no statistically significant interaction between gender and program levels in the for-profit institution's electronics programs in regard to self-confidence. Even though there was no significant main effect of program level, there was a significant main effect of gender on self-confidence. Male students had significantly higher self-confidence ratings than female students in the end program level, and the effect size was close to medium. The research findings indicated that there was no significant interaction between gender and program level in regard to self-efficacy. There was no significant main effect of gender or program level on self-efficacy, either.

The findings generally agreed with the literature review that females had significantly lower ratings than males in regard to self-confidence. The results of this study did not support the literature which indicated that self-efficacy was an issue for the retention of female students in undergraduate SMET programs. Neither did this study support past research that women pursuing undergraduate degrees in SMET fields showed more anxiety and, therefore, less self-efficacy than men did.

I. Introduction

Background and the Statement of the Research Problem

According to statistics taken after September 11, 2001, The United States Bureau of Labor Statistics[1] reports that the need for scientists and engineers is projected to increase at an annual rate of 6.4% between 2000 and 2010, with about 5 million jobs expected in 2010 in the fields of science, mathematics, engineering, and technology (SMET). Women, underrepresented

minorities, and persons with disabilities represented only about 20% of the workers in the SMET fields in 1997, although they constituted about 70% of the total work force (Commission on the Advancement of Women and Minorities in Science, Engineering, and Technology Development [CAWMSET])[2]. Despite an increase of women in SMET programs to 20% of total undergraduate enrollment, this number still falls short of the projected demand.

One key issue is the low enrollment of female students in undergraduate SMET programs, stemming from deficiencies in mathematics and science as well as low interest in these subjects at the pre-college level[2]. In a high quality peer reviewed journal published by American Society of Engineering Education (ASEE), Felder, Felder, Mauney, Hamrin, and Dietz drew from empirical studies over five consecutive semesters to conclude that the poor quality of SMET professors' teaching techniques and dissatisfaction with the SMET programs are other major issues related to the enrollment and retention of female students in undergraduate SMET programs[3]. According to these researchers, parental discouragement, male dominance, and stereotyping could have been major contributors to women's lack of self-confidence. Socio-economic status (SES) differences in secondary education can also affect the enrollment of post-secondary students in the United States. Anyon describes how the unequal opportunities created by SES can result in unequal success in school, leading to unfair advantages in obtaining decent employment[4].

DeVry University is one of the largest private higher education systems in North America and it offers career-oriented, technology-based undergraduate and graduate programs to 49,000 high school graduates and working adults through 65 locations throughout the United States and in Canada. In 1957, DeVry University started granting associate degrees in electronics engineering technology (EET) and in 1969 it became a bachelor's degree granting institution in the same discipline. DeVry University's second bachelor's degree program was introduced in 1979 as Computer Science for Business which was later renamed Computer Information Systems (CIS).

In order to meet the growing demand for business and technology programs, DeVry University introduced its bachelor's degree programs in business and telecommunications in the 1980s. Technical Management curriculum, followed by the introduction of the Information Technology, Computer Engineering Technology (CET), and Network Systems Administration Programs (NSA) were introduced in 1994, 1998, 1999, and 2002. In 2003, DeVry University started offering Biomedical Engineering Technology (BET), Biomedical Informatics, and Health Information Technology programs. Since 1987, DeVry University's Graduate School of Management has been offering master's degrees in business programs. Today Business Administration, Accounting and Financial Management, Human Resource Management, Information Systems Management, Project Management, Public Administration, and Network and Communications Management are offered nationwide and online as master's degree programs.

Studying the enrollment and retention issues of DeVry University's electronics students could improve the enrollment and retention rates of female students and of students from other colleges and universities, and thus help meet the work-force needs of the 21st century. The researcher studied the differences between male and female students with respect to self-confidence, self-efficacy and the impact of these factors on enrollment and retention in electronics programs at

DeVry University's Chicago area campuses. Since students' attitudes change during their college years, the researcher also studied the change during different program levels with respect to self-confidence and self-efficacy in electronics programs at DeVry University's Chicago area campuses.

Significance of the Study

Research has been conducted on the following variables that are relevant to the enrollment and retention of undergraduate female and male SMET students at colleges and universities other than DeVry University: (1) self-confidence; and (2) self-efficacy[2,3,8,9,11,13]. There is a gap in the research on the differences between male and female students from different program levels in terms of the above-mentioned variables. The researcher investigated the differences between male and female students in the electronics programs at DeVry University's Chicago area campuses in terms of self-confidence and self-efficacy. The study helped explain the low enrollment of female students and included recommendations on how to increase it. The results could also help female enrollment increase in undergraduate electronics and SMET programs at other DeVry University campuses, as well as at other colleges and universities. Only then may the work force demands for the 21st century predicted by the United States Bureau of Labor Statistic be met[1].

Delimitations

The sample for data collection is delimited to electronics students at DeVry University's Chicago area campuses. Electronics students are sampled from the five trimesters of Electronics and Computer technology (ECT) and nine trimesters of EET/CET departments.

Research Questions

The following are the research questions for the proposed study:

1. On self-confidence:
    a. Is there a significant difference between the genders of students in electronics programs at DeVry University's Chicago area campuses in regard to self-confidence?
    b. Is there a significant difference between the program levels in electronics programs at DeVry University's Chicago area campuses in regard to self-confidence?
    c. Is there an interaction between the genders of students and the program levels in electronics programs at DeVry University's Chicago area campuses in regard to self-confidence?

2. On self-efficacy:
    a. Is there a significant difference between the genders of students in electronics programs at DeVry University's Chicago area campuses in regard to self-efficacy?
    b. Is there a significant difference between the program levels in electronics programs at DeVry University's Chicago area campuses in regard to self-efficacy?

c. Is there an interaction between the genders of students and program levels in electronics programs at DeVry University's Chicago area campuses in regard to self-efficacy?

II. Literature Review

The literature review will include the following main topics: (a) self-confidence; (b) self-efficacy; and (c) professional societies and mentoring. A review of the literature shows that the self-confidence and self-efficacy are relevant issues to the enrollment and retention of undergraduate female SMET students[2,3,8,9,11,13]. Professional societies and mentoring are the main topics for an optimal delivery system for enrollment and retention of female SMET students[2,3,13].

Self-Confidence

The issue of self-confidence affects female students' enrollment and retention in undergraduate SMET programs. Research found that self-confidence levels in SMET learning are different across race[5,6]. For example, in an empirical study focused on longitudinal data involving large nationally representative samples, African-American women were independent and assertive and in some situations they showed more self-confidence in SMET education than women from other races or ethnic groups[5]. According to a study sample drawn from high school and beyond (HSB) data set, compared to Hispanic men, Hispanic women lagged behind in self-confidence and performance in high school mathematics and science courses[6]. In the demanding chemical engineering program at North Carolina State University (NCSU), an empirical study over five consecutive semesters suggested that male students resented women students, parents discouraged daughters from enrolling in the program, and women perceived engineering as unfeminine[3]. All could have been major contributors to women's lack of self-confidence and their tendency to stay away from chemical engineering programs.

An empirical study was conducted by Heyman, Martyna, and Bhatia at the University of California at San Diego in order to understand why fewer women than men enter, and more women than men leave the engineering fields[7]. The results showed that women were more inclined than men to believe that achievement in engineering relates to their fixed abilities, and when faced with difficulties they tend to leave the engineering programs[7]. A study of the Women in Engineering (WIE) program at the University of Washington (UW) found that many women lost interest in SMET and changed majors during the first two years[8]. Women's self-confidence measured by the responses to surveys, dropped significantly after their freshmen year ($p < .001$). One-fourth of women who stayed in the program reported a lack of self-confidence, which doubled by their senior year in SMET programs[8].

Contrary to the above-mentioned research, two recent nationwide empirical studies by Huang et al. in two National Center for Education Statistics (NCES) reported that the issue of self-confidence for women was not a statistically significant predictor for the completion of SMET degrees[9]. Tobias's experimental findings were based on the open-ended interviews with seven successful men and women in other fields than SMET, who took one semester of mathematics and science courses of their choice[23]. According to Tobias, lack of pre-college mathematics and

science interest and mentoring, lack of cooperative and interactive ways of teaching seem to be the reasons for the low enrollment and attrition of women in the mathematics and science programs[23]. Mentors, advisors, elementary and secondary teachers must help students increase their interest so that a larger proportion of students including women with low self-confidence will be prepared for the mathematics and science fields in college. Tobias[23] further stated, "Most importantly, the science faculty must find a way to provide the welcome and success nontraditional science students require in the classroom" (p.88). In order to increase success, policy must be recommended and implemented to expose middle and high school students continuously to higher levels of mathematics.

According to Huang et al., the retention rate of female students to graduation overall is higher than that of male students[9]. At Georgia Southern University, rate of participation, commitment to major, and achievement were similar for upper-class SMET male and female undergraduate students; intention to enroll in graduate school was significantly higher for females than males, and confidence in major/career was significantly greater for males than females[22]. For women, having the self-confidence to enroll in SMET fields also relates to their perception of traditional versus changing gender roles[9]. Research shows conflicting views with respect to the reason that women major in SMET.

According to Ware and Lee, women who have strong career commitments are more likely to stay in SMET fields[6]. On the contrary, Maple and Stage report that women with strong career aspirations are more likely to switch from majoring in SMET[10]. Reading Maple and Stage's report could lower the self-confidence of women and dissuade them from majoring in SMET. An ethnographic study was conducted over three years (1990-1993) with 335 students at seven 4-year institutions, where about 75% of the data were collected by interviews and 25% in focus groups[11]. In this study, women and minorities who take advanced placement (AP) mathematics and science courses in high school develop strong academic self-confidence at the college level, whereas students who don't take advanced courses in high-school are overwhelmed and switch to other majors or drop out of college[11].

Self-Efficacy

Self-efficacy describes a person's belief in his or her abilities and is important in exploring ways of teaching and advising female students. According to Bandura, self-efficacy depends on performance, observing and learning from others, encouragement, and freedom from anxiety[12]. The reasons that self-efficacy is an issue for the retention of female students in undergraduate SMET are: scarcity of role models for encouragement and verbal support, lack of academic advising, and professors not giving practical examples to explain the theories presented in class[13]. Women pursuing undergraduate degrees in SMET fields showed more anxiety and, therefore, less self-efficacy than men did[3]. The belief that a woman loses her femininity if she enters the SMET fields may not be valid[14]. According to Mathias-Riegel, counselors do not have enough knowledge about engineering and technology to mention appealing factors such as companies that offer flexibility in work hours[14]. Hence, they don't discuss these fields with female students, who remain unaware of them. Tharp concluded that education, professional, and personal support affected women's self-efficacy[15]. As a result of overcoming barriers such as isolation and sexual harassment, women's self-efficacy increased.

Professional Societies and Mentoring

Professional societies and mentors help women raise self-confidence and self-efficacy levels. Women's professional societies and minority programs that arrange accomplishment-praising recognition events and present role models who provide verbal and emotional support help female students raise their self-efficacy levels[13]. WIE society members encourage one another to stay in SMET through participation in internships, coop programs, and conferences at Purdue University[2]. The WIE program helps female students with interactive workshops, where faculty and teaching assistants learn methods for instructional delivery. Muller, Dokter, Ryan-Alapati, and Mueller found that 95% of the women who used MentorNet, which is an E-Mentoring network, persisted in SMET fields[16]. Role models are presented to discourage stereotyping; students engage in hands-on experiences with computers and other devices; and students participate in social and educational activities that raise self-confidence and self-efficacy[2]. The Society of Women Engineers (SWE) and the American Society of Engineering Education (ASEE) are also national organizations that excel in mentoring and professional assistance. Kids in College (KIC) is a program sponsored by CSU's College of Applied Human Sciences at Fort Collins that invites students from elementary and secondary schools to take courses such as Funky CAD Design, Making Multimedia, Robotics, and Viz-ware Techno Drawing[17]. Through KIC females can get exposed to mathematics and science at an early age which could encourage them to pursue SMET fields in college.

III. Method

Variables

Gender and program level were the two independent variables (IV). Male and female were the two levels of gender, and program level had three categories: beginning (B), middle (M), and end (E) of the electronics programs. Table 1 displays that the B level was the first two trimesters of the ECT or the first three trimesters of the EET/CET programs. The M level was the third trimester of the ECT or the fourth through sixth trimesters of the EET/CET programs. The E level was the fourth and fifth trimesters of the ECT or the seventh through ninth trimesters of the EET/CET programs. The reason for separating B and M program levels was the leveling off of student attrition after the first two trimesters of the ECT or the first three trimesters of the EET/CET programs. Since ECT students start working on their senior projects during their 4th,

Table 1
Program Level and Trimester of Electronics Programs in DeVry University's Chicago Area Campuses

Program Level	ECT Trimester	EET/CET Trimester
Beginning (B)	1, 2	1, 2, 3
Middle (M)	3	4, 5, 6
End (E)	4, 5	7, 8, 9

and EET/CET students during their 7th trimesters, separating M and E program levels at these trimesters was logical.

For the two research questions there were two dependent variables (DV) as follows: self-confidence and self-efficacy. Most of the questions used seven-point Likert scales, ranging from 1 = Strongly Disagree (SD) to 7 = Strongly Agree (SA).

Population

Surveys were administered to 576 students in electronics programs at DeVry-Chicago and DeVry-Tinley Park campuses in the fall 2004 trimester. The members of the participating student population came predominantly from African-American, East-European, Hispanic, and Asian backgrounds. They were usually first- or second-generation American citizens. Since they were usually the first in their families who have had the opportunity to attend college, their family and educational backgrounds were similar.

Instrument

For this paper, the instrument consisted of 15 items with Likert scales and 8 items on personal and demographic information. These questions are attached as Appendix A. The researcher developed all the questions except for the ten questions related to self-efficacy that were taken directly from the General Self-Efficacy Scale (GSE) developed by Jerusalem and Schwarzer[18]. The researcher adapted five questions for self-confidence from the Women in Engineering Programs and Advocates Network (WEPAN) Student Experience Survey[19]. Table 2 shows the measures and the survey questions related to each measure.

Each measure was based on Likert scale and/or personal/demographic questions. The seven levels of the Likert scale were: 1 = Strongly Agree (SA), 2 = Disagree (D), 3 = Mildly disagree (MD), 4 = Neither agree nor disagree (N), 5 = Mildly agree (MA), 6 = Agree (A), and 7 = Strongly agree (SA).

Table 2

Measures and the Related Questions

Measures	Questions
Self-Confidence	1-5
Self-Efficacy	6-15
Gender, Trimester Enrolled, Age	16-18

The dissertation committee comprised a panel of experts who reviewed the questionnaire and established content validity of the instrument. The review involved feedback on how well the survey questions might measure the variables of self-confidence self-efficacy, gender, trimester enrolled and age.

The researcher conducted a pilot test of the instrument at DeVry-DuPage campus, which is one of the three DeVry University's Chicago area campuses. To determine the reliability of the instrument, Cronbach's alphas were calculated as the internal consistency coefficients for the summated scales. The researcher repeated the reliability test after the data collection. Table 3 is the summary of the summated scales with the associated questions, corresponding alphas for the pilot and actual studies.

Table 3

Original Summated Scales, Related Questions, and Cronbach's Alphas for Pilot and Actual Studies

Original Summated Scales	Questions	Cronbach's Alphas for Pilot Study	Cronbach's Alphas for Actual Study
Self-Confidence	1-5	.79	.72
Self-Efficacy	6-15	.86	.85

Data Collection Procedure

After the Human Research Committee's approval, Dean of Electronics sent the recruitment e-mail to electronics faculty at DeVry-Chicago and DeVry-Tinley Park campuses requesting 10-15 minutes of their class time to administer the survey. After communicating with the faculty, the researcher administered the questionnaires to 576 electronics students at DeVry-Chicago and DeVry-Tinley Park campuses. One class from each trimester in ECT, EET and CET programs per campus was selected in order to ensure an adequate number of female responses for data analysis. Since most students from the same cohort take the same courses in a given trimester, the researcher had the choice of selecting classes to survey according to the number of females present in class, class instructor's and researcher's availability, and time of the day.

Participants completed the questionnaires anonymously to ensure the confidentiality of the information and placed them in individual envelopes, which they themselves sealed. The researcher and/or the class instructor placed all the sealed envelopes in a larger envelope. All the instructors returned the sealed large envelopes to the researcher.

After the data collection, all data were entered into the SPSS data editor with the variables defined. All surveys were numbered by the SPSS data editor. The researcher used the course number including the major of the students surveyed in order to code the trimester information into program levels. Table 4 shows frequencies and percentages of gender and program level of the participants.

Table 4

Frequencies and Percentages of Gender and Program Level (N = 576)

	Male		Female		Total	
Program Level	*N*	*%*	*N*	*%*	*N*	*%*
Beginning (B)	168	84.8	30	15.2	198	100.0
Middle (M)	122	80.3	30	19.7	152	100.0
End (E)	183	82.1	40	17.9	223	100.0
Total	473	82.5	100	17.5	573	100.0

Data Analysis

Data analysis is composed of two parts: (1) descriptive statistics, and (2) quantitative inferential analyses. The first part is the descriptive statistics for the demographic data and the dependent variables involved in the study. Frequencies and percentages were the methods used to report descriptive statistics as the first part of the data analysis.

In the quantitative inferential analyses section, the design classification was a 2 x 3 factorial analysis of variance (ANOVA) as the method of inferential statistics to answer the first set of three questions related to self-confidence. Since there were two DVs, the researcher needed two of the 2 x 3 factorial ANOVAs to answer the two sets of questions. Each ANOVA table gave the statistical significance and interaction of the variables and the researcher computed R squared and eta squared to interpret the effect sizes[20].

For each of the two research questions, the researcher explored first if there was an interaction between gender and program level in regard to the dependent variable. If the interaction was statistically significant, the interaction was examined first, and then the main effects of gender and program level were investigated. If there was a statistically significant main effect of gender, then cell contrast tests were performed in order to identify which simple effects of gender were statistically significant at each category of program level[21]. If the interaction was not statistically significant, the main effects were examined first, followed by cell contrast tests.

IV. Results

Descriptive Statistics

Demographic data of participants' gender, program level, and age was collected through questions 16-18 of the survey. Questions 1-15 measured self-confidence and self-efficacy of the participants. Frequencies and percentages were the methods used to report descriptive statistics. Variations in sample size come from the fact that all students did not answer all the survey questions. As a result, different sample sizes are described in each dependent variable.

Table 5 shows that there were 475 male and 101 females in the sample. Of the 576 participants, 82.5% were males, and 17.5% were females. Of those who reported their program level, 34.6% were at the beginning, 26.5% were at the middle, and 38.9% were at the end program levels.

Table 5

Demographic Characteristics of Participants (N = 576)

Characteristic	N	%
Gender		
Male	475	82.5
Female	101	17.5
Program Level		
Beginning	198	34.6
Middle	152	26.5
End	223	38.9
Missing	3	
Age Group		
18-21	230	40.4
21-25	169	29.7
26-30	85	14.9
31-40	52	9.1
41 and up	33	5.8
Missing	7	

The majority (85%) of participants were between the ages of 18 and 30, with approximately half (40.4%) in the first group (18-21 years), nearly one-third (29.7%) in the second group (21-25 years), and about one-sixth (14.9%) in the third group (26-30 years). Close to 15% of participants were between the ages of 31 and 40 (9.1%), or 41 and older (5.8%). Table 5 shows frequencies and percentages of each gender and program level of the participants.

Self-Confidence

Table 6 presents ratings for self-confidence of students in DeVry University's electronics programs at the Chicago area campuses. Self-confidence measures the student's self-perceived abilities in mathematics, physics, electronics and computer technology. Students who scored "mildly agree" (5) and higher fall under "% Agree" column, and the "% Disagree" column includes ratings of "mildly disagree" (3) and below. On the summated scale, of the 576 students, 79% indicated that they had some degree of self-confidence in mathematics, physics, electronics, and computer technology, while 6.9% indicated they did not. The mean rating of 5.53 was about half way between "mildly agree" (5) and "agree" (6).

Table 6
Frequencies, Percentages, Means, Standard Deviations for Summated Self-Confidence Ratings

Rating	*N*	% Agree	% Disagree	*M*	*SD*
Summated Self-Confidence	576	79.0	6.9	5.53	.95
Math/Physics Confidence	571	84.1	9.5	5.57	1.37
Math/Physics Confidence Increase	566	74.6	11.3	5.31	1.53
Electronics Confidence	569	82.6	8.8	5.40	1.27
Electronics Confidence Increase	575	85.0	6.1	5.73	1.29
Confidence in Major	574	81.7	6.8	5.66	1.38

Note. Ratings based on a scale of 1 to 7 with 1 = strongly disagree, 2 = disagree, 3 = mildly disagree, 4 = neither agree nor disagree, 5 = mildly agree, 6 = agree, and 7 = strongly agree.

Self-Efficacy

Table 7 presents ratings for self-efficacy of students in DeVry University's electronics programs at the Chicago area campuses. Self-efficacy measures the student's perception of his/her abilities to solve difficult problems, deal efficiently with unexpected events, accomplish goals, and remain calm when facing difficulties. On the summated scale, of the 576 students, 85.2% indicated some self-efficacy in mathematics, physics, electronics, and computer technology, while 1.2% indicated they did not. The mean rating of 5.68 was closer to "agree" (6) than "mildly agree" (5). The two highest mean

Table 7
Frequencies, Percentages, Means, Standard Deviations for Summated Self-Efficacy Ratings

Rating	*N*	% Agree	% Disagree	*M*	*SD*
Summated Self-Efficacy	576	85.2	1.2	5.68	.69
Solve Hard Problems	573	93.9	3.5	6.10	1.04
Get What I Want	573	73.8	4.0	5.33	1.20
Achieve Goals	573	84.5	7.0	5.51	1.15
Deal Efficiently	575	87.5	4.5	5.63	1.07
Handle the Unforeseen	574	84.0	3.1	5.50	1.08
Solve Most Problems	573	84.5	4.5	6.21	.82
Calm Facing Difficulties	563	79.6	8.7	5.39	1.40
Solutions While Confronting	574	89.9	3.8	5.59	.97
Solutions While in Trouble	572	93.0	1.0	5.81	.90
Handle Whatever Comes	573	91.1	2.4	5.74	.99

Note. Ratings based on a scale of 1 to 7 with 1 = strongly disagree, 2 = disagree, 3 = mildly disagree, 4 = neither agree nor disagree, 5 = mildly agree, 6 = agree, and 7 = strongly agree.

ratings were "solve hard problems" ($M = 6.10$) and "solve most problems" ($M = 6.21$). The two lowest mean ratings were "calm facing difficulties" ($M = 5.39$) and "get what I want" ($M = 5.33$).

Quantitative Inferential Analyses

Research Question 1

Gender and program level are the two independent variables used in all the research questions. Gender contains two levels, male and female; and program level has three categories: beginning (B), middle (M), and end (E) of the electronics programs. Self-confidence is the dependent variable in this research question, which measures the student's abilities in mathematics, physics, electronics and computer technology in DeVry University's electronics programs at the Chicago area campuses.

The researcher performed a 2 x 3 factorial ANOVA test for self-confidence as a function of gender and program levels. Table 8a shows the means and standard deviations for the program levels by gender. Table 8b indicates that there was no significant interaction between gender and program levels ($p = .978$). Since there was not a significant interaction, the profile plot shows approximately parallel lines for male and female (see Figure 1).

Even though there was no significant main effect of program level, $F\ (2,567) = 1.06$, $p = .349$, there was a significant main effect of gender on self-confidence, $F\ (1,567) = 10.28$, $p = .001$. Males had 0.33 points higher average rating than females in self-confidence (see Table 8a). Eta for gender was 0.134, which according to Cohen, is a small effect size[24].

Table 8a
Means and Standard Deviations for Self-Confidence as a Function of Gender and Program Level

	Male			Female			Total	
Program Level	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*
Beginning	5.51	.95	168	5.15	1.25	30	5.46	1.01
Middle	5.68	.89	122	5.36	1.29	30	5.62	.99
End	5.60	.86	183	5.28	.84	40	5.54	.87
Total	5.59	.90	473	5.26	1.10	100	5.53	.95

Cell contrast tests were performed in order to identify which simple effects of gender (male versus female) were statistically significant at each category of program level (beginning, middle, and end). Since Levene's test of equality of error variances was significant, the researcher used equal variances not assumed in the contrast tests. Contrast tests revealed that there was a significant difference between male and female students in the end program level in terms of self-confidence. Male students had significantly higher self-confidence ratings than female students, $t\ (58.61) = 2.19$, $p < 0.05$. Mean difference (MD) between the males and

females in the end program level was 0.32, the pooled standard deviation was 0.85, and the effect size, d = .32/.85 = .38, which according to Cohen, is close to medium effect size[24]. There were no significant differences between males and females in the beginning program level, and between males and females in the middle program level, in regard to self-confidence.

Table 8b
Two-Way Analysis of Variance for Self-Confidence as a Function of Gender and Program Level

Variance and Source	*df*	*MS*	*F*	η^2
Self-Confidence				
Gender	1	9.16	10.28**	.018
Program Level	2	.94	1.06	.004
Gender*Program Level	2	.02	.02	.000
Error	567	.89		

** p = .001

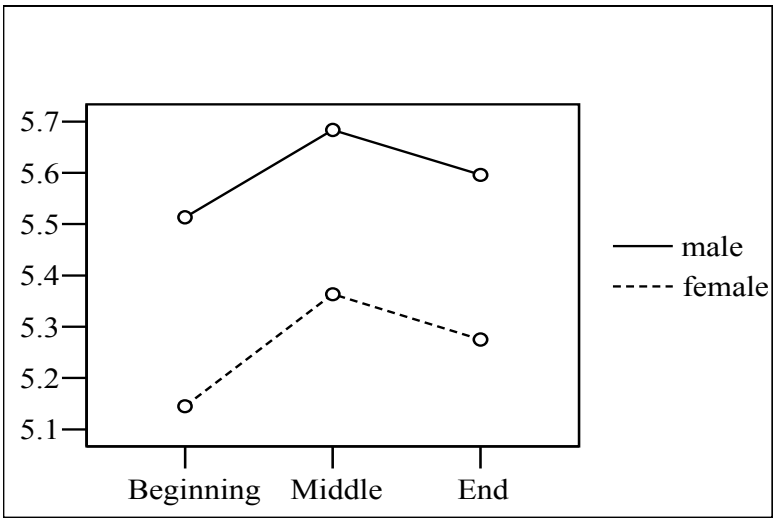

Figure 1. Plot of three simple effects on self-confidence.

Research Question 2

Self-efficacy is the dependent variable, which measures the student's perception of his/her abilities to solve difficult problems, deal efficiently with unexpected events, accomplish goals, and remain calm when facing difficulties.

The researcher performed a 2 x 3 factorial ANOVA test for self-efficacy as a function of gender and program level. Table 9a shows the means and standard deviations for the program levels by gender. Table 9b indicates that there was no significant interaction between gender and program level (p = .955). There was no significant main effect of gender or program level on self-efficacy, either.

Table 9a

Means and Standard Deviations for Self-Efficacy as a Function of Gender and Program Level

	Male			Female			Total	
Program Level	*M*	*SD*	*n*	*M*	*SD*	*N*	*M*	*SD*
Beginning	5.62	.72	168	5.72	.67	30	5.63	.71
Middle	5.65	.63	122	5.80	.72	30	5.68	.65
End	5.71	.69	183	5.82	.64	40	5.73	.68
Total	5.66	.69	473	5.79	.67	100	5.68	.68

Table 9b

Two-Way Analysis of Variance for Self-Efficacy as a Function of Gender and Program Level

Variance and Source	*df*	*MS*	*F*	η^2
Self-Efficacy				
Gender	1	1.24	2.65	.005
Program Level	2	.27	.59	.002
Gender*Program Level	2	.02	.05	.000
Error	567	.47		

V. Discussion

Research Question 1

Summary of Research Question 1 Findings

The research findings showed that there was no statistically significant interaction between gender and program levels in DeVry University's electronics programs in regard to self-confidence. Even though there was no significant main effect of program level, there was a significant main effect of gender on self-confidence. A significant difference was found between male and female students in the end program level in terms of self-confidence. Male students had significantly higher self-confidence ratings than female students in the end program level, and the effect size was close to medium.

Both female and male self-confidence levels increased slightly at the end program level compared to the beginning program level. In general, females were almost as self-confident as males; their self-confidence levels were not significantly lower except at the end of their program. On a 0-7 Likert scale, the mean rating of 5.53 was about half way between "mildly agree" (5) and "agree" (6). Of the 475 male and 101 female students, 14.3% of the females and 5.6% of the males and 6.9% of the 576 students, indicated that they, to some degree, lacked self-confidence.

Discussion of Research Question 1

The results of this study generally supported the findings that women who stayed in the SMET programs reported low ratings for self-confidence[8]. Even though the current results were not consistent with Brainard and Carlin's findings that women's self-confidence dropped significantly after their freshmen year, in general, they agreed with Brainard and Carlin's results that women's self-confidence increased toward their senior years. In previous literature, women pursuing undergraduate degrees in SMET showed less self-confidence than men did[3,7,22].

One reason that females had significantly lower self-confidence ratings than males in the end program level may be that the number of females is larger in the end ($N = 40$) than the beginning or middle program levels ($N = 30$ each). That along with lower variability of the females in the end ($SD = .84$) than the beginning ($SD = 1.25$) or middle ($SD = 1.29$) program levels may cause the difference between males and females to be significant on self-confidence ratings in the end program level.

Research Question 2

Summary of Research Question 2 Findings

The research findings indicated that there was no significant interaction between gender and program level in regard to self-efficacy. There was no significant main effect of gender or program level on self-efficacy, either.

Discussion of Research Question 2

The results of this study did not support the literature which indicated that self-efficacy was an issue for the retention of female students in undergraduate SMET programs[13]. Neither did this study support past research that women pursuing undergraduate degrees in SMET fields showed more anxiety and, therefore, less self-efficacy than men did[3]. Observing and learning from others, receiving encouragement from professors, classmates, and others may have freed DeVry University's female students from anxiety, and raised their self-efficacy.

Recommendations for Future Research

All the results in this study used students' self-perceptions of their self-confidence, self-efficacy, and other variables. Self-perceptions can be different than the real data. The researcher recommends a comparison of students' self-perceptions with their actual grades in college for a future study.

In order to explore further the difference between the males and females in terms of the dependent variables that affect enrollment and retention in electronics, the researcher recommends replication of the current study for technology and business programs at DeVry University. Race can be included as the third independent variable or it can be considered in other studies. The research should include the comparison of females in electronics versus technology/business programs.

Further research is needed to compare the males and females in all SMET fields at other colleges and universities in terms of the dependent variables that affect enrollment and retention. The current study can be repeated for different SMET fields and universities. Race can be included as a third independent variable or it can be considered in other studies. The research should include the comparison of females in different SMET programs at different universities.

Finally, the researcher recommends further research on the retention of females versus males in the electronics programs at DeVry University.

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APPENDIX A

Student Questionnaire

Thank you for taking the time to fill out this questionnaire. Your honest response is extremely important; all responses will be kept confidential and anonymous.

1 = Strongly disagree (SD)
2 = Disagree (D)
3 = Mildly disagree (MD)
4 = Neither agree nor disagree (N)
5 = Mildly agree (MA)
6 = Agree (A)
7 = Strongly agree (SA)

For questions 1-15, please circle the number that best describes your experiences.

	SD	D	MD	N	MA	A	SA
1. I am confident in my abilities in math and physics courses.	1	2	3	4	5	6	7
2. My self-confidence in math and physics has increased since I entered DeVry University.	1	2	3	4	5	6	7
3. I am confident in my abilities in electronics or computer engineering technology courses.	1	2	3	4	5	6	7
4. My self-confidence in electronics has increased since I entered DeVry University.	1	2	3	4	5	6	7
5. I am confident that electronics or computer engineering technology is the right major for me.	1	2	3	4	5	6	7
6. I can always manage to solve difficult problems if I try hard enough.	1	2	3	4	5	6	7
7. If someone opposes me, I can find the means and ways to get what I want.	1	2	3	4	5	6	7
8. It is easy for me to stick to my aims and accomplish my goals.	1	2	3	4	5	6	7
9. I am confident that I could deal efficiently with unexpected events.	1	2	3	4	5	6	7
10. Thanks to my resourcefulness, I know how to handle unforeseen situations.	1	2	3	4	5	6	7
11. I can solve most problems if I invest the necessary effort.	1	2	3	4	5	6	7
12. I can remain calm when facing difficulties because I can rely on my coping abilities.	1	2	3	4	5	6	7
13. When I am confronted with a problem, I can usually find several solutions.	1	2	3	4	5	6	7
14. If I am in trouble, I can usually think of a solution.	1	2	3	4	5	6	7
15. I can usually handle whatever comes my way.	1	2	3	4	5	6	7
16. Gender □ Male □ Female							
17. I am a ____ trimester student at DeVry University. □ 1st □ 2nd □ 3rd □ 4th □ 5th □ 6th □ 7th □ 8th □ 9th							
18. My age category is: □ Under 18 □ 18-21 □ 21-25 □ 26-30 □ 31-40 □ 41 and up							