DISSERTATION

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

Submitted by

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In partial fulfillment of the requirements

For the Degree of Doctor of Philosophy

Colorado State University

Fort Collins, Colorado

Fall 2005

UMI Number: 3200652

COLORADO STATE UNIVERSITY

August 22, 2005

WE HEREBY RECOMMEND THAT THE DISSERTATION PREPARED UNDER OUR SUPERVISION BY ARAM AGAJANIAN ENTITLED 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 BE ACCEPTED AS FULFILLING IN PART REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY.

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ABSTRACT OF DISSERTATION

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

The objective of this dissertation was to compare men and women in terms of variables related to enrollment and retention issues in electronics and computer engineering technology programs at DeVry University's Chicago area campuses. The study used 2 x 3 factorial ANOVA and multiple regression in order to analyze the quantitative data.

Surveys were administered to 576 students in electronics programs at DeVry University's Chicago and Tinley Park campuses in the fall 2004 trimester. The response rate was 63.9%. The survey instrument asked for information on the 11 dependent variables, gender, program level, and age. The instrument also asked two open-ended questions about students' pre-college mathematics/science and electronics interests and how DeVry experience impacted them.

The results revealed that females had significantly lower ratings than males in terms of: (a) self-confidence, (b) pre-college encouragement, (c) pre-college consideration to apply for electronics, and (d) household income. Statistical analyses also indicated significant differences for program level in regard to: (a) satisfaction with electronics programs and (b) pre-college encouragement. Significant interactions of gender and program level were found in terms of parents' education and pre-college encouragement.

Multiple regression analysis indicated that self-confidence; approachability, concern, and fairness of the electronics professors; female gender; and beginning program level combine to be significant predictors of satisfaction with electronics programs.

The findings generally agreed with the literature review that females had significantly lower ratings than males in regard to the following: (a) self-confidence, (b) pre-college encouragement, and (c) pre-college consideration to apply for electronics programs. In general, the results supported recent previous literature that there were no significant differences between males and females in terms of: (a) pre-college mathematics/science interest and grades and (b) years of mathematics/science in high school. The results generally did not support the previous literature that females report significantly lower ratings than males in regard to: (a) self-efficacy, (b) professors' approachability, concern, and fairness, and (c) satisfaction with electronics programs. The findings generally did not agree with the literature review that females rate professors' use of teamwork significantly more helpful than males.

The study concludes that lack of pre-college encouragement seems to be the most important reason for low female enrollment in electronics programs at DeVry and recommends ways to increase pre-college encouragement.

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DEDICATION

I dedicate this dissertation to my beloved wife, Ms. Tilda Agajanian, as a gift for our eighth wedding anniversary. Tilda has been providing me continuous encouragement, understanding, help, support, sacrifice, and unconditional love ever since I started pursuing a doctoral degree ten years ago. Especially for the last five-and-a-half years, as I spent many nights and weekends away from Tilda in order to work on my doctoral studies, she sacrificed her time helping and supporting me throughout this process. Without her commitment, I would not have been able to fulfill the requirements of the Ph.D.

I also dedicate this dissertation to my mother, Ms. Juliette Mavigoz, who encouraged me all my life to pursue education and excel in my studies. Her determination that her only child attends college and establishes residency in the United States, at the cost of her being left alone in Turkey for several years, is an outstanding example of sacrificial love.

I congratulate my grandmother, Ms. Maritza Mavigoz, who graduated from Euphrates American College and worked as an administrator at a hospital in Turkey in the early 1900's. Her example of being one of the few female role models who achieved higher education and pursued a career in administration inspired me to continue my education, become a professor, pursue my doctorate, and quench my desire for life-long learning.

I thank my mother's cousin, Mr. Joseph Arslan, and his wife, Mrs. Ayda Arslan, for their help and financial support during my undergraduate years in the United States and for their continuous love throughout the years. Mr. Joseph Arslan's receiving M.S. degrees from Istanbul and Cornell Universities and his successful career as a civil engineer have influenced my pursuit of electrical engineering as a career.

I am deeply grateful to my father-in-law and mother-in-law, Mr. and Mrs. Sarkis and Sella Girjigian for their continuous help, financial support, love, patience, perseverance and dedication during the last ten years.

Finally, I am very grateful to my friends, colleagues at DeVry University for their help, encouragement, time, love and patience.

ՁՕՆ

Աւարտաճառս կը ձօնեմ իմ սիրելի կնոջս Թիլտային մեր ամուսնութեան ութներրորդ տարելիցին առթիւ։

Տօքթօրայի դասերը սկսայ առնել տասը տարի առաջ։ Այդ ժամանակէն մինչեւ վկայական ստանալս Թիլտան զերմարդկային համբերութեամբ եւ անփոխարինելի զոհողութեամբ միշտ զօրավիգ կանգնեցաւ իմ աշխատանքներուս մէջ։ Այստեղ հպարտութեամբ կը յայտնեմ որ առանց Թիլտային սիրոյն եւ քաջալերանքին պիտի չկարենայի այս աստիճանին հասնիլ։

Այստեղ որդիական սիրով երախտապարտութիւնս կը յայտնեմ սիրելի մայրիկիս Տկն. Ժուլիէթ Մավիկէօզի, որուն քաջալերութեամբը ուսումս յառաջդիմութեամբ շարունակեցի եւ աւարտեցի։

Մայրիկիս փափաքն էր, իր մէկ հատիկ զաւակը համալսարան աւարտէր եւ Ամերիկա հաստատուէր, հոգ չէ որ ինք Պոլսոյ մէջ առանձին պիտի մնար։

Միշտ պիտի յիշեմ մեծմայրիկս Տիկ. Մարիձա Մավիկէոզը որ Եփրատի Ամերիկեան համալսարանը աւարտեց եւ իրր տնօրէնուհի աշխատեցաւ Խարբերդի հիւանդանոցին մէջ։ Մեծմօրս համալսարան վերջացնելը եւ իր յարատեւ աշխատանքը ինծի ներշնչեց որ համալսարան յաճախեմ, փրոֆէսէօր ըլլամ, տօքթօրայի աստիճան ստանամ, սորվիմ ու սորվեցնեմ կեանքիս մինչեւ վերջը։

Շատ շնորհակալ եմ մօրս զարմիկին Տիար Ժօզէֆ Արսլանին եւ իր կնոջ Տիկ. Այտա Արսլանին որ ինծի թէ նիւթականով եւ թէ բարոյականով օգնեցին համալսարանի տարիներուս ընթացքին Ամերիկայի մէջ եւ իրենց շարունակ սէրն ու գուրգուրանքը ցոյց տուին: Դր. Ժոզէֆ Արսլանին Պոլսոյ Թէքնիքական ու Ամերիկայի Քորնէլ Համալսարաններէն ստացած մաքիստրոսի աստիճանները եւ իր յաջող շենքի ճարտարապետական արուեստը ազդեցիկ եղաւ իմ ելեկտրականութեան ճարտարապետութեան հետեւելուս որոշումին վրայ:

Կը յայտնեմ սրտագին շնորհակալութիւններս իմ աներ հօրս ու աներ մօրս Տէր եւ Տկն. Սարգիս եւ Սելլա Կոճիկեաններուն որոնք իրենց նիւթական ու բարոյական օգնութիւնը հայթայթեցին, համբերեցին եւ անհուն սէր ու գուրգուրանք բաժնեցին իրենց զաւակներուն համահաւասար չափով եւ հասցուցին այս աստիճանիս:

Շնորհակալ եմ մտերիմ ընկերներուս եւ Տէվրայ Համալսարանի մէջ միասին աշխատած փրոֆէսէօրներուն որ միշտ իրենց օգնութիւնը, քաջալերութիւնը, ժամանակը, սէրն ու համբերութիւնը բաժնեցին ինծի հետ:

Յարգանքներով

Արամ Աղաճանեան

Օգոստոս 22, 2005

ACKNOWLEDGEMENTS

I would like to thank Dr. William Timpson, my advisor, for his approval of my dissertation topic, for his support and encouragement throughout the dissertation process. His advice before the content preliminary exams encouraged me to prepare for the exams, pass them successfully, and move on with the dissertation.

I am extremely grateful to Dr. George Morgan, my co-advisor, for his extraordinary dedication to daily communication and hands-on support, from the beginning to the end of my study. His expert advice in quantitative research methods, his inspiring methods of teaching the quantitative data analysis and interpretation course, and his extensive experience in dissertation writing support have motivated me to start, continue, and finish my dissertation.

My appreciation also goes to Drs. Gene Gloeckner and Barbara Wallner for their willingness to serve in my committee and provide support for my dissertation. Dr. Gloeckner's quantitative research methods course and research preliminary exams motivated me to select quantitative methods to analyze the data in my study. Dr. Barbara Wallner's experience with "Kids in College" and her suggestions for the literature review also helped me to expand on my dissertation.

I would like to thank Dr. Patrick Mayers for initiating the faculty academic sabbatical opportunities. I thank Drs. Gene Hallongren, John Gibbons, Stan Lan, and professor Patrick O'Connor for their approval of my taking the academic sabbatical so that I could work on my dissertation.

I am deeply indebted to all my CSU DeVry-Chicago cohort members, specifically Drs. Stan Lan, Catherine Carter, Ahmed Khan, Telly Courialis, and professors Sue Kyriazopoulos, David Loggins for their support during the times we took CSU core courses together and throughout my dissertation.

My special thanks also go to Drs. Gene Hallongren, John Gibbons , Stan Lan, Susan Friedberg; professors Nancy Mocek, Patrick O'Connor, Reda Elias, Joseph Booker, John Kronenberger, George Dean; and registrar Randy Green for helping me to administer the surveys for the pilot and actual data collection at DeVry University's Chicago, Tinley Park, and DuPage campuses.

Finally, I thank all the electronics and computer engineering technology professors and the students whose classes I visited in order to administer the surveys.

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CHAPTER 1: INTRODUCTION

Background and the Statement of the Research Problem

According to statistics taken after September 11, 2001, The United States Bureau of Labor Statistics (2001) 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], 2000). 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 (CAWMSET, 2000). In a high quality peer reviewed journal published by American Society of Engineering Education (ASEE), Felder, Felder, Mauney, Hamrin, and Dietz (1995) 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.

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 (1997) describes how the unequal opportunities created by SES can result in unequal success in school, leading to unfair advantages in obtaining decent employment.

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 (DeVry University, 2004). In 1957, DeVry 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'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 introduced its bachelor's degree programs in business and telecommunications in the 1980s (DeVry University, 2004). 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 started offering Biomedical Engineering Technology (BET), Biomedical Informatics, and Health Information Technology programs. Since 1987, DeVry University's Keller 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; professors' use of teamwork; approachability, concern, and fairness of electronics professors; pre-college mathematics and science interest level and grades; pre-college encouragement; pre-college consideration to apply for electronics; satisfaction with electronics programs; years of mathematics and science in high school; parents' education; and household income, and the impact of the above 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; self-efficacy; professors' use of teamwork; approachability, concern, and fairness of electronics professors; pre-college mathematics and science interest level and grades; pre-college encouragement; pre-college consideration to apply for electronics; satisfaction with electronics programs; years of mathematics and science in high school; parents' education; and household income, in electronics programs at DeVry University's Chicago area campuses.

Research Questions

Gender levels are male and female students and program levels are beginning (B), middle (M), and end (E) of the electronics programs. The B level is the first two trimesters of the electronics and computer technology (ECT) or the first three trimesters of the EET/CET programs. The M level is the third trimester of the ECT or the fourth through sixth trimesters of the EET/CET programs. The E level is the fourth and fifth trimesters of the ECT or the seventh through ninth trimesters of the EET/CET programs. 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?

3. On approachability, concern, and fairness of electronics professors in electronics programs at DeVry University's Chicago area campuses:

   a. Is there a significant difference between the genders of students in regard to approachability, concern, and fairness of electronics professors in electronics programs at DeVry University's Chicago area campuses?

   b. Is there a significant difference between the program levels in regard to approachability, concern, and fairness of electronics professors in electronics programs at DeVry University's Chicago area campuses?

   c. Is there an interaction between the genders of students and program levels in regard to approachability, concern, and fairness of electronics professors in electronics programs at DeVry University's Chicago area campuses?

4. On pre-college mathematics/science interest and grades:

   a. Is there a significant difference between the genders of students in electronics programs at DeVry University's Chicago area campuses in regard to pre-college mathematics/science interest and grades?

b. Is there a significant difference between the program levels in electronics programs at DeVry University's Chicago area campuses in regard to pre-college mathematics/science interest and grades?

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 pre-college mathematics/science interest and grades?

5. On student satisfaction with electronics programs:

    a. Is there a significant difference between the genders of students in electronics programs at DeVry University's Chicago area campuses in regard to satisfaction with electronics programs?

    b. Is there a significant difference between the program levels in electronics programs at DeVry University's Chicago area campuses in regard to satisfaction with electronics programs?

    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 satisfaction with electronics programs?

6. On pre-college years of mathematics and science in high school:

    a. Is there a significant difference between the genders of students in electronics programs at DeVry University's Chicago area campuses in regard to years of mathematics and science in high school?

    b. Is there a significant difference between the program levels in electronics programs at DeVry University's Chicago area campuses in regard to years of mathematics and science in high school?

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 years of mathematics and science in high school?

7. On parents' education:

    a. Is there a significant difference between the genders of students in electronics programs at DeVry University's Chicago area campuses in regard to parents' education?

    b. Is there a significant difference between the program levels in electronics programs at DeVry University's Chicago area campuses in regard to parents' education?

    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 parents' education?

8. On professors' use of teamwork:

    a. Is there a significant difference between the genders of students in electronics programs at DeVry University's Chicago area campuses in regard to professors' use of teamwork?

    b. Is there a significant difference between the program levels in electronics programs at DeVry University's Chicago area campuses in regard to professors' use of teamwork?

    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 professors' use of teamwork?

9. On pre-college encouragement:
    a. Is there a significant difference between the genders of students in electronics programs at DeVry University's Chicago area campuses in regard to pre-college encouragement?
    b. Is there a significant difference between the program levels in electronics programs at DeVry University's Chicago area campuses in regard to pre-college encouragement?
    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 pre-college encouragement?
10. On pre-college consideration to apply for electronics:
    a. Is there a significant difference between the genders of students in electronics programs at DeVry University's Chicago area campuses in regard to pre-college consideration to apply for electronics?
    b. Is there a significant difference between the program levels in electronics programs at DeVry University's Chicago area campuses in regard to pre-college consideration to apply for electronics?
    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 pre-college consideration to apply for electronics?
11. On household income:

a. Is there a significant difference between the genders of students in electronics programs at DeVry University's Chicago area campuses in regard to household income?

b. Is there a significant difference between the program levels in electronics programs at DeVry University's Chicago area campuses in regard to household income?

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 household income?

12. Is there a combination of self-confidence; self-efficacy; approachability, concern, and fairness of the electronics professors; pre-college mathematics/science interest and grades; years of mathematics/science in high school; parents' education; professors' use of teamwork; pre-college encouragement; pre-college consideration to apply for a career-oriented university; household income; genders of students; and program levels that predict student satisfaction with the electronics programs at DeVry University's Chicago area campuses better than any predictor alone?

Definitions of Terms

The following terms are used throughout the dissertation:

(1) Electronics Programs

In the electronics programs there are two departments at DeVry University's Chicago area campuses. The first one is Electronics and Computer technology (ECT), and the second one is the combined Electronics Engineering Technology (EET)/Computer Engineering Technology (CET) departments.

(2) Enrollment

Enrollment in the electronics programs at DeVry University's Chicago area campuses.

(3) Program Levels

Program levels are beginning (B), middle (M), and end (E) of the electronics programs. The B level is the first two trimesters of the electronics and computer technology (ECT) or the first three trimesters of the EET/CET programs. The M level is the third trimester of the ECT or the fourth through sixth trimesters of the EET/CET programs. The E level is the fourth and fifth trimesters of the ECT or the seventh through ninth trimesters of the EET/CET programs.

(4) Retention

Retention of students in the electronics programs at DeVry University's Chicago area campuses.

(5) Satisfaction

Student satisfaction with the electronics programs and professors, and career opportunities in electronics at DeVry University's Chicago area campuses.

(6) Self-Confidence

Student's perception of his or her abilities to be successful in electronics or computer engineering technology programs at DeVry University's Chicago area campuses.

(7) Self-Efficacy

Student's belief in his or her abilities to be successful in electronics or computer engineering technology programs at DeVry University's Chicago area campuses; it depends on performance, observing and learning from others, encouragement, and freedom from anxiety.

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 in ECT and nine trimesters of EET/CET departments.

Assumptions and Limitations

The researcher made the following assumptions and considered the following limitations:

1. Participants would answer the questions truthfully and without bias.
2. The instrument used for questionnaires would measure the variables described in the research questions and it would be valid and reliable.
3. The researcher would be able to collect and analyze data and state the research results and conclusions objectively, without bias.
4. The results and the conclusions of the dissertation would be applicable to electronics programs at other DeVry University locations and to similar programs at other academic institutions.

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; (2) self-efficacy; (3) teaching environments of SMET professors; (4) pre-college mathematics and science interest; (5) satisfaction with electronics programs; (6) pre-college mathematics/science background; and (7) SES (Felder et al., 1995; Ambrose, Lazarus, & Mair, 1998; Brainard & Carlin, 1998; Chan, 2000; Huang, Taddese, & Walter, 2000; CAWMSET, 2000; Seymour & Hewitt, 1997; NSF, 2003; Astin & Sax, 1996; Barinaga, 1993). 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 the eleven variables of self-confidence; self-efficacy; professors' use of teamwork; approachability, concern, and fairness of electronics professors; pre-college mathematics and science interest level and grades; pre-college encouragement; pre-college consideration to apply for electronics; satisfaction with electronics programs; years of mathematics and science in high school; parents' education; and household income of the participants. 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 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 (U.S. Bureau of Labor Statistics, 2001).

Researcher's Perspective

The researcher has been an electronics professor at DeVry-Chicago for the last ten years and during that time has observed a low percentage of female enrollments in its electronics programs. Although the female students perform as well or better than the male students in the electronics courses, low female enrollment continues to be a major problem for the student population at DeVry-Chicago and other DeVry campuses.

Since most females who are enrolled in electronics in the first trimester stay in the program and graduate at DeVry-Chicago, variables such as self-confidence; self-efficacy; professors' use of teamwork; approachability, concern, and fairness of electronics professors; pre-college encouragement; pre-college consideration to apply for electronics; satisfaction with electronics programs don't seem to be major factors affecting the retention of female students. The factor that seems to affect initial enrollment of female students in electronics is pre-college mathematics and science interest levels. The researcher's bias, related to both his personal experience and to the literature review, is that females are not usually encouraged to study electronics or engineering at the pre-college level. Females seldom have the opportunity to be mentored by family, friends, and/or teachers. Counselors and advisors at high schools and colleges do not seem to encourage females enough to take courses in mathematics, science, or engineering, or to pursue the SMET fields. Low mathematics and science interest levels during the pre-college years seem to lead females to pursue fields other than SMET and thus decrease SMET enrollment in colleges and universities.

CHAPTER 2: LITERATURE REVIEW

The literature review will include the following main topics: (a) female students in undergraduate SMET Programs in the United States as a special population; (b) issues related to the enrollment and retention of undergraduate female SMET students; (c) optimal service delivery system and implications for staff development, curriculum development, and instructional methods; (d) policy development; and (e) conclusion.

Female Students in Undergraduate SMET Programs in the United States as a Special Population

Low enrollment numbers is one of the major reasons that undergraduate female SMET students are considered a special population. Other reasons include society supporting inequality, dominance by certain groups, and disempowerment of marginalized groups (Banks, 1997). Compared to 16% in 1990, the undergraduate enrollment of women in science and engineering rose to about 20% in 1999 in the United States (National Science Foundation [NSF], 2003). In 1999 white females totaled 18% of the white science and engineering enrollment; Asian, Hispanic, and American Indian females totaled 23% to 25% of their population's enrollment; and African-American females were 34% of the total African-American enrollment (NSF, 2003).

In part related to the current low percentage of female student enrollments, the future work force will not be able to meet the demand for SMET professionals.

According to statistics taken after September 11, 2001, the need for scientists and engineers is expected to grow at an annual rate of 6.4% between 2000 and 2010, and approximately 5 million jobs are projected in SMET-related fields by 2010 (U.S. Bureau of Labor Statistics, 2001). 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 (CAWMSET, 2000). At these rates, the labor demand for the 2000–2010 job projections will not be met unless there is an influx of non-traditional SMET professionals into the work force (CAWMSET, 2000). Despite the increase of women in SMET programs to 20% of the total undergraduate enrollment in the 1990s, this number still falls short of the projected demand.

Issues Related to the Enrollment and Retention of Undergraduate Female SMET Students

A review of the literature shows that the following issues are relevant to the enrollment and retention of undergraduate female SMET students: (1) self-confidence; (2) self-efficacy; (3) teaching environments of SMET professors; (4) pre-college experience; (5) SES; and (6) satisfaction (Felder et al., 1995; Ambrose, Lazarus, & Mair, 1998; Brainard & Carlin, 1998; Chan, 2000; Huang, Taddese, & Walter, 2000; CAWMSET, 2000; Seymour & Hewitt, 1997; NSF, 2003; Astin & Sax, 1996; Barinaga, 1993; Seymour & Hewitt, 1994; Reis, 2001).

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 (Hanson, 1996; Ware and Lee, 1988). 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 (Hanson, 1996). 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 (Ware and Lee, 1988). 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 (Felder et al., 1995). 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 (2002) 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. 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 (Heyman et al., 2002). 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. Women's self-confidence measured by the responses to surveys, dropped significantly after their freshmen year ($p < .001$) (Brainard & Carlin, 1998). One-fourth of women who stayed in the program reported a lack of self-confidence, which doubled by their senior year in SMET programs (Brainard & Carlin, 1998).

Contrary to the above-mentioned research, two recent nationwide empirical studies by Huang et al. (2000) 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. Tobias's (1990) 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. 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. 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 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. (2000), the retention rate of female students to graduation overall is higher than that of male students. 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 (Hughes, 2002). For women, having the self-confidence to enroll in SMET fields also relates to their perception of traditional versus changing gender roles (Huang et al., 2000). Research shows conflicting views with respect to the reason that women major in SMET.

According to Ware and Lee (1988), women who have strong career commitments are more likely to stay in SMET fields. On the contrary, Maple and Stage (1991) report that women with strong career aspirations are more likely to switch from majoring in SMET. 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 (Seymour & Hewitt, 1997). 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 (Seymour & Hewitt, 1997).

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 (1986), self-efficacy depends on performance, observing and learning from others, encouragement, and freedom from anxiety. 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 (Ambrose et al., 1998).

Women pursuing undergraduate degrees in SMET fields showed more anxiety and, therefore, less self-efficacy than men did (Felder et al., 1995). The belief that a woman loses her femininity if she enters the SMET fields may not be valid (Mathias-Riegel, 2004). 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. Hence, they don't discuss these fields with female students, who remain unaware of them. Tharp (2002) concluded that education, professional, and personal support affected women's self-efficacy. As a result of overcoming barriers such as isolation and sexual harassment, women's self-efficacy increased.

Teaching Environments of SMET Professors

SMET professors' teaching environments can affect the self-confidence of their female students. In the NCSU study, undergraduate female students expressed their enthusiasm for group work, yet, during cooperative learning sessions, women were interrupted and/or ignored by their male counterparts, which decreased their self-confidence (Felder et al., 1995). The same study found that women tended to dislike the abstractness of SMET subjects as well as the grade competition emphasized by professors. According to Sorby's (2001) literature review, women have fewer of the spatial/visualization skills that are essential in SMET fields than men, mainly because of the lack of the following activities: playing with construction toys as a child; taking courses in drafting, auto-mechanics, mathematics and sciences at secondary school; playing three-dimensional computer games; and playing certain sports. Colleges that focus on grades instead of people, poor teaching techniques, lack of good teaching assistants, and the inapproachability of faculty force women and many minority students to leave SMET fields (Seymour & Hewitt, 1997). According to a NSF (1998) report:

> To be faced with the prospect of four years of relative isolation and perceived male hostility on the one hand, and the abrupt withdrawal of familiar sources of praise, encouragement, and reassurance by faculty on the other, is the most common reason for the loss of self-confidence that makes able women in the sciences and engineering vulnerable to field switching. (p.41)

In a comprehensive meta-analysis, Reis (2001) synthesized many articles and indicated that women experienced different treatment and sex discrimination from professors that lowered their self-confidence, learning ability, expectations, and self-esteem. In an empirical study conducted through questionnaires at the University of Michigan showed that women considered college science classes to be unfriendly, and they felt uncomfortable working in competitive environments (Manis, Thomas, Sloat, & Davis, 1989).

Pre-College Experience

Despite having an aptitude for mathematics and science that is equal to or higher than that of males, female students' interest in these subjects decreases during pre-college years. There is not much difference in the mathematics and science achievement scores of pre-college males and females and they take the same number of upper-level mathematics and science courses (CAWMSET, 2000). Contrary to the CAWMSET report, Maple and Stage (1991) claim that females and most minorities take fewer advanced courses in math. Even though according to CAWMSET female achievement in mathematics and science courses has increased, Huang et al. (2000) report that female interest continues to decrease during pre-college years.

In a comprehensive report written to President Clinton and the members of Congress, a taskforce at NSF summarized studies suggesting that women's lack of interest in mathematics and science may come from secondary school teachers who discourage females from entering the SMET fields (CAWMSET, 2000). This dissertation will refer to the detailed discussions about the observations made in this report. Sadker and Sadker (1994) visited classes and made the following observations on gender inequity that results in low self-esteem and achievement of girls in elementary and secondary schools, and colleges: (a) teachers pay less attention to girls and give them less feedback; (b) girls comment significantly less often than boys do in class; (c) contributions of women are rarely written in books or mentioned in the curricula; (d) male students, teachers, and administrators give female students "unwanted sexual attention."

The gender gap on student participation in class is larger in college than elementary and secondary schools and two-thirds of the silent students in college are women (Sadker, Sadker, Fox, & Salata, 1994). Through a synthesis of 1,300 studies on girls in school and equity for girls, American Association of University Women (AAUW, 1992) reported that teachers gave more opportunities to boys than girls to perform hands-on demonstrations in class. Since girls were not able to participate in hands-on demonstrations that are essential in learning science, they received unfair treatment and they learned less mathematics, science, and computer technology than boys did. In a meta-analysis study, Sadker, Sadker, and Klein (1991) stated that teachers treated girls unfairly by encouraging males to participate more in class and discouraging girls by expecting less academic performance from them. The gender inequity is larger in college where male students populate most of the SMET classes and hold most of the leadership positions (Sadker, Sadker, Fox, & Salata, 1994).

Women's lack of interest in mathematics and science may also come from parents, or society in general, all of which discourage females from entering traditionally male-dominated fields such as auto-mechanics, electronics and computer technology, and other careers that require mathematics and science backgrounds (CAWMSET, 2000). Parental attitudes can differ toward boys and girls in terms of raising their children (Reis, 2001). According to the interviews conducted by Kuebli and Fivush (1992), parents encouraged stereotyping by using greater number of emotion words with 40-month old daughters than with sons. Through the surveys administered to the parents of junior high boys and girls, parents perceived that daughters put more effort into mathematics while sons used their ability more. Yee and Eccles (1988) concluded that parents' stereotypical perception could discourage daughters from future success in mathematics.

In a cross-cultural study on achievement tests in mathematics and reading, Lummis and Stevenson (1990) found that the mothers encouraged girls in reading and boys in mathematics. Mothers not encouraging girls in mathematics could result in lower achievement test scores than boys (Lummis & Stevenson, 1990). Milgram (2005) reported that since most of the girls are not encouraged to play computer games or games that develop construction, spatial/visualization, problem solving, and hands-on skills, they don't have the skills to achieve in SMET fields. Reis (2001) noted that not being able to play with certain toys such as construction sets frustrated the gifted girls. Sorby (2001) concluded that playing with construction toys as a child help develop spatial/visualization skills that are required in SMET fields.

Lack of encouragement from school, parents, and society seem to affect the female self-confidence. According to a nationwide survey administered to 3,000 children in 12 locations, girls and boys begin first grade with comparable self-confidence and continue until fourth grade (AAUW, 1991). It was also found that girl self-confidence drops down substantially between grades 4 and 10, and most of the girls come out of adolescence with lower expectations of themselves and their abilities than boys do (AAUW, 1991). According to Felder et al. (1995), parental discouragement, male dominance, and stereotyping could contribute to women's lack of self-confidence. Chan (2000) explains that even the brightest females in SMET classes underestimate their abilities in mathematics, and that is related to a lack of role models in mathematics and engineering. According to Seymour and Hewitt (1997), education majors who teach mathematics and science at the secondary schools have increased and the number of women and minority secondary school teachers as role models has decreased. As a result the quality of mathematics and science instruction has worsened (Seymour & Hewitt, 1997). Contrary to CAWMSET, Paolucci (2001) found that there were no differences between the science grades of male and female high school students and that interest in mathematics and science was equal for both sexes.

Since females have an aptitude for mathematics and science that is equal to or higher than that of males (CAWMSET, 2000), efforts should be made to increase female interest in these subjects during pre-college years (Tobias, 1990; Office of Technology Assessment [OTA], 1988). OTA (1988) reported that in order to increase the pool of future scientists, continuous recruitment and retention processes should be implemented. The number of future scientists can be increased by practicing the following: (a) more students should be attracted to science during pre-college years; (b) since practical experience is essential in science, elementary school teachers and college professors should teach more hands-on (OTA, 1988). According to Tobias (1990), in general, “top tier” students in mathematics and science have the qualities of self-motivation, self-confidence, intelligence, curiosity; they are involved in the science community; and they don’t need mathematics/science classes or curriculum in mathematics and science. Since there is a need to increase women and minorities in SMET fields (NSF, 2003), “second tier” students must also be considered for mathematics and science (Tobias, 1990). Tobias defines the population of students who are not from the “top tier” as “second tier” or “different.” “Second tier” consists of women and minorities who can still achieve in mathematics/science if they were recruited, rewarded and retained from elementary schools to colleges. “Recruitment” could include improving the teaching styles of pre-college science teachers and college professors, updating the elementary and secondary science curricula and developing mentoring strategies that prepare students for college SMET programs.

Socio-economic Status (SES)

SES is related to politics, economics, family and social backgrounds, gender, culture, race, and ethnicity (Cunningham, 1996). The dictionary defines SES as “a particular group in society having a common economic, cultural, and political status” (Flexner, 1987, p. 1810). Diversity is affected not just by race, but also by ethnicity, gender, and SES. In order to serve diverse student populations, educators need to integrate diversity into the curriculum by being sensitive to student needs. Freire (2004) explains that understanding the impact of a culture’s SES on the learning process is as important as comprehending the factors of race or sex. SES in the United States is defined according to how an individual obtains money (Cunningham, 1996). According to Cunningham, people of upper SES—the rich, receive their money from interest; individuals who have middle SES earn money through wages; while persons of lower SES, or the poor, collect money through food stamps, public housing, or welfare. The definition of SES, however, changes according to who has political clout, power, and/or money.

SES differences in secondary education in the United States affect the enrollment of students, including female students, in undergraduate SMET programs. Anyon (1997) describes how unequal opportunities created by varying SES can result in unequal success in secondary and post-secondary education, and lead to inequality of employment opportunity. Students of lower SES attend crowded inner-city schools where teachers often lack certification, resources such as computers and lab equipment are in short supply, outside activities are limited, and traditional lecturing is the norm (Anyon, 1997). Students of upper and middle SES tend to go to suburban schools where class sizes are smaller, teachers are almost always certified, computers and labs are updated and in ample supply, activities vary between lecturing and interactive discussion, and students benefit from field trips and independent projects. Many inner-city students suffer from a lack of nutrition and/or poor health care; as a result they are mentally and emotionally distressed, and their attendance rates are lower than those of upper SES students. The above-mentioned differences in SES create inequalities in student learning.

Proponents of multicultural education advocate equal learning opportunity for all students, regardless of their backgrounds or SES (Banks, 2002). Banks states that according to the paradigm of multiculturalism, schools should use teaching strategies that respect and take into account the various cultures of low-income students and minorities. If teachers are culturally sensitive—that is, if they create culturally compatible environments—then they are confronted with a less difficult task (Ladson-Billings, 1994). The case of female students in undergraduate SMET programs is a prime example of how SES issues affect a special population. An optimal service delivery system would offer solutions, including better secondary school education and a continuing effort to enroll and retain female students in undergraduate SMET programs.

Family background and the availability of financial aid are socioeconomic issues that affect the enrollment and retention of female students in undergraduate SMET programs. Parental SES, education, careers, and emotional and financial support influence women's choice of higher education. Lower-income female Hispanic students who attend college usually work to support themselves and their families. These women, bound by strong family ties, feel an obligation to help their families financially, even during their college years (Seymour & Hewitt, 1997). Demanding time schedules result in these students' changing majors or dropping out. Despite these pressures, many women who are in the undergraduate SMET programs remain and graduate (Huang et al., 2000). It seems like low household income and lack of parental encouragement are some of the reasons for low female enrollment and retention in SMET programs.

Another issue is the availability of sufficient financial aid for low-income students. An NSF (2003) report indicated that providing a $1,000.00 loan instead of a grant reduces the probability of a low-income student's graduation by 17%. Federal student aid policy has been to award twice as much in loans as compared to grants over the last thirteen years (NSF, 2003). In both 1995 and 1996, 52% of female students and 47% of male students received financial aid in science and engineering (NSF, 2003). Among female students in higher education, 45% receive grants, 27% receive loans, and 80% work, but only 14% work the recommended 15 hours or less per week (King, 1999). According to Huang et al., there was no statistically significant relationship between female SMET students' enrollment and the financial aid they received.

Satisfaction

Satisfaction seems to relate to self-confidence, encouragement, fulfillment of expectations and wishes, freedom from doubt or anxiety, flexible curriculum, competition, and challenge. During their first year of chemical engineering studies at NCSU, women showed more anxiety, less satisfaction, higher expectations, and less self-confidence than men did (Felder et al., 1995). According to Felder et al. (1995), women predicted their grades significantly less accurately during their junior years than men did, which was probably the effect of an underestimation of their abilities related to female students' lowered expectations. An empirical study was conducted in order to explain the reason for under representation of women in engineering curricula (Henes, Bland, Darby, & MacDonald, 1995). After the analyses of the responses to the open-ended questions and follow-up discussions with women, engineering faculty, and engineers, Henes, et al. (1995) reported that the reasons women get dissatisfied and leave SMET are psychological alienation, not being able to relate to basic theoretical courses, "chilly" classroom environments, and a lack of mentors.

Other reasons for women's dissatisfaction include their having more interest in majors other than SMET, stereotyping of SMET as male fields, a lack of academic advising, low faculty expectations, a fixed or rigid curriculum, and the competitive nature of science and engineering (Astin & Sax, 1996; Seymour & Hewitt, 1994). According to Brainard and Carlin (1998), self-confidence, positive influence of professors/advisors, and influence of SMET courses are positively correlated with persistence in SMET programs. An emphasis by SMET professors on grades and competition instead of on people, poor teaching styles, and the nonresponsiveness of faculty force women and minority students to become dissatisfied and leave SMET fields (Seymour & Hewitt, 1997).

In her dissertation Horner (1968) reported that expectation of success in a competitive environment especially against men creates fear, anxiety, social rejection, and loss of femininity. Women who face competition try to reduce it and increase collaboration instead (Barinaga, 1993). In the chemical engineering program at NCSU, men who failed courses were more inclined to repeat the courses, as opposed to women, who failed, became dissatisfied, and switched to other majors (Felder et al., 1995). An empirical study conducted at different elementary schools showed that males persist more than females when they are confronted with challenges (Dweck and Repucci, 1973). Women who experience a lack of self-confidence and encouragement, high expectations and anxiety, a fixed or rigid curriculum, competition and challenge, stereotyping, and an unapproachable faculty tend to be dissatisfied and leave the SMET fields more than men do.

Summary

The key findings include: Male resentment and parental discouragement could contribute to the lack of self-confidence in females; the retention rate of female students is higher than that of males; the self-confidence and self-efficacy of female students increase through the activities of professional societies; teaching techniques of SMET professors are poor; female students in secondary schools develop apathy for mathematics and science; low-income minority and female students are not well prepared academically, financially, or socially to enter SMET fields (Felder et al., 1995; Ambrose, Lazarus, & Mair, 1998; Brainard & Carlin, 1998; Chan, 2000; Huang, Taddese, & Walter, 2000; CAWMSET, 2000; Seymour & Hewitt, 1997; NSF, 2003).

According to Felder et al. (1995), parental discouragement, male dominance, and stereotyping could contribute to women's lack of self-confidence and self-efficacy. Women's self-confidence dropped significantly after their freshmen year ($p < .001$) (Brainard & Carlin, 1998). Contrary to Brainard and Carlin's findings, Huang et al. (2000) reported that the issue of self-confidence for women was not a statistically significant predictor for the completion of SMET degrees. Huang et al. found that the retention rate of the female students is higher than that of males. Scarcity of role models, lack of academic advising, and professors stressing theory without providing examples all decrease female students' self-efficacy (Ambrose et al., 1998). According to Seymour and Hewitt (1997) the reasons women give when leaving SMET programs include their being interrupted or ignored by men during cooperative learning, abstractness of SMET subjects, grade competition, lack of good teaching assistants, and poor teaching techniques of professors.

Even though according to CAWMSET female achievement in mathematics and science courses has increased, Huang et al. (2000) report that female interest continues to decrease during pre-college years. Most female students of lower SES are not motivated to enroll in SMET programs because they attend secondary schools where role models and professional societies are few, instructors lack a variety of teaching methods, and mathematics and science instruction is inadequate. Although financial aid does not seem to be a statistically significant differential factor in female enrollment, demanding work-study schedules related to low-incomes and the federal government's practice of awarding twice as many dollars in loans as grants affect the retention of female students (NSF, 2003).

Optimal Service Delivery System and Implications for Staff Development, Curriculum Development, Instructional Methods

The following are the main topics for an optimal delivery system for enrollment and retention of female SMET students: (1) professional societies and mentoring; (2) instructional methods and teacher preparation; and (3) pre-college experience and financial aid (Ambrose et al., 1998; CAWMSET, 2000; Felder et al., 1995; Sneller, 2001; Sorby, 2001; Finke, 2000; Belenky, Clinchy, Goldberger, & Tarule 1986).

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 (Ambrose et al., 1998). WIE society members encourage one another to stay in SMET through participation in internships, coop programs, and conferences at Purdue University (CAWMSET, 2000). 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 (2002) found that 95% of the women who used MentorNet, which is an E-Mentoring network, persisted in SMET fields. 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 (CAWMSET, 2000). 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 (KIC, 2004). Through KIC females can get exposed to mathematics and science at an early age which could encourage them to pursue SMET fields in college.

Instructional Methods and Teacher Preparation

Instructional techniques that match women's learning styles help them stay in undergraduate SMET programs. Professors should stress the value of each student's contributions during cooperative learning sessions, so that women as well as men benefit from learning (Felder et al., 1995). Timpson and Bendel-Simso (1996) state, "When managed effectively, groups provide a social foundation that bolsters students' critical thinking skills and creativity" (p.109). Women and second tier students respond well to cooperative methods of learning that emphasize teamwork rather than competition (Tobias, 1990). Female students tend to be more comfortable during cooperative learning sessions that facilitate teamwork than males do (Felder et al., 1995). In a meta-analysis study, Sneller (2001) discusses how professors can help retain female students by applying the "3 Rs of Gender Equity": recognizing the problem, reevaluating teaching methods, and reconstructing classrooms. According to Sneller, professors should treat all students fairly with respect to gender, instead of directing a disproportionate number of questions to men or allowing men to dominate discussions.

Sorby (2001) suggests a 3-D spatial/visualization skills course that helps female engineering students in graphics, design, and drafting to be more successful. In-depth interviews with 135 women, followed by a case study revealed that women learn best when connected to the teacher and to the subject matter (Belenky et al., 1986). They further state that the teacher's task is to "assist the students in giving birth to their own ideas, in making their own tacit knowledge explicit, and elaborating on it" (Belenky et al., 1986, p. 217). Since feminist teachers tend to be more interested in students' personal experiences and their understanding of the material being taught, they often encourage students to discover their own voices and assess relationships between teacher and students (Finke, 2000). Through the discovery of voice and relationships, proper channels of communication open up to facilitate teaching and learning, and instructors show openness and accessibility to students.

Feminist pedagogy encourages feminist teachers to promote classrooms where equality is achieved among students of different gender, race, class, sexual preference, ethnicity, and age (Finke, 2000). Rinehart and Watson (2002) helped increase the number of women graduating in engineering by applying the "Learning Community Theory" model, which combines active learning strategies with team teaching. Through this program female students gained a better understanding of the material in less time and earned higher grades. The curricular and pedagogical changes in SMET instruction required by the Accreditation Board of Engineering Technology (ABET) lead to a more practical and social teaching styles, which are more attractive to female students and their preferred ways of learning (Farrell, 2002). Strand and Mayfield (2002) surveyed female college students by asking questions about their high-school mathematics and science experiences. They found that the female-friendly teaching styles, such as emphasizing the success of many as opposed to the success of a few, and relating to real-world situations improved female interest in mathematics and sciences and encouraged them to pursue SMET fields in college (Strand & Mayfield, 2002).

As a solution to the gender inequity problems Sadker and Sadker (1994) developed training programs for elementary and secondary teachers, administrators and college professors to improve their way of teaching in order to become more equitable and effective when their verbal interactions with students create gender bias. Through the training programs, teachers, administrators and professors can recognize their mistakes on gender bias and correct them. They also learn about gender-fair books within their academic disciplines and complement their teaching by including works about women in their courses (Sadker & Sadker, 1994). Although the training programs helped reduce the gender bias, they didn't help enough to prepare teachers to prevent the subtle and damaging effects of gender inequity from happening in the classrooms (Sadker, 1999). Sadker further states that as the mathematics and science gender gap gets smaller, a larger gender gap develops in technology mainly because of the computer revolution.

Projects such as "The Rocky Mountain Teacher Education Collaborative" (RMTEC) sponsored by NSF trained elementary and high-school mathematics and science teachers to apply innovative ways of teaching in order to prepare females to pursue SMET fields in college. RMTEC had the following goals: (a) to restructure, reform, or develop creative ways to teach for the elementary and high school mathematics and science teachers; (b) to coordinate the efforts between three institutions of higher education, several community colleges and school districts in Colorado; (c) recruit and retain women and minorities to teach mathematics and science ("A Final Issue", 2003).

Pre- College Experience and Financial Aid

Professional societies are effective in attracting pre-college females to SMET programs. The Center for the Advancement of Hispanics in Science and Engineering Education (CAHSEE), which is primarily concerned with women, launched a program in 1992 for minority students in grades 7 through 11: Students competed to enter a six-week intensive program in SMET emphasizing the development of critical thinking skills in mathematics and science (CAWMSET, 2000). CAHSEE offers another program during the school year, which is eleven weeks long and prepares students to obtain high scores in the PSAT and SAT exams (CAWMSET, 2000). Bristol Community College's Women in Technology (WIT) Program involves high school women working on engineering projects at Texas Instruments. Of WIT program participants in 1997 and 1998, 65% applied for SMET programs in colleges (Boudria, 2002). The Southeastern Consortium for Minorities in Engineering (SECME) is instrumental in increasing female undergraduate SMET enrollment by forming school-university partnerships (Loftus, 2004). SECME's director, Freeman, who started the Mathletics camp program, teaches mathematics to pre-college students through sports. Mathletics encourages parents to appreciate science more, as they are involved in workshops with hands-on projects.

Students can also join Freeman's Early College Program in 7^{th} grade and complete two years of college while in high school (Loftus, 2004). Efforts other than professional societies should be made to bring more women into SMET fields. It is best if female representatives from SMET academia and industry visit students in grades 6 through 12, working with guidance counselors to describe the SMET employment market, describe working conditions, and answer relevant questions using their firsthand experience (Mathias-Riegel, 2004). Special scholarship programs have been set up since 1997 at Indiana University-Purdue University Indianapolis (IUPUI) to graduate the most females in technology compared to other universities in year 2001–2002 (Mathias-Riegel, 2004).

For her dissertation Edwards (2002) designed after-school technological activities for low-income African-American middle-school girls. These activities created opportunities for the girls to learn about the work of famous African-American women in science and practice similar activities to theirs in order to participate in long-term science/technology projects; role models presented science and technology fields as avenues to gaining higher SES. Longitudinal survey responses of 320 male and female high-school students indicated that SMET summer programs influenced females more than males in their decision to pursue SMET fields in college because of the friendly academic environment and emotionally satisfying SMET activities (Lee, 2002). The National Action Council for Minorities in Engineering (NACME) is the nation's largest source for scholarships for women and minority engineers; it has awarded 18,000 scholarships since 1974 (Society of Women Engineers [SWE], 2004). According to SWE (2004), the retention rate of NACME scholars is 85%.They achieve an average GPA of 3.1 and 40% are female students. Since the1970s NACME has been taking an active role with companies and universities including MIT, Stanford, DuPont, IBM, and National Academies of Science and Engineering, urging them to consider race in their hiring/admissions procedures and policies in order to increase female and minority enrollments and retention in SMET.

Summary

The key findings include: Societies for undergraduate female SMET students help women increase their self-confidence and self-efficacy; teaching techniques such as cooperative learning, the "3Rs of gender equity", 3-D spatial/visualization, and feminist pedagogy are helpful; pre-college help such as professional societies encouraging the development of critical thinking skills in mathematics and science attract female students to SMET programs (Ambrose et al., 1998; CAWMSET, 2000; Felder et al., 1995; Sneller, 2001; Sorby, 2001; Finke, 2000; Belenky, Clinchy, Goldberger, & Tarule 1986). Engineering societies such as WIT, WIE, CAHSEE, SWE, and ASEE encourage women to stay in undergraduate SMET programs through participation in professional activities that raise their self-confidence and self-efficacy (CAWMSET, 2000).

The instructional methods of undergraduate SMET professors should be sensitive to diversity in gender, ethnicity, race, culture, and social class and should include student-centered learning, such as cooperative learning; the application of the "3 Rs of Gender Equity"; teaching 3-D spatial/visualization skills; and the application of feminist pedagogy emphasizing student/teacher and student/subject relationships and discovery of student voice (Sneller, 2001; Sorby, 2001; Finke, 2000; Belenky et al., 1986). The CAHSEE society helps minorities in grades 7 through 11 develop critical thinking skills in mathematics and science (CAWMSET, 2000). In an optimal delivery system, faculty and staff apply these suggestions for mentoring, instructional methods, staff development, and inclusive diversity-sensitive curriculum development in order to increase retention rates of female SMET students, including students of lower SES.

Policy Development

The main topics to explore are: (1) the need for policy development; and (2) recommendations by CAWMSET (CAWMSET, 2000). Increasing certification rates of mathematics and science teachers in inner-city schools and good counseling on how to obtain financial aid for undergraduate SMET programs would require policy changes in individual schools, state and federal government. Any policy should include financial aid packages to attract young women from lower SES backgrounds to enroll and stay in undergraduate SMET programs.

CAWMSET (2000) examined the reasons for low enrollment and graduation of women, underrepresented minorities, and persons with disabilities, and generated recommendations. CAWMSET recommends that all states adopt legislation requiring schools to collect achievement data on students disaggregated by SES, race, ethnicity, gender, culture, and disability, and to be accountable for success in meeting state achievement standards. CAWMSET's second recommendation is the expansion of high school assessment techniques in accelerated mathematics and science programs where federal, state, and local partnerships increase the number of role models, encourage women and minorities, and raise their interest in mathematics and science. The third CAWMSET recommendation is for the federal government to enact legislation increasing the funding of the Pell Grant Program for women and underrepresented minorities with maximum awards of $6,418.00. This recommendation also implies that the majority of financial support should come from grants and scholarships, rather than loans. The fourth recommendation is about nationwide accountability implemented by a collaborative body that continues the CAWMSET's efforts. This collaborative body composed of members from state and federal governments, industry, and academia, as well as students, would create action plans; coordinate and delegate these actions; and monitor progress through data collection, analysis, and reporting.

In summary, CAWMSET (2000) recommends that federal, state, and local governments intervene to increase the number of qualified mathematics and science teachers and improve assessment techniques in mathematics and science programs, which would increase female secondary students' interest in mathematics and science. CAWMSET also recommends that financial support come from grants and scholarships. A collaborative body composed of representatives from government, industry, and academia would create action plans in order to implement and act on these recommendations and accomplish nationwide accountability (CAWMSET, 2000). As a result of policy development and implementation, the issues of apathy for mathematics and science and financial preparation at the pre-college level would be resolved, and the number of female students applying and enrolling in SMET programs would increase.

Conclusion

Parental discouragement, male dominance, and stereotyping are related to women's lack of self-confidence and self-efficacy (Felder et al., 1995). Women's self-confidence dropped significantly after their freshmen year ($p < .001$) (Brainard & Carlin, 1998). Contrary to Brainard and Carlin's findings, Huang et al. (2000) reported that self-confidence for women was not a statistically significant predictor for the completion of SMET degrees. According to Huang et al. (2000), the retention of female students in undergraduate SMET programs is higher than that of males. Although women's self-efficacy suffers from a scarcity of mentors, insufficient academic advising, and poor instructional techniques, the women already enrolled in undergraduate SMET programs have enough self-efficacy to graduate. Insufficient formal education and apathy for mathematics and science in primary and secondary schools are primary reasons for the low enrollment rates of women in undergraduate SMET programs (Huang et al., 2000; CAWMSET, 2000). SES, politics, economics, family and social backgrounds, gender, culture, race, and ethnicity are interrelated subjects (Cunningham, 1996). Unequal opportunities created by low SES can cause unequal educational success in secondary and post-secondary schools and lead to unbalanced employment opportunities (Anyon, 1997). Undergraduate female SMET students in the United States are a special population that is adversely affected by the inequality that SES creates. Socioeconomic factors, including family background and financial aid, are important, but the women who do enroll in the undergraduate SMET programs manage their socioeconomic needs in order to graduate (Seymour & Hewitt, 1997; NSF, 2003).

Professional societies present good role models, mentors, workshops, and activities that raise mathematics and science interest, as well as the self-confidence and self-efficacy of undergraduate female SMET students (CAWMSET, 2000). To optimize a service delivery system, instructors must develop student-centered teaching methods, such as cooperative learning and feminist pedagogy that are sensitive to diversity, including gender, ethnicity, race, culture, and SES (Felder et al., 1995; Finke, 2000; Belenky et al., 1986). CAWMSET recommends that the government intervene to increase the number of qualified women teachers in mathematics and science programs and that the majority of financial support come from grants and scholarships. Pre-college policy development for mathematics and science curricula that meet world standards should include striving for a proportionate number of female teachers and training counselors who are able to give sound advice on obtaining financial aid for undergraduate SMET programs.

The key to the success of CAWMSET's (2000) recommendations is the implementation of the nationwide accountability action plan. Only when this action plan is implemented will more women and underrepresented minorities from lower SES enroll in and graduate from SMET programs. Only then will the goals of multicultural education be reached: all students regardless of race, gender, ethnicity, culture, or SES will have access to undergraduate SMET programs and the United States work force will be prepared for 21st century–needs in the fields of mathematics, science, engineering, and technology (Banks, 2002).

CHAPTER THREE: METHOD

Research Design and Rationale

The research design for the dissertation had three parts: descriptive, quantitative inferential, and qualitative. The first part was the descriptive statistics for the demographic data and the dependent variables involved in the study. The quantitative inferential part of the study included eleven major complex difference and interaction questions with each question consisting of three subquestions. The research explored the differences between male and female students in the electronics programs at DeVry University's Chicago area campuses in terms of the eleven variables of (a) self-confidence, (b) self-efficacy, (c) professors' use of teamwork, (d) approachability, concern, and fairness of electronics professors, (e) pre-college mathematics and science interest level and grades, (f) pre-college encouragement, (g) pre-college consideration to apply for electronics, (h) satisfaction with electronics programs, (i) years of mathematics and science in high school, (j) parents' education, and (k) household income of the participants.

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

Table 3.1

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

For the first eleven research questions, there were eleven dependent variables (DV) as follows: self-confidence; self-efficacy; professors' use of teamwork; approachability, concern, and fairness of electronics professors; pre-college mathematics and science interest level and grades; pre-college encouragement; pre-college consideration to apply for electronics; satisfaction with electronics programs; years of mathematics and science in high school; parents' education; and household income of the participants. Most of the questions used seven-point Likert scales, ranging from 1 = Strongly Disagree (SD) to 7 = Strongly Agree (SA).

The design classification was a 2 x 3 factorial, which was analyzed with an analysis of variance (ANOVA) to answer the three questions related to each dependent variable. Since there were eleven DVs, the researcher needed eleven 2 x 3 factorial ANOVAs to answer the first eleven sets of questions (Morgan, Leech, Gloeckner, & Barrett, 2004).

The quantitative inferential part of the research design also included the analysis of the answers to the twelfth research question which was a complex associational question. Since there were twelve variables to correlate, the researcher analyzed the answers with multiple regression based on a correlation matrix for the twelve variables (Morgan, Leech, Gloeckner, & Barrett, 2004).

Through a qualitative analysis approach, the researcher analyzed the answers given to the two open-ended questions at the end of the questionnaire (Creswell, 1998). Individual responses were compiled and coded into categories using SPSS. Frequencies and percentages were the statistical methods used to report the results.

Site and Participants

The study was conducted at DeVry University's Chicago area campuses, which are DeVry-Chicago, DeVry-Tinley Park, and DeVry-DuPage. At the DeVry-Chicago campus, fall 2004 enrollment numbers showed 2459 students registered for classes. The Bachelor of Science in Business Administration (BSBA) program had 26.5% of the students, CIS enrollment was 18.6%, EET/CET was next with 18% enrollment, ECT represented 14% of the student population, Network Communications (NCM) followed with 10.2%, Technical Management (TM) enrollment was 5.6%, and the newest program, called Network Systems Administration (NSA) represented 1.1% (J. Gibbons, personal communication, November 4, 2005). DeVry Advantage Academy (DAA) high school students taking courses at DeVry were not included in the percentages given above. Table 3.2a shows that the three programs studied had 783 students broken down as follows: ECT had 279 male and 58 female students; EET's enrollment was 202 males and 30 females; and 173 males and 41 females were enrolled in the CET program (R. Green, personal communication, April 24, 2005).

Table 3.2a

Fall 2004 ECT, EET and CET Student Enrollments for DeVry-Chicago

Electronics Program	Male	Female
ECT	279	58
EET	202	30
CET	173	41
Total	654	129

At DeVry-Tinley Park campus, fall 2004 enrollment numbers showed 1274 students registered for classes. The Bachelor of Science in Network Communications (BSNCM) program had 22.4% of the students, Business Administration (BA) enrollment was 17.3%, EET/CET was next with 16.2% enrollment, Technical Management (TM) represented 14.9% of the student population, CIS followed with 13.4%, ECT enrollment was 13.3%, and Network Systems Administration (NSA) represented 2.1% (R. Green, personal communication, April 24, 2005).

Table 3.2b shows that the three programs studied had 375 students broken down as follows: ECT had 149 male and 19 female students; EET's enrollment was 110 males and

13 females; and 71 males and 13 females were enrolled in the CET program (R. Green, personal communication, April 24, 2005).

Table 3.2c demonstrates that the three programs studied at DeVry-Chicago and Tinley Park had a total of 1158 students broken down as follows: ECT had 428 male and 77 female students; EET's enrollment was 312 males and 43 females; and 244 males and 54 females were enrolled in the CET program (R. Green, personal communication, April 24, 2005).

Table 3.2b

Fall 2004 ECT, EET and CET Student Enrollments for DeVry-Tinley Park

Electronics Program	Male	Female
ECT	149	19
EET	110	13
CET	71	13
Total	330	45

Table 3.2c

Fall 2004 ECT, EET and CET Student Enrollments for DeVry-Chicago and Tinley Park

Electronics Program	Male	Female
ECT	428	77
EET	312	43
CET	244	54
Total	984	174

The researcher administered surveys at the DeVry-DuPage campus only for the pilot study. DeVry-DuPage had similar student population at DeVry-Chicago. 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 and Measures

Instrument

The instrument consisted of 26 items with Likert scales, 8 items on personal and demographic information, and two open-ended questions. The cover letter and the questionnaire 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 (2004). The researcher adapted five questions for self-confidence from the Women in Engineering Programs and Advocates Network (WEPAN) Student Experience Survey (Brainard & Huang, 2000). Table 3.3 shows the 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 3.3

Measures and the Related Questions

Measures	Questions
Self-Confidence	1-5
Self-Efficacy	6-10, 19-23
Professors' Use of Teamwork	11
Approachability, Concern, and Fairness of Electronics Professors	12-14
Pre-college Mathematics/science Interest and Grades	15, 16, 27
Pre-College Encouragement	17
Pre-College Consideration to Apply for Electronics	18
Satisfaction with Electronics Programs	24-26
Years of Mathematics/science in High School	28, 29
Parents' Education	31, 32
Household Income	30
Gender, Trimester Enrolled, Age	33-35

Response Rate

In general, one class section for each trimester per program level for each major (ECT, EET, CET) was selected from the day courses at DeVry-Chicago and Tinley Park campuses. Depending of the availability of night courses, several night classes were also sampled at both campuses. The total number of students in the selected sample of electronics students was 901 (R. Green, personal communication, Feb 23, 2005). Of the 901 students, 576 responded the survey, which is the actual sample, and the response rate was 63.9%. Absences from class during survey administration, the voluntary nature of survey taking, students from other majors taking electronics courses and students who already took the surveys in other classes were among the reasons that the total number of responses was lower than the total number of students in the selected sample. Since the response rate was good, the researcher believes that the actual sample would be representative of the selected sample, and the results of this study could be generalizable to other DeVry University campuses in North America, and to the electronics programs at other comparable colleges or universities.

Validity

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; professors' use of teamwork; approachability, concern, and fairness of electronics professors; pre-college mathematics and science interest level and grades; pre-college encouragement; pre-college consideration to apply for electronics; satisfaction with electronics programs; years of mathematics and science in high school; parents' education; household income; gender; trimester enrolled; and age.

Reliability

The researcher conducted a pilot test of the instrument at DeVry-DuPage, 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 original summated scales. The researcher repeated the reliability test after the data collection. Table 3.4 is the summary of the original summated scales with the associated questions, corresponding alphas for the pilot and actual studies.

Table 3.4

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	6-10, 19-23	.86	.85
Teaching Environment of Professors	11-14	.62	.73
Pre-College Mathematics/science Interest	15-18	.41	.61
Satisfaction with Electronics Programs	24-26	.79	.86
Pre-college Mathematics/science Background	27-29	.62	.65
SES	30-32	.61	.61

Although a few of the alphas were improved after the data collection, several were still not high enough. Questions 11, 17, 18, and 30 did not correlate well with the original summated scales. The researcher reorganized the items in the survey then, recalculated alphas, and modified four of the original summated scales to form the following: approachability, concern, and fairness of electronics professors; pre-college mathematics and science interest level and grades, years of mathematics and science in high school, and parents' education. Questions 11, 17, 18, 30 that correspond to professors' use of teamwork, pre-college encouragement, pre-college consideration to apply for electronics, and household income were made separate variables of one item each. Table 3.5 represents the recalculation of Cronbach's alphas for the actual study with the revised summated scales. The improved internal consistency reliability measures indicated that questions correlated well to form approachability, concern, and fairness of electronics professors; pre-college mathematics and science interest level and grades; years of mathematics and science in high school; and parents' education as the revised summated scales. The alpha of .65 for the pre-college mathematics/science interest and grades measure was a minimally acceptable consistency reliability coefficient. The revised summated scales in table 3.5 were used in chapter four to perform statistical analysis.

Table 3.5

Cronbach's Alphas for Actual Study with Revised Summated Scales

Measures	Cronbach's Alphas
Self-Confidence	.72
Self-Efficacy	.85
Approachability, Concern, and Fairness of Electronics Professors	.83
Pre-college Mathematics/science Interest and Grades	.65
Satisfaction with Electronics Programs	.86
Years of Mathematics/science in High School	.74
Parents' Education	.71

Data Collection Procedure

The researcher submitted the Application to Use Human Subjects form (H-100) to the Human Research Committee (HRC) at Colorado State University. The cover letter and student questionnaire (see Appendix A), recruitment e-mail (see Appendix B), and letter of agreement (see Appendix C) were attached to the H-100 form.

After the HRC's approval, Dr. Stan Lan, Dean of Electronics sent the recruitment e-mail to electronics faculty at DeVry University's Chicago and 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 the first through fifth trimester students in ECT; and first through ninth trimester students in EET and CET programs at DeVry-Chicago and Tinley Park. Occasionally, during times when the researcher was unavailable, the class instructors gave the surveys. Table 3.1 displayed 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. 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 3.6 shows frequencies and percentages of gender and program level of the participants.

Table 3.6

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 three parts: (1) descriptive statistics, (2) quantitative inferential analyses, and (3) qualitative 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 eleven DVs, the researcher needed eleven of the 2 x 3 factorial ANOVAs to answer the eleven 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 (Morgan, Griego, & Gloeckner, 2001).

For each of the eleven 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 (Morgan, Leech, Gloeckner, & Barrett, 2004). If the interaction was not statistically significant, the main effects were examined first, followed by cell contrast tests.

To answer the twelfth research question, multiple regression was conducted to investigate which combination of self-confidence; self-efficacy; approachability, concern, and fairness of the electronics professors; pre-college mathematics/science interest and grades; years of mathematics/science in high school; parents' education; professors' use of teamwork; pre-college encouragement; pre-college consideration to apply for a career-oriented university; household income; genders of students; and program levels predict satisfaction with the electronics programs at DeVry-Chicago better than any predictor alone. The researcher used a Pearson correlation matrix of the 12 predictor variables to check for multicollinearity (Morgan, Leech, Gloeckner, & Barrett, 2004). The correlation table showed the Pearson correlation coefficients, and significance levels.

Through a qualitative analysis approach, the researcher analyzed the answers given to the two open-ended questions at the end of the questionnaire (Creswell, 1998). Individual responses were compiled and coded into categories using SPSS. Frequencies and percentages were the statistical methods used to report the results.

CHAPTER 4: RESULTS

Overview

This chapter presents descriptive statistics and the findings of quantitative inferential and qualitative analyses of male and female students in terms of their enrollment and retention issues in DeVry University's electronics programs at the Chicago area campuses. The first section is the descriptive statistics of the demographic data and the dependent variables involved in the study. In the quantitative inferential analyses section, the researcher addresses each research question in the same order as written in chapter 1 by performing statistical analysis using SPSS. In the qualitative analyses section, two open-ended questions from the survey were analyzed using coding, frequencies, and percentages.

Descriptive Statistics

Demographic data of participants' gender, program level, and age was collected through questions 33-35 of the survey. Questions 1-35 measured (a) self-confidence, (b) self-efficacy, (c) professors' use of teamwork, (d) approachability, concern, and fairness of electronics professors, (e) pre-college mathematics and science interest level and grades, (f) pre-college encouragement, (g) pre-college consideration to apply for electronics, (h) satisfaction with electronics programs, (i) household income, (j) years of mathematics and science in high school, and (k) parents' education 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 4.1 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. The majority (85%) of participants were between the

Table 4.1

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	

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 3.5 showed frequencies and percentages of each gender and program level of the participants.

Self-Confidence

Table 4.2 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 4.2

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 4.3 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 4.3

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" ($M = 5.33$).

Professors' Use of Teamwork; Approachability, Concern, and Fairness of Electronics Professors; Pre-College Mathematics/science Interest and Grades; Pre-College Encouragement; Pre-College Consideration to Apply for Electronics

Table 4.4 presents students' ratings for professors' use of teamwork; approachability, concern, and fairness of electronics professors; pre-college mathematics/science interest and grades; pre-college encouragement; and pre-college consideration to apply for electronics in DeVry University's electronics programs at the Chicago area campuses. Professors' use of teamwork measures the level of teamwork or group/project work professors encourage where students support and assist each other. Of the 575 students, 74.4% indicated professors' use of teamwork, while 14.8% indicated they did not. The mean rating of 5.36 was closer to "mildly agree" (5) than "agree" (6).

Approachability, concern, and fairness of electronics professors measures the approachability of professors to the students, their levels of concern for student success, and their ability to promote equality in electronics classes. On the summated scale, of the 576 students, 75% agreed that the electronics professors were approachable, concerned, and fair, while 11.3% indicated they were not. The mean rating of 5.39 was closer to "mildly agree" (5) than "agree" (6). The mean rating on "professors are encouraging" ($M = 5.17$) is lower than the mean ratings on "professors promote equality" ($M = 5.50$) and "professors are approachable" ($M = 5.49$).

Pre-college mathematics/science interest and grades measure the student's pre-college interest and participation in mathematics/science projects, societies or interest

Table 4.4

Frequencies, Percentages, Means, Standard Deviations for Professors' Use of Teamwork; Summated Approachability, Concern, and Fairness of Electronics Professors; Summated Pre-College Mathematics/science Interest and Grades Ratings; Pre-College Encouragement; and Pre-College Consideration to Apply for Electronics Ratings

Rating	*N*	% Agree	% Disagree	*M*	*SD*
Professors' Use of Teamwork	575	74.4	14.8	5.36	1.67
Summated Approachability, Concern, Fairness of Electronics Professors	576	75.0	11.3	5.39	1.22
Professors are Approachable	575	81.7	10.8	5.49	1.40
Professors are Encouraging	576	73.6	11.6	5.17	1.44
Professors Promote Equality	575	78.6	21.4	5.50	1.40
Summated Pre-College Mathematics/science Interest and Grades	576	-	-	4.06	1.22
Mathematics/science Interest	575	73.6	14.8	5.33	1.70
Mathematics/science Projects	575	38.1	39.1	3.92	2.00
Mathematics/science Grades	566	-	-	2.94*	0.82*
Pre-College Encouragement	575	51.5	32.5	4.29	2.03
Pre-College Consideration to Apply for Electronics	575	59.8	26.3	4.69	1.87

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.
* *Note.* Ratings based on a scale of 0 to 4 with 0 = F, 1 = D, 2 = C, 3 = B, and 4 = A.

groups, and pre-college mathematics/science average grades. The mean rating on "mathematics/science projects" (M = 3.92) is lower than the mean ratings on "mathematics/science interest" (M = 5.33).

Pre-college encouragement measures the influence role models such as family members, friends, and pre-college teachers had on the student's majoring in electronics and computer technology. Of the 575 students, 51.5% agreed that they had pre-college encouragement, while 32.5% indicated they did not. The mean rating of 4.29 was closer to “neither agree nor disagree” (4) than “mildly agree” (5).

Pre-college consideration to apply for electronics measures the level of pre-college consideration to apply for electronics or computer engineering technology programs at a career-oriented university. Of the 575 students, 59.8% agreed that they had considered applying for electronics, while 26.3% indicated they did not. The mean rating of 4.69 was close to “mildly agree” (5).

Satisfaction with Electronics Programs

Table 4.5 presents ratings for satisfaction with electronics programs of students in DeVry University’s electronics programs at the Chicago area campuses. Satisfaction with

Table 4.5

Frequencies, Percentages, Means, Standard Deviations for Summated Satisfaction with Electronics Programs Ratings

Rating	*N*	% Agree	% Disagree	*M*	*SD*
Summated Satisfaction with Electronics Programs	575	63.8	20.0	4.95	1.42
Satisfaction with Electronics Programs	574	69.9	19.9	4.91	1.62
Satisfaction with Electronics Professors	574	73.5	17.9	5.04	1.63
Satisfaction with Electronics Career Opportunities	571	65.1	16.6	4.89	1.60

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.

electronics programs measures the student’s satisfaction with electronics professors, electronics programs, and the career opportunities. On the summated scale, of the 575 students, 63.8% demonstrated some satisfaction with electronics programs, while 20.0% said they did not. The mean rating of 4.95 was close to “mildly agree” (5).

Household Income

Table 4.6 presents ratings for household income of students in DeVry University’s electronics programs at the Chicago area campuses. Of the 552 students, about one-third (33.2%) reported that their household income was “$50,000 or above”, while 66.8% indicated “$49,000 or less.” The mean rating of 2.05 was about “$30,000-49,000” (2).

Table 4.6

Frequencies, Percentages, Means and Standard Deviations for Household Income Ratings (N = 576)

Rating	*N*	%	*M*	*SD*
Household Income	552	100.0	2.05	1.05
$29,000 or less	223	40.4		
$30,000-49,000	146	26.4		
$50,000-79,000	114	20.7		
$80,000 or above	69	12.5		
Missing	24	4.2		

Note. Ratings based on a scale of 1 to 4 with 1 = $29,000 or less, 2 = $30,000-49,000, 3 = $50,000-79,000, and 4 = $80,000 or above.

Years of Mathematics and science in High School; Parent’s Education

Table 4.7a presents ratings for years of mathematics and science in high school of students in DeVry University’s electronics programs at the Chicago area campuses. Years of mathematics and science in high school measures the number of years of mathematics and science the student took in high school. Of the 572 students, over one-fourth (28.4%) of students indicated “4 years or more” of mathematics and science in high school, while

71.5% indicated "less than 4 years." On the summated years of mathematics/science in high school scale, the mean rating of 3.20 was closer to 3 than 4 years.

Table 4.7a

Frequencies, Percentages, Mean and Standard Deviation for Years of Mathematics/science in High School Ratings

Rating	*N*	%	*M*	*SD*
Years of Mathematics/science in High School	572	100.0		
1	30	5.2		
2	110	19.3		
3	269	47.0		
4	161	28.1		
5	2	.3		
Missing	4			
Summated Years of Mathematics/science in High School	572		3.20	.77
Years of Mathematics in High School	570		3.42	.81
Years of Science in High School	569		2.98	.91

Note. Ratings for mean and standard deviation based on a scale of 1 to 4 with 1 = 1, 2 = 2, 3 = 3, and 4 = 4.

Table 4.7b displays ratings for parents' education of students in DeVry University's electronics programs at the Chicago area campuses. Parents' education measures the highest educational levels student's parents' achieved. Of the 568 participants, 35.5% reported that their parents' highest educational level was "some college" and more, while 64.4% reported less than "some college." On the summated parents' education scale, the mean rating of 2.42 was between "H.S. degree" (2) and "some college" (3).

Table 4.7b

Frequencies, Percentages, Mean and Standard Deviation for Parents' Education Ratings

Rating	*N*	%	*M*	*SD*
Parents' Education	568	100.0		
Less than H.S. degree	141	24.8		
H.S. degree	225	39.6		
Some College	128	22.5		
B.S./B.A. or more	74	13.0		
Missing	8			
Summated Parents' Education	568		2.42	.95
Father's Highest Education	552		2.36	1.08
Mother's Highest Education	567		2.47	1.06

Note. Ratings for mean and standard deviation based on a scale of 1 to 4 with 1 = Less than H.S. degree, 2 = H.S. degree, 3 = Some College, and 4 = B.S./B.A. or more.

Quantitative Inferential Analyses

Research Question 1

The first research question was to explore: (a) if there was a significant difference between the genders of students in DeVry University's electronics programs at the Chicago area campuses in regard to self-confidence; (b) if there was a significant difference between the program levels in DeVry University's electronics programs at the Chicago area campuses in regard to self-confidence; and (c) if there was an interaction between the genders of students and the program levels in DeVry University's electronics programs at the Chicago area campuses in regard to self-confidence.

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 4.8a shows the means and standard deviations for the program levels by gender. Table 4.8b 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 4.1).

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 4.8a). Eta for gender was 0.134, which according to Cohen (1988), is a small effect size.

Table 4.8a

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

Table 4.8b

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		

** $p = .001$

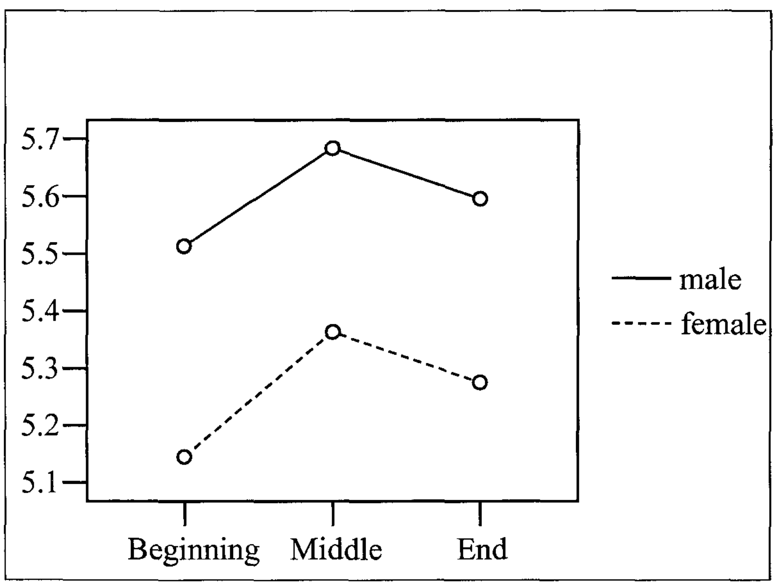

Figure 4.1. Plot of three simple effects on self-confidence.

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 (1988), is close to medium effect size. 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.

Research Question 2

The second research question was to investigate: (a) if there was a significant difference between the genders of students in DeVry University's electronics programs at the Chicago area campuses in regard to self-efficacy; (b) if there was a significant difference between the program levels in DeVry University's electronics programs at the Chicago area campuses in regard to self-efficacy; and (c) if there was an interaction between the genders of students and the program levels in DeVry University's electronics programs at the Chicago area campuses in regard to self-efficacy. 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 4.9a shows the means and standard deviations for the program levels by gender. Table 4.9b 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 4.9a

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 4.9b

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		

Research Question 3

The third research question was to examine: (a) if there was a significant difference between the genders of students in DeVry University's electronics programs at the Chicago area campuses in regard to approachability, concern, and fairness of electronics professors; (b) if there was a significant difference between the program levels in DeVry University's electronics programs at the Chicago area campuses in regard to approachability, concern, and fairness of electronics professors; and (c) if there was an interaction between the genders of students and the program levels in DeVry University's electronics programs at the Chicago area campuses in regard to approachability, concern, and fairness of electronics professors. Approachability, concern, and fairness of electronics professors is the dependent variable that measures the approachability of professors to the students, their levels of concern for student success, and their ability to promote equality in electronics classes.

The researcher performed a 2 x 3 factorial ANOVA test for approachability, concern, and fairness of electronics professors as a function of gender and program level. Table 4.10a shows the means and standard deviations for the program level by gender. Table 4.10b indicates that there was no significant interaction between gender and program level ($p = .586$). There was no significant main effect of gender or program level on approachability, concern, and fairness of electronics professors, either.

Table 4.10a

Means and Standard Deviations for Approachability, Concern, and Fairness of Electronics Professors as a Function of Gender and Program Level

	Male			Female			Total	
Program Level	*M*	*SD*	*n*	*M*	*SD*	*N*	*M*	*SD*
Beginning	5.44	1.15	168	5.10	1.64	30	5.39	1.24
Middle	5.45	1.05	122	5.18	1.62	30	5.39	1.18
End	5.40	1.21	183	5.38	1.36	40	5.39	1.23
Total	5.42	1.15	473	5.23	1.51	100	5.39	1.22

Table 4.10b

Two-Way Analysis of Variance for Approachability, Concern, and Fairness of Electronics Professors as a Function of Gender and Program Level

Variance and Source	*df*	*MS*	*F*	η^2
Approachability, Concern, and Fairness of Professors				
Gender	1	3.54	2.34	.004
Program Level	2	.42	.28	.001
Gender*Program Level	2	.80	.54	.002
Error	567	1.49		

Research Question 4

The fourth research question was to explore: (a) if there was a significant difference between the genders of students in DeVry University's electronics programs at the Chicago area campuses in regard to pre-college mathematics/science interest and grades; (b) if there was a significant difference between the program levels in DeVry University's electronics programs at the Chicago area campuses in regard to pre-college mathematics/science interest and grades; and (c) if there was an interaction between the genders of students and the program levels in DeVry University's electronics programs at the Chicago area campuses in regard to pre-college mathematics/science interest and grades. Pre-college mathematics/science interest and grades is the dependent variable, which measures pre-college interest and participation in mathematics/science projects, societies or interest groups, and pre-college mathematics/science average grades of the students in DeVry University's electronics programs at the Chicago area campuses.

The researcher performed a 2 x 3 factorial ANOVA test for pre-college mathematics/science interest and grades as a function of gender and program level. Table

4.11a shows the means and standard deviations for the program levels by gender. Table 4.11b indicates that there was no significant interaction between gender and program level (p = .404). There was no significant main effect of gender or program level on pre-college mathematics/science interest and grades, either.

Table 4.11a

Means and Standard Deviations for Pre-college Mathematics/science Interest and Grades as a Function of Gender and Program Level

	Male			Female			Total	
Program Level	*M*	*SD*	*n*	*M*	*SD*	*N*	*M*	*SD*
Beginning	3.98	1.19	168	3.69	1.47	30	3.93	1.24
Middle	3.99	1.30	122	4.12	1.46	30	4.02	1.33
End	4.21	1.13	183	4.20	1.15	40	4.21	1.13
Total	4.07	1.20	473	4.04	1.35	100	4.07	1.23

Table 4.11b

Two-Way Analysis of Variance for Pre-college Mathematics/science Interest and Grades as a Function of Gender and Program Level

Variance and Source	*df*	*MS*	*F*	η^2
Pre-college Mathematics/science Interest and Grades				
Gender	1	.13	.09	.000
Program Level	2	4.08	2.73	.010
Gender*Program Level	2	1.36	.91	.003
Error	567	1.50		

Research Question 5

The fifth research question was to investigate: (a) if there was a significant difference between the genders of students in DeVry University's electronics programs at the Chicago area campuses in regard to satisfaction with electronics programs; (b) if there was a significant difference between the program levels in DeVry University's electronics programs at the Chicago area campuses in regard to satisfaction with electronics programs; and (c) if there was an interaction between the genders of students and the program levels in DeVry University's electronics programs at the Chicago area campuses in regard to satisfaction with electronics programs. Satisfaction with electronics programs is the dependent variable, which measures the student's satisfaction with electronics professors, electronics programs, and the career opportunities that DeVry University's Chicago area campuses offer.

The researcher performed a 2 x 3 factorial ANOVA test for satisfaction with electronics programs as a function of gender and program levels. Table 4.12a shows the means and standard deviations for the program levels by gender. Table 4.12b indicates that there was no significant interaction between gender and program levels (p = .451).

Table 4.12a

Means and Standard Deviations for Satisfaction with Electronics Programs as a Function of Gender and Program Level

	Male			Female			Total	
Program Level	*M*	*SD*	*n*	*M*	*SD*	*N*	*M*	*SD*
Beginning	5.39	1.19	168	5.19	1.36	30	5.36	1.22
Middle	4.75	1.43	122	5.04	1.66	30	4.81	1.48
End	4.66	1.52	182	4.77	1.33	40	4.68	1.48
Total	4.95	1.42	472	4.98	1.44	100	4.95	1.43

Table 4.12b

Two-Way Analysis of Variance for Satisfaction with Electronics Programs as a Function of Gender and Program Level

Variance and Source	*df*	*MS*	*F*	η^2
Satisfaction with Electronics Programs				
Gender	1	.34	.17	.000
Program Level	2	9.62	4.93**	.017
Gender*Program Level	2	1.56	.80	.003
Error	566	1.95		

$^{**}p < 0.01$

Even though there was no significant main effect of gender, $F\,(1{,}566) = .17, p = .678$, there was a significant main effect of program level on satisfaction with electronics programs, $F\,(2{,}566) = 4.93, p < 0.01$. Mean rating of the students at the beginning program level was 0.55 points higher than the students at the middle program level, and students at the beginning program level had 0.68 points higher ratings than the students at the end program level (see Table 4.12a). Eta for program level was 0.13, which according to Cohen (1988), is a small effect size.

One-way ANOVA test was performed in order to identify which simple main effects of program level (beginning versus middle, beginning versus end, and middle versus end) were statistically significant for both genders, $F\,(2,\, 569) = 13.42, p = .000$. Games-Howell post hoc test revealed that that there was a significant difference between the ratings at the beginning and middle program levels in terms of satisfaction with electronics programs. Both genders at the beginning program level had significantly higher ratings than at the middle program level, $p < 0.001$. Mean difference (MD) between the ratings at the beginning and middle program levels was .56, the pooled standard deviation was 1.35, and the effect size, $d = .56/1.35 = .42$, which according to Cohen (1988), is close to medium effect size. Games-Howell post hoc test also revealed that there was a significant difference between the ratings at the beginning and end program levels in terms of satisfaction with electronics programs. Both genders at the beginning program level had significantly higher ratings than at the end program level, $p < 0.001$. Mean difference (MD) between the ratings at the beginning and end program levels was .68, the pooled standard deviation was 1.35, and the effect size, $d = .68/1.35 = .50$, which according to Cohen (1988), is medium effect size. There was no significant difference between the ratings at the middle and end program levels in terms of satisfaction with electronics programs.

A visual inspection of the profile plot in Figure 4.2, for both genders displays a large difference between the ratings at the beginning and middle program levels, and between the ratings at the beginning and end program levels in terms of satisfaction with electronics programs.

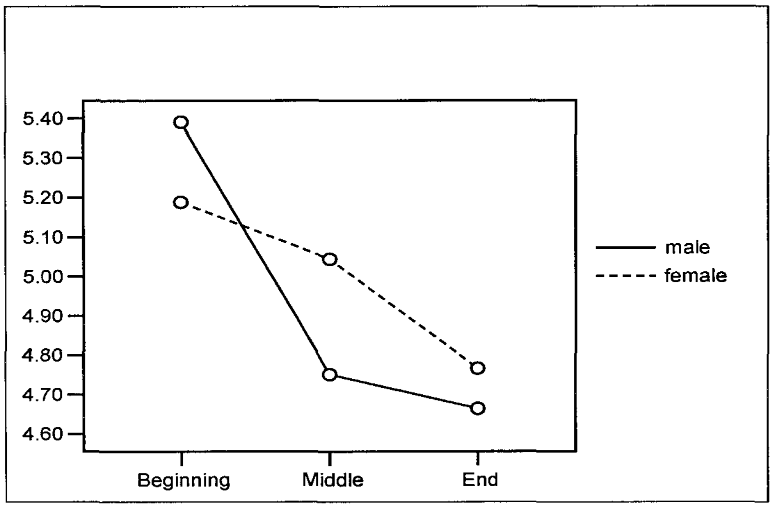

Figure 4.2. Plot of simple effects on satisfaction with electronics programs.

Research Question 6

The sixth research question was to explore: (a) if there was a significant difference between the genders of students in DeVry University's electronics programs at the Chicago area campuses in regard to years of mathematics and science in high school; (b) if there was a significant difference between the program levels in DeVry University's electronics programs at the Chicago area campuses in regard to years of mathematics and science in high school; and (c) if there was an interaction between the genders of students and the program levels in DeVry University's electronics programs at the Chicago area campuses in regard to years of mathematics and science in high school. Years of mathematics and science in high school is the dependent variable, which measures the number of years of mathematics and science the student took in high school.

The researcher performed a 2 x 3 factorial ANOVA test for years of mathematics and science in high school as a function of gender and program level. Table 4.13a shows the means and standard deviations for the program levels by gender. Table 4.13b

Table 4.13a

Means and Standard Deviations for Years of Mathematics and science in High School as a Function of Gender and Program Level

	Male			Female			Total	
Program Level	*M*	*SD*	*n*	*M*	*SD*	*N*	*M*	*SD*
Beginning	3.21	.75	168	3.26	.75	29	3.22	.75
Middle	3.20	.77	121	3.15	.87	30	3.19	.78
End	3.22	.76	181	3.04	.85	40	3.19	.78
Total	3.21	.76	470	3.14	.83	99	3.20	.77

indicates that there was no significant interaction between gender and program level (p = .508). There was no significant main effect of gender or program level on years of mathematics and science in high school, either.

Table 4.13b

Two-Way Analysis of Variance for Years of Mathematics and science in High School as a Function of Gender and Program Level

Variance and Source	*df*	*MS*	*F*	η^2
Years of Mathematics and science in High School				
Gender	1	.30	.51	.001
Program Level	2	.30	.50	.002
Gender*Program Level	2	.41	.68	.002
Error	563	.60		

Research Question 7

The seventh research question was to investigate: (a) if there was a significant difference between the genders of students in DeVry University's electronics programs at the Chicago area campuses in regard to parents' education; (b) if there was a significant difference between the program levels in DeVry University's electronics programs at the Chicago area campuses in regard to parents' education; and (c) if there was an interaction between the genders of students and the program levels in DeVry University's electronics programs at the Chicago area campuses in regard to parents' education. Parents' education is the dependent variable, which measures student's parents' highest educational levels.

The researcher performed a 2 x 3 factorial ANOVA test for parents' education as a function of gender and program levels. Table 4.14a shows the means and standard deviations for the program levels by gender. Table 4.14b reveals that there was a significant interaction between gender and program levels on parents' education, $F(2, 560) = 4.42$, $p < 0.05$. Eta for the interaction was .126, which according to Cohen (1988), is a small effect size.

Table 4.14a

Means and Standard Deviations for Parents' Education as a Function of Gender and Program Level

	Male			Female			Total	
Program Level	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*
Beginning	2.46	.92	164	2.08	.68	30	2.40	.89
Middle	2.29	.98	121	2.67	.94	30	2.36	.98
End	2.51	.96	181	2.30	1.01	30	2.48	.97
Total	2.44	.95	466	2.35	.92	40	2.42	.95

Table 4.14b

Two-Way Analysis of Variance for Parents' Education as a Function of Gender and Program Level

Variance and Source	*df*	*MS*	*F*	η^2
Parents' Education				
Gender	1	.41	.46	.001
Program Level	2	1.10	1.24	.004
Gender*Program Level	2	3.92	4.42*	.016
Error	560	.89		

* $p < 0.05$

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 not significant, the researcher used equal variances assumed in the contrast tests. Contrast tests showed that there was a significant difference between male and female students in the beginning program level in terms of parents' education (see Figure 4.3). Male students had significantly higher parents' education ratings than female students, t (560) = 2.02, $p < 0.05$. Mean difference between the males and females in the beginning program level was 0.38, the pooled standard deviation was 0.80, and the effect size, d = .38/.80 = .48, which according to Cohen (1988), is medium effect size. Contrast tests also revealed that there was a significant difference between male and female students in the middle program level in terms of parents' education (see Figure 4.3). Female students had significantly higher parents' education ratings than male students, t (560) = -1.97, p = 0.05. Mean difference between the males and females in the middle program level was -.38, the pooled standard deviation was 0.96, and the effect size, d = .38/.96 = .40, which according to Cohen (1988), is close medium effect size. There were no significant differences between males and females in the end program level in regard to parents' education.

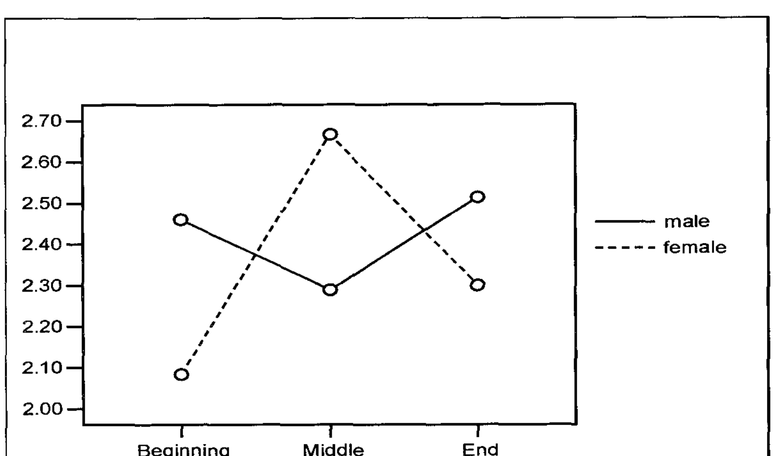

Figure 4.3. Plot of three simple effects on parents' education.

Research Question 8

The eighth research question was to examine: (a) if there was a significant difference between the genders of students in DeVry University's electronics programs at the Chicago area campuses in regard to professors' use of teamwork; (b) if there was a significant difference between the program levels in DeVry University's electronics programs at the Chicago area campuses in regard to professors' use of teamwork; and (c) if there was an interaction between the genders of students and the program levels in DeVry University's electronics programs at the Chicago area campuses in regard to professors' use of teamwork. Professors' use of teamwork is the dependent variable, which measures the level of teamwork or group/project work professors encourage where students support and assist each other.

The researcher performed a 2 x 3 factorial ANOVA test for professors' use of teamwork as a function of gender and program level. Table 4.15a shows the means and standard deviations for the program levels by gender. Table 4.15b indicates that there was no significant interaction between gender and program level ($p = .883$). There was no significant main effect of gender or program level on professors' use of teamwork, either.

Table 4.15a

Means and Standard Deviations for Professors' Use of Teamwork as a Function of Gender and Program Level

	Male			Female			Total	
Program Level	*M*	*SD*	*n*	*M*	*SD*	*N*	*M*	*SD*
Beginning	5.31	1.70	168	5.17	1.95	30	5.29	1.74
Middle	5.43	1.58	122	5.31	1.76	29	5.41	1.61
End	5.37	1.64	183	5.43	1.62	40	5.38	1.63
Total	5.37	1.64	473	5.31	1.75	99	5.36	1.66

Table 4.15b

Two-Way Analysis of Variance for Professors' Use of Teamwork as a Function of Gender and Program Level

Variance and Source	*df*	*MS*	*F*	η^2
Professors' Use of Teamwork				
Gender	1	.41	.15	.000
Program Level	2	.80	.29	.001
Gender*Program Level	2	.35	.13	.000
Error	566	2.78		

Research Question 9

The ninth research question was to explore: (a) if there was a significant difference between the genders of students in DeVry University's electronics programs at the Chicago area campuses in regard to pre-college encouragement; (b) if there was a significant difference between the program levels in DeVry University's electronics programs at the Chicago area campuses in regard to pre-college encouragement; and (c) if there was an interaction between the genders of students and the program levels in DeVry University's electronics programs at the Chicago area campuses in regard to pre-college encouragement. Pre-college encouragement is the dependent variable, which measures the influence role models such as family members, friends, and pre-college teachers had on the student's majoring in electronics and computer technology.

The researcher performed a 2 x 3 factorial ANOVA test for pre-college encouragement as a function of gender and program levels. Table 4.16a shows the means and standard deviations for the program levels by gender. Table 4.16b reveals that there was a significant interaction between gender and program levels on pre-college encouragement, $F(2, 566) = 5.17, p < 0.01$. Eta for the interaction was 0.134, which according to Cohen (1988), is a small effect size.

Table 4.16a

Means and Standard Deviations for Pre-College Encouragement as a Function of Gender and Program Level

	Male			Female			Total	
Program Level	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*
Beginning	4.48	1.99	168	2.83	2.02	30	4.23	2.08
Middle	4.34	1.93	122	4.43	2.10	30	4.36	1.96
End	4.33	2.02	182	4.00	2.10	40	4.27	2.04
Total	4.39	1.99	472	3.78	2.15	100	4.28	2.03

Table 4.16b

Two-Way Analysis of Variance for Pre-College Encouragement as a Function of Gender and Program Level

Variance and Source	*df*	*MS*	*F*	η^2
Pre-College Encouragement				
Gender	1	31.87	7.94**	.014
Program Level	2	14.26	3.55*	.012
Gender*Program Level	2	20.75	5.17**	.018
Error	566	4.01		

* $p < 0.05$, ** $p < 0.01$

There was a significant main effect of gender, $F(1, 566) = 7.94, p < 0.01$, and a significant main effect of program level on pre-college encouragement, $F(2, 566) = 3.55$, $p < 0.05$. Males had 0.61 points higher average ratings than females, females from the end of program level had 1.6 points higher average ratings than females from the beginning of program level, and females from the middle program level had 1.17 points higher average ratings than females from the beginning of program level in regard to pre-college encouragement (see Table 4.16a). Eta for gender was 0.12, and eta for program level was 0.11, which according to Cohen (1988), are small effect sizes.

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 not significant, the researcher used equal variances assumed in the contrast tests. Contrast tests demonstrated that there was a significant difference between male and female students in the beginning program level in terms of pre-college encouragement (see Figure 4.4). Male students had significantly higher pre-college encouragement ratings than female students, $t\ (566) = 4.14, p < 0.001$. Mean difference (MD) between the males and females in the beginning program level was 1.64, the pooled standard deviation was 2.01, and the effect size, $d = 1.64/2.01 = .82$, which according to Cohen (1988), is large effect size. There were no significant differences between males and females in the middle program level or between males and females in the end program level in regard to pre-college encouragement.

The statistically significant interaction is seen in that the lines on the profile plot in Figure 4.4 intersect. A visual inspection of the profile plot also displays a large difference between males and females in the beginning program level, but little difference between males and females in the middle program level, or between males and females in the end program level, in terms of pre-college encouragement.

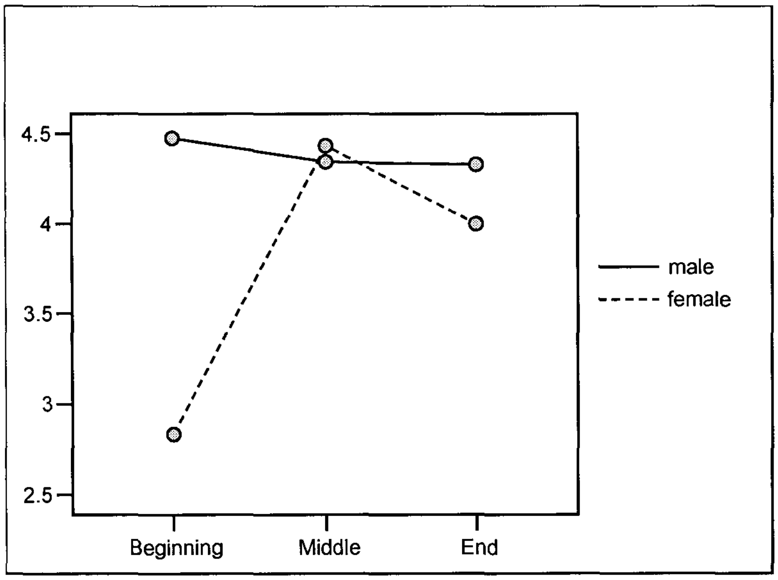

Figure 4.4. Plot of three simple effects on pre-college encouragement.

Research Question 10

The tenth research question was to investigate: (a) if there was a significant difference between the genders of students in DeVry University's electronics programs at the Chicago area campuses in regard to pre-college consideration to apply for electronics; (b) if there was a significant difference between the program levels in DeVry University's electronics programs at the Chicago area campuses in regard to pre-college consideration to apply for electronics; and (c) if there was an interaction between the genders of students and the program levels in DeVry University's electronics programs at the Chicago area campuses in regard to pre-college consideration to apply for electronics. Pre-college consideration to apply for electronics is the dependent variable, which measures the level of pre-college consideration to apply for electronics or computer engineering technology programs at a career-oriented university.

The researcher performed a 2 x 3 factorial ANOVA test for pre-college consideration to apply for electronics as a function of gender and program levels. Table 4.17a shows the means and standard deviations for the program levels by gender. Table 4.17b indicates that there was no significant interaction between gender and program levels (p = .281).

Table 4.17a

Means and Standard Deviations for Pre-College Consideration to Apply for Electronics as a Function of Gender and Program Level

	Male			Female			Total	
Program Level	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*
Beginning	4.92	1.85	168	4.27	2.03	30	4.82	1.89
Middle	4.40	1.81	122	4.47	2.01	30	4.41	1.84
End	4.90	1.78	182	4.25	2.06	40	4.78	1.84
Total	4.78	1.82	472	4.32	2.02	100	4.70	1.86

Table 4.17b

Two-Way Analysis of Variance for Pre-College Consideration to Apply for Electronics as a Function of Gender and Program Level

Variance and Source	*df*	*MS*	*F*	η^2
Pre-College Consideration to Apply for Electronics				
Gender	1	13.74	4.01*	.007
Program Level	2	.76	.80	.001
Gender*Program Level	2	4.36	.28	.004
Error	566	3.43		

** p = .05

Even though there was no significant main effect of program level, $F(2,566) = 1.27$, $p = .281$, there was a significant main effect of gender on pre-college consideration to apply for electronics, $F(1,566) = 4.01$, $p = .046$. Males had 0.46 points higher average rating than females in pre-college consideration to apply for electronics (see Table 4.17a). Eta for gender was 0.084, which according to Cohen (1988), is close to a small effect size.

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 not significant, the researcher used equal variances 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 pre-college consideration to apply for electronics. Male students had significantly higher pre-college consideration to apply for electronics ratings than female students, $t(566) = 2.00$, $p < 0.05$. Mean difference (MD) between the males and females in the end program level was 0.65, the pooled standard deviation was 1.92, and the effect size, $d = .65/1.92 = .34$, which according to Cohen (1988), is small effect size. 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 pre-college consideration to apply for electronics.

A visual inspection of the profile plot in Figure 4.5 displays a large difference between males and females in the end program level and a similarly large but not significant difference at the beginning program level ($p = .07$) in terms of pre-college consideration to apply for electronics.

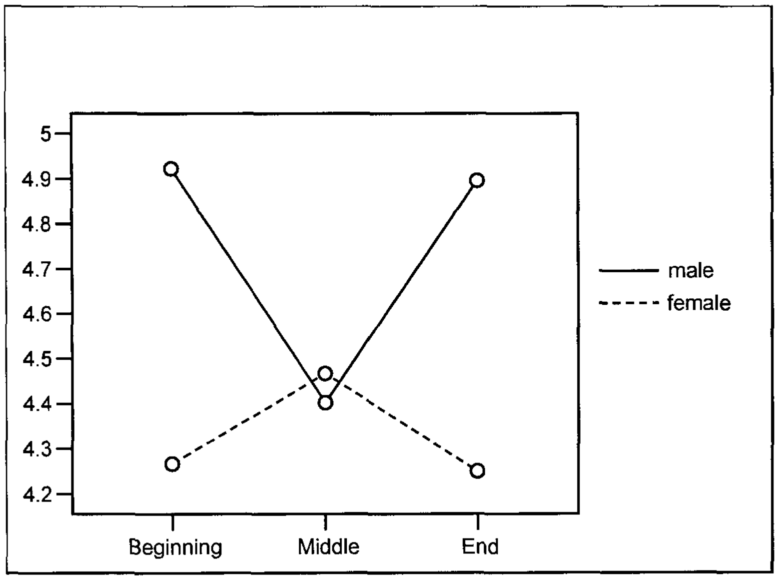

Figure 4.5. Plot of three simple effects on pre-college consideration to apply for electronics.

Research Question 11

The eleventh research question was to examine: (a) if there was a significant difference between the genders of students in DeVry University's electronics programs at the Chicago area campuses in regard to household income; (b) if there was a significant difference between the program levels in DeVry University's electronics programs at the Chicago area campuses in regard to household income; and (c) if there was an interaction between the genders of students and the program levels in DeVry University's electronics programs at the Chicago area campuses in regard to household income.

The researcher performed a 2 x 3 factorial ANOVA test for household income as a function of gender and program levels. Table 4.18a shows the means and standard deviations for the program levels by gender. Table 4.18b indicates that there was no significant interaction between gender and program levels (p = .117).

Even though there was no significant main effect of program level, $F(2,543) = .64, p = .53$, there was a significant main effect of gender on household income, $F(2,543) = 7.48, p < .01$. Males had 0.32 points higher average rating than females in household income (see Table 4.18a). Eta for gender was 0.12, which according to Cohen (1988), is a small effect size.

Table 4.18a

Means and Standard Deviations for Household Income as a Function of Gender and Program Level

	Male			Female			Total	
Program Level	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*
Beginning	2.21	1.11	159	1.55	.74	29	2.11	1.09
Middle	2.05	1.00	118	1.79	1.03	28	2.00	1.01
End	2.07	1.08	180	2.00	.91	35	2.06	1.05
Total	2.11	1.07	457	1.79	.91	92	2.06	1.05

Table 4.18b

Two-Way Analysis of Variance for Household Income as a Function of Gender and Program Level

Variance and Source	*df*	*MS*	*F*	η^2
Household Income				
Gender	1	8.19	7.48**	.014
Program Level	2	.70	.64	.002
Gender*Program Level	2	2.36	2.15	.008
Error	543	1.10		

** $p = .01$

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 beginning program level in terms of household income. Male students had significantly higher household income ratings than female students, $t\ (543) = 3.10, p < 0.01$. Mean difference (MD) between the males and females in the beginning program level was 0.66, the pooled standard deviation was 0.93, and the effect size, $d = .66/.93 = .71$, which according to Cohen (1988), is close to large effect size. There were no significant differences between males and females in the middle program level, and between males and females in the end program level, in regard to household income.

A visual inspection of the profile plot in Figure 4.6 displays a large difference between males and females in the beginning program level in terms of household income.

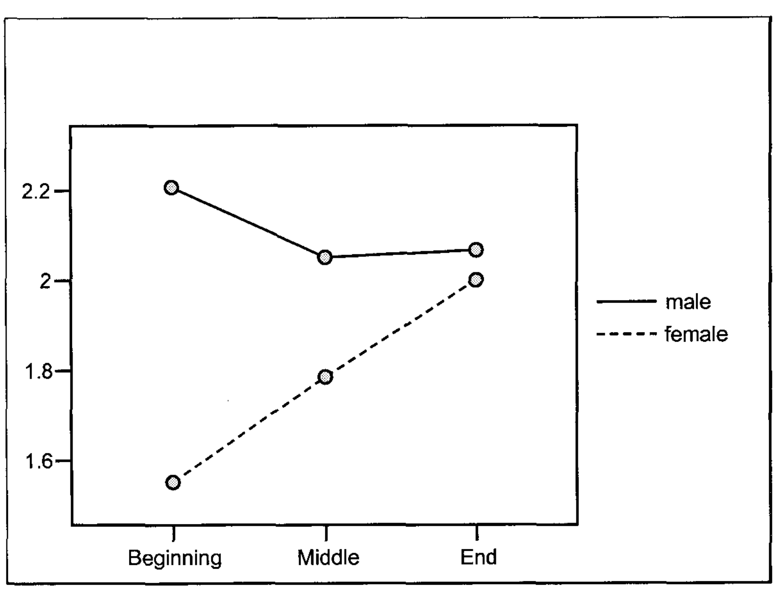

Figure 4.6. Plot of three simple effects on household income.

Research Question 12

The twelfth research question was to explore how well the combination of self-confidence; self-efficacy; approachability, concern, and fairness of the electronics professors; pre-college mathematics/science interest and grades; years of mathematics/science in high school; parents' education; professors' use of teamwork; pre-college encouragement; pre-college consideration to apply for a career-oriented university; household income; genders of students; and program levels predict satisfaction with the electronics programs in DeVry University's electronics programs at the Chicago area campuses.

Multiple regression was conducted to investigate the best predictors of satisfaction with the electronics programs. Table 4.19a shows the means, standard deviations, and correlation of satisfaction with electronics programs and predictor variables. Table 4.19b demonstrates intercorrelations of the 12 predictor variables. Only two medium to high correlations of .41 and .49 in table 4.19b indicated the presence of some but not much multicollinearity.

Table 4.19a

Means, Standard Deviations, and Correlation of Satisfaction with Electronics Programs and Predictor Variables (N = 540)

Variable	*M*	*SD*	Satisfaction with Electronics Programs
Predictor Variable			
Self-Confidence	5.55	.94	.50***
Self-Efficacy	5.70	.68	.24***
Approachability, concern, and fairness of the professors	5.40	1.23	.64***
Pre-college mathematics/science interest and grades	4.08	1.22	.11**
Years of mathematics/science in high school	3.21	.76	.03
Parents' education	2.42	.96	-.02
Professors' use of teamwork	5.34	1.68	.21***
Pre-college encouragement	4.30	2.02	.15***
Pre-college consideration to apply for a career-oriented university	4.69	1.84	.13***
Household income	2.07	1.06	-.07*
Genders of students	.17	.37	-.00
Program levels	2.05	.86	-.20***

$^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$.

Table 4.19b

Intercorrelations of the Twelve Predictor Variables of Satisfaction with Electronics Programs
(N = 540)

Variable	2	3	4	5	6	7	8	9	10	11	12
Predictor Variable											
1. S-C	.41	.49	.17	-.00	-.04	.13	.07	.08	-.03	-.12	.03
2. S-E	-	.27	.24	.01	-.01	.13	.04	.03	-.00	.08	.05
3. A-C-F		-	.12	-.01	.04	.29	.13	.07	-.02	-.05	-.01
4. P-MS-I			-	.33	.04	.16	.22	.25	-.04	.01	.09
5. Y-MS				-	.20	.08	.10	.11	.11	-.01	-.01
6. P-Ed					-	.07	.06	-.03	.26	-.05	.03
7. P-U-T						-	.19	.15	-.04	-.01	.03
8. P-En							-	.35	.02	-.13	.00
9. P-C-A								-	-.05	-.09	-.01
10. H-I									-	-.11	-.02
11. G-S										-	.02
12. P-L											-

Note. S-C = Self-confidence, S-E = Self-efficacy, A-C-F = Approachability, concern, and fairness of the professors, P-MS-I = Pre-college mathematics/science interest and grades, Y-MS = Years of mathematics/science in high school, P-Ed = Parents' education, P-U-T = Professors' use of teamwork, P-En = Pre-college encouragement, P-C-A = Pre-college consideration to apply for a career-oriented university, H-I = Household income, G-S = Genders of students, and P-L = Program levels.

Table 4.19a displayed that there was a significant association between approachability, concern, and fairness of the electronics professors and satisfaction with the electronics programs, $r = .64, p < .001$. According to Cohen (1988), this is close to a very large effect size. The direction of the association was positive, which implied that students who had high ratings in approachability, concern, and fairness of the electronics professors were likely to have high satisfaction with the electronics programs, or vice versa. The *r*-squared (r^2) displayed that 41% of the variance in satisfaction with the electronics programs could be predicted from approachability, concern, and fairness of the electronics professors.

In addition, table 4.19a indicated that there was a significant association between self-confidence and satisfaction with the electronics programs, $r = .50, p < .001$. According to Cohen (1988), this is a large effect size. The direction of the association was positive, which implied that students who had high self-confidence scores were likely to have high satisfaction with the electronics programs, or vice versa. The *r*-squared (r^2) indicated that 25% of the variance in satisfaction with the electronics programs could be predicted from self-confidence.

Table 4.19a also showed that there were significant associations between self-efficacy, pre-college mathematics/science interest and grades, professors' use of teamwork, pre-college encouragement, pre-college consideration to apply for a career-oriented university, household income, program levels; and satisfaction with the electronics programs. The correlation coefficients (r) ranged from -.20 to .24, significances (p) ranged from .001 to .05, and the effect sizes varied from "close to small" to "close to medium." The *r*-squared's (r^2) indicated that .5% to 5.8% of the variance in satisfaction with the electronics programs could be predicted from self-efficacy, pre-college mathematics/science interest and grades, professors' use of teamwork, pre-college encouragement, pre-college consideration to apply for a career-oriented university, household income, or program levels.

Simultaneous multiple regression analysis for satisfaction with electronics programs from the predictor variables is presented in table 4.19c. Table 4.19c also displays that the betas (β) for self-confidence; approachability, concern, and fairness of the electronics professors; genders of students, and program levels combine to be significant predictors of satisfaction with electronics programs. The other 8 variables do not add to the predictor. When all 12 variables are combined to predict satisfaction with electronics programs, $F\ (12, 527) = 46.78, p < .001$. The adjusted $R^2 = .51$ in table 4.18c indicated that 51% of the variance in satisfaction with electronics programs could be explained by the model. According to Cohen (1988), this is a very large effect size. The findings suggest that the student who reported high ratings on approachability, concern, and fairness of the electronics professors, who was self-confident, female, and at the beginning program level was satisfied the most with electronics programs. More details can be found in the discussion section of research question 12.

Table 4.19c
Simultaneous Multiple Regression Analysis Summary for the Variables Predicting Satisfaction with Electronics Programs (N = 540)

Variable	*B*	*SEB*	β
Self-Confidence	.40	.06	.26***
Self-Efficacy	-.02	.07	-.01
Approachability, concern, and fairness of the professors	.59	.04	.51***
Pre-college mathematics/science interest and grades	-.02	.04	-.02
Years of mathematics/science in high school	.06	.06	.03
Parents' education	-.03	.05	-.02
Professors' use of teamwork	.02	.03	.02
Pre-college encouragement	.04	.02	.05
Pre-college consideration to apply for a career-oriented university	.05	.03	.06
Household income	-.06	.04	-.05
Genders of students	.26	.12	.07*
Program levels	-.34	.05	-.20***
Constant	-.15	.46	

Note. $R^2 = .51$; $F\ (12, 527) = 46.78, p < .001$
*$p < .05$; **$p < .01$; *** $p < .001$.

Qualitative Analyses

Question1: What were the most important factors in high school that led you to select an electronics or computer engineering technology field in college? The statistical methods used to analyze the data were coding, recoding, frequencies, and percentages.

Table 4.20a displays the most important factors in high school that led the students to select an electronics or computer engineering technology field in college. The researcher compiled and coded the open-ended responses into categories.

Table 4.20a
Frequencies and Percentages of Responses to " Most Important Factors in High School that Led Students to Select an Electronics or Computer Engineering Technology Field in College"

Categories	Frequency[a]	%[b]
Like/love of mathematics, science, electronics, or computers; and having skills, abilities, and confidence in them	195	34
High school mathematics/science, electronics, computer courses/clubs/experiences	121	21
High school mathematics/science, electronics, computers, technology, engineering interest and grades	113	20
Negative high school experiences	44	8
Post-high school reasons	43	8
Positive teacher influences in high school	39	7
Job Opportunities	37	6
Positive DeVry factors	32	6
Positive pre-college family/friends influences/encouragements	17	3
Military service related reasons	13	2
Negative DeVry factors	3	1
None and missing	110	19

[a]$N = 576$
[b]Percentages total greater than 100% due to multiple responses

The most important factor was "Like/love of mathematics, science, electronics, or computers; and having skills, abilities, and confidence in them" as mentioned by 195 respondents (34%). Sample comments were:

Ease of understanding mathematics& science
Personal research into the field
Fascination with technology
It has always been my dream
Very good in mathematics
Love/like of computers (computer geek)
Self curiosity led me to this field
Like to build & fix computers
Like to work with hands
Curiosity on how things work

The next important factor was "High school mathematics/science, electronics, computer courses/clubs/experiences" as reported by 121 respondents (21%). Sample comments were:

Took CISCO networking courses in high school
Took programming classes in high school
Took science, mathematics & computer technology courses in high school
Robotics team
After school programs
Electronics classes in high school
Drafting classes
Science fairs
Computer club
Wanted to learn more electronics after high school

The factor of "High school mathematics/science, electronics, computers, technology, engineering interest and grades" was stated by 113 respondents (20%). Sample comments were:

Good high school grades in mathematics & science
Interested in computers & electronics
Challenge of understanding electronics
Interested in electronics before high school
Interests in technology

The category of "Negative high school experiences" was reported by 44 respondents (8%). Sample comments were:

Most teachers did not care
No electronic or computers classes at school
High school had nothing to do with my decision
Not choice major in high school
High school principal said I would not amount to much

The next factor was "Post-high school reasons" as mentioned by 43 respondents (8%). Sample comments were:

As adult, increased interests in science and computers
As adult, returned to college with no high school influence
Adult's current job required computer engineering
Outsourcing have forced me to enter the electronics field
Decided years later

The factor of "Positive teacher influences in high school" was stated by 39 respondents (7%). Sample comments were:

Most important factor in high school is the teachers
Mathematics teacher(s)
High school graphics arts teacher
Science teacher(s)
Mechanical engineering teacher(s)

The next response was "Job opportunities" as mentioned by 37 respondents (6%). Sample comments were:

Plenty of opportunities
Engineering profession is rewarding in salary
Knowing that tech fields are the direction of the future
Being told I can make good money
Growing and expanding electronics field

The category of "Positive DeVry factors" was stated by 32 respondents (6%). Sample comments were:

High school counselor informed me about electronics fields at DeVry
Attending the College EXCEL program at DeVry

DeVry representative at the job fairs
DeVry representative came to my high school
Location of DeVry

The factor of "Positive pre-college family/friends influences/encouragements" was reported by 17 respondents (3%). Sample comments were:

Family influences
Family businesses
Friends entered IT fields
Family attended DeVry
Met engineers

The next category was "Military service related reasons" as mentioned by 13 respondents (2%). Sample comments were:

During Navy training
After military service

The last response of "Negative DeVry factors" was stated by 3 respondents (1%). Sample comments were:

DeVry representative misinformed me
Cost of DeVry is too high

Of 767 responses, 610 (about 80%) were positive and 47 (about 6%) were negative.

In summary, the most important factors in high school that led the students to select an electronics or computer engineering technology field in college were: "like/love of mathematics, science, electronics, or computers; and having skills, abilities, and confidence in them", "high school mathematics/science, electronics, computer courses/clubs/experiences", and "high school mathematics/science, electronics, computers, technology, engineering interest and grades."

Question2: How has your experience at DeVry (course and/or instructor) impacted your interest in electronics or computer engineering technology? The statistical methods used to analyze the data were coding, recoding, frequencies and percentages.

Table 4.20b displays the ways students' experiences at DeVry (course and/or instructor) have impacted their interest in electronics or computer engineering technology. The researcher compiled and coded the open-ended responses into categories.

The most frequent response was "Increased interest in electronics or computer engineering technology" as mentioned by 165 respondents (29%). Sample comments were:

Increased interests in computer engineering technology
Increased interests in electronics
Increased interest due to hands-on
Increased interest in hardware and software
Increased interest so much that I want to obtain a M.S. & Ph.D.

The next category was "Increased knowledge, skills, motivation, hands-on experience in electronics or computer engineering technology" as reported by 139 respondents (24%). Sample comments were:

Hands-on experience
Have benefited from DeVry
The more I learn the more I want to learn
Motivated to learn more
Increased knowledge by learning hands-on
Learned to work in groups
Learned many more ideas & concepts
Courses lead you to troubleshoot circuits
Knowledge provided opportunities in vast range of applications
Made me want to learn more about computers

Table 4.20b

Frequencies and Percentages of Responses to "Ways Student Experiences at DeVry (Course and/or Instructor) Have Impacted Their Interest in Electronics or Computer Engineering Technology"

Categories	Frequency[a]	%[b]
Increased interest in electronics or computer engineering technology	165	29
Increased knowledge, skills, motivation, hands-on experience in electronics or computer engineering technology	139	24
Professors' approachability, knowledge, and encouragement increased interest in electronics or computer engineering technology	93	16
Did not change interest in electronics or computer engineering technology	49	9
Dissatisfaction with electronics or computer engineering technology programs and career opportunities DeVry offers	48	8
Issues with some professors decreased interest in electronics or computer engineering technology	48	8
Satisfaction with electronics or computer engineering technology programs and career opportunities DeVry offers	43	8
Personal difficulties with electronics/computer classes	34	6
Decreased interest in electronics or computer engineering technology	31	5
Other	15	3
None and Missing	79	14

[a]*N* = 576
[b]Percentages total greater than 100% due to multiple responses

The response of "Professors' approachability, knowledge, and encouragement increased interest in electronics or computer engineering technology" was stated by 93 respondents (16%). Sample comments were:

Professors update their knowledge and learn new technology
Some professors are really interested in my success
Professors have passion for their field
Can talk to professors
Professors are knowledgeable
Some teachers work hard with you to help make you feel confident
Professors motivate me to enhance problem-solving techniques
Professors have good work background
Professors increase interest by making class interesting
Professors are encouraging

The category of "Did not change interest in electronics or computer engineering technology" was reported by 49 respondents (9%). Sample comments were:

Did not change interest
No Effect
Increased interest in some areas and decreased in other
No impact yet
Maybe once I get into my 3^{rd} or 4^{th} term

The next category was "Dissatisfaction with electronics or computer engineering technology programs and career opportunities DeVry offers" as mentioned by 48 respondents (8%). Sample comments were:

Feel I am in the wrong field but I will finish
Courses are harder than expected
DeVry made me dislike electronics
More hands on courses are needed
Lack of job placement
Classes go by so fast that it is hard to learn electronics and it's a waste of money
Disappointed with core classes
Conflicting class schedules
Lack of state of the art lab equipment
No activities or clubs for night classes

The response of "Issues with some professors decreased interest in electronics or computer engineering technology" was stated by 48 respondents (8%). Sample comments were:

Some professors increase interest, some decrease interest
Some professors teach you, others leave you hanging
Teaching in monotone voice makes classes boring
Some professors encourage, others discourage
Poor communications of the professors
Some professors make me feel that the field is only for males
Some professors make me want to leave
Some professors are knowledgeable but unable to teach

The next response was "Satisfaction with electronics or computer engineering technology programs and career opportunities DeVry offers" as mentioned by 43 respondents (8%). Sample comments were:

DeVry has shown me different options/directions for careers
Interested in graduate school to pursue an MBA
Excited about graduation and professors were great
I am sure I picked the right field
DeVry made me think what I want to do

The category of "Personal difficulties with electronics/computer classes" was stated by 34 respondents (6%). Sample comments were:

Feel unable due to lack of ability to complete the program
Hard time keeping up with the class
Discouraged due to lack of work (jobs)
Not sure of the field
I will prove that women can make good engineers

The response of "Decreased interest in electronics or computer engineering technology" was reported by 31 respondents (5%). Sample comments were:

Killed my interest
Negative impact
Lost drive

The last category was "Other" as mentioned by 15 respondents (3%). Sample comments were:

Small classes are good
DeVry has a negative impact on returning adult students
Work in the field. Education process is never ending. DeVry keeps me sharp.
There is always something new at DeVry
DeVry is challenging and I like it
There are problems with male students

Of 744 responses, 534 (about 72%) were positive and 210 (about 28%) were negative.

In summary, the most important ways students' experiences at DeVry (course and/or instructor) have impacted their interest in electronics or computer engineering technology were: "increased interest in electronics or computer engineering technology", "increased knowledge, skills, motivation, hands-on experience in electronics or computer engineering technology", and "professors' approachability, knowledge, and encouragement increased interest in electronics or computer engineering technology".

Summary

Table 4.21 presents a summary of results for main effects of gender and program level on self-confidence; self-efficacy; approachability, concern, and fairness of electronics professors; pre-college mathematics and science interest level and grades; satisfaction with electronics programs; years of mathematics and science in high school; parents' education; professors' use of teamwork; pre-college encouragement; pre-college consideration to apply for electronics; and household income. Significant differences were found for gender: females had lower ratings than males in terms of self-confidence, pre-college encouragement; pre-college consideration to apply for electronics; and household income. Significant differences were found for program level: students at the

Table 4.21

Main Effects on the Eleven Dependent Variables

Dependent Variables	Main Effects: Gender	Program Level	Interaction[d]
Self-Confidence	*	NS	NS
Self-Efficacy	NS	NS	NS
Approachability, Concern, and Fairness of Electronics Professors	NS	NS	NS
Pre-college Mathematics/science Interest and Grades	NS	NS	NS
Satisfaction with Electronics Programs	NS	*	NS
Years of Mathematics/science in High School	NS	NS	NS
Parents' Education	NS	NS	S
Professors' Use of Teamwork	NS	NS	NS
Pre-College Encouragement	*	**	S
Pre-College Consideration to Apply for Electronics	*	NS	NS
Household Income	*	NS	NS

[d] See Table 4.22 for interpretation of the significant interactions
S: Significant interaction
NS: Non-significant effect.
* Males higher than females or beginning level higher than middle or end
** Beginning level lower than middle or end

beginning level had higher ratings than students at the middle or end program levels in regard to satisfaction with electronics programs and students at the beginning level had lower ratings than students at the middle or end program levels in regard to pre-college encouragement. Significant interactions were also found in regard to parents' education and pre-college encouragement (see table 4.22).

Table 4.22 shows the simple main effects of gender on the eleven dependent variables. Significant differences were found for gender at the beginning program level:

Table 4.22

Simple Main Effects (Male vs. Female) on the Eleven Dependent Variables

	Simple Main Effects Male vs. Female		
Dependent Variables	Beginning Program Level	Middle Program Level	End Program Level
Self-Confidence	NS	NS	*
Self-Efficacy	NS	NS	NS
Approachability, Concern, and Fairness of Electronics Professors	NS	NS	NS
Pre-college Mathematics/science Interest and Grades	NS	NS	NS
Satisfaction with Electronics Programs	NS	NS	NS
Years of Mathematics/science in High School	NS	NS	NS
Parents' Education	*	**	NS
Professors' Use of Teamwork	NS	NS	NS
Pre-College Encouragement	*	NS	NS
Pre-College Consideration to Apply for Electronics	NS	NS	*
Household Income	*	NS	NS

NS: Non-significant effect.
* Ratings for males were higher than females.
** Ratings for females were higher than males.

ratings for males were higher than females in regard to parents' education, pre-college encouragement and household income. Significant differences were found for gender at the middle program level: ratings for females were higher than males in regard to parents' education. Significant differences were also found for gender at the end program level: ratings for males were higher than females in regard to self-confidence and pre-college consideration to apply for electronics.

Table 4.23 presents a summary of results for the simple main effects of program level on the eleven dependent variables. Significant differences were found between

Table 4.23
Simple Main Effects (Beginning vs. Middle, Beginning vs. End, and Middle vs. End Program Levels) on the Eleven Dependent Variables

	Simple Main Effects Beginning vs. Middle, Beginning vs. End, and Middle vs. End Program Levels		
Dependent Variables	Beginning vs. Middle	Beginning vs. End	Middle vs. End
Self-Confidence	NS	NS	NS
Self-Efficacy	NS	NS	NS
Approachability, Concern, and Fairness of Electronics Professors	NS	NS	NS
Pre-college Mathematics/science Interest and Grades	NS	NS	NS
Satisfaction with Electronics Programs	*	**	NS
Years of Mathematics/science in High School	NS	NS	NS
Parents' Education	NS	NS	NS
Professors' Use of Teamwork	NS	NS	NS
Pre-College Encouragement			
Pre-College Consideration to Apply for Electronics	NS	NS	NS
Household Income	NS	NS	NS

NS: Non-significant effect.
* Ratings at the beginning program level were higher than the middle program levels.
** Ratings at the beginning program level were higher than the end program levels.

ratings at the beginning vs. middle and between ratings at the beginning vs. end program levels for both genders: ratings at the beginning program level were higher than the middle program levels and ratings at the beginning program level were higher than the end program levels in terms of satisfaction with electronics programs.

Table 4.24 displays the relationships between 12 predictor variables and satisfaction with electronics programs. There were significant positive correlations

Table 4.24
Relationships between Predictor Variables and Satisfaction with Electronics Programs

Predictor Variables	Correlation	MR
Self-Confidence	+	+
Self-Efficacy	+	NS
Approachability, Concern, and Fairness of Electronics Professors	+	+
Pre-college Mathematics/science Interest and Grades	+	NS
Years of Mathematics/science in High School	NS	NS
Parents' Education	NS	NS
Professors' Use of Teamwork	+	NS
Pre-College Encouragement	+	NS
Pre-College Consideration to Apply for Electronics	+	NS
Household Income	_	NS
Genders of Students	NS	+ *
Program Levels	_	_

MR: Multiple regression.
NS: Non-significant.
+ Significant positive correlation beta with satisfaction with electronics programs.
- Significant negative correlation beta with satisfaction with electronics programs.
* *Note.* 0 = Male, 1 = Female.

between satisfaction with electronics programs and the following predictor variables: self-confidence; self-efficacy; approachability, concern, and fairness of electronics professors; pre-college mathematics and science interest level and grades; years of mathematics and science in high school; professors' use of teamwork; pre-college encouragement; and pre-college consideration to apply for electronics. There were significant negative correlations between satisfaction with electronics programs and the following predictor variables: household income and program levels. Table 4.24 also indicates that self-confidence; approachability, concern, and fairness of the electronics professors; genders of students; and program levels combine to be significant predictors of satisfaction with electronics programs.

CHAPTER 5: DISCUSSION

Overview

The purpose of the current research was to conduct a comparative study on the issues that affect enrollment and retention of female students in DeVry University's electronics programs at the Chicago area campuses. The dissertation explored if there were statistically significant differences between males and females with respect to self-confidence; self-efficacy; approachability, concern, and fairness of the electronics professors; pre-college mathematics/science interest and grades; satisfaction with the electronics programs; years of mathematics/science in high school; parents' education; professors' use of teamwork; pre-college encouragement; pre-college consideration to apply for a career-oriented university; and household income. The research also investigated if there were significant differences between program levels and if the interaction was significant between the genders of students and program levels with respect to the above-mentioned dependent variables.

The dissertation further examined if there was a combination of self-confidence; self-efficacy; approachability, concern, and fairness of the electronics professors; pre-college mathematics/science interest and grades; years of mathematics/science in high school; parents' education; professors' use of teamwork; pre-college encouragement; pre-college consideration to apply for a career-oriented university; household income; genders of students; and program levels that would predict satisfaction with the electronics programs better than any variable alone. The last part of the dissertation coded, categorized and explored the most frequent survey answers to the two open-ended questions.

As reported in chapter 3, the surveys were administered to the students in electronics programs at DeVry-Chicago and DeVry-Tinley Park. The actual sample size was 576, and the response rate was 63.9%. The survey instrument asked for information on the eleven dependent variables, gender, program level, and age. The instrument also asked two open-ended questions about students' pre-college mathematics/science and electronics interests and how DeVry experience impacted them.

Research Question 1

Research question 1 explored: (a) whether there was a significant difference between the genders of students in DeVry University's electronics programs in regard to self-confidence; (b) whether there was a significant difference between the program levels in regard to self-confidence; and (c) whether there was an interaction between the genders of students and the program levels in regard to self-confidence.

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 (Brainard & Carlin, 1998). 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 (Felder et al., 1995; Hughes, 2002; Heyman et al., 2002).

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

Research question 2 investigated: (a) whether there was a significant difference between the genders of students in DeVry University's electronics programs in regard to self-efficacy; (b) whether there was a significant difference between the program levels in regard to self-efficacy; and (c) whether there was an interaction between the genders of students and the program levels in regard to self-efficacy.

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.

In general, males were similar to females in self-efficacy. On a 0-7 Likert scale, the mean rating of 5.68 was closer to "agree" (6) than "mildly agree" (5). Of the 576 students, 79% indicated that they had some self-efficacy.

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 (Ambrose et al., 1998). 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 (Felder et al., 1995). Observing and learning from others, receiving encouragement from professors, classmates, and others may have freed DeVry female students from anxiety, and raised their self-efficacy.

Research Question 3

The research question 3 examined: (a) if there was a significant difference between the genders of students in DeVry University's electronics programs in regard to approachability, concern, and fairness of electronics professors; (b) if there was a significant difference between the program levels in regard to approachability, concern, and fairness of electronics professors; and (c) if there was an interaction between the genders of students and the program levels in regard to approachability, concern, and fairness of electronics professors.

Summary of Research Question 3 Findings

The research findings revealed that there was no significant interaction between gender and program level in regard to approachability, concern, and fairness of electronics professors. There was no significant main effect of gender or program level on approachability, concern, and fairness of electronics professors, either.

Both males and females reported that professors in DeVry University's electronics programs generally were approachable, concerned, and fair. On a 0-7 Likert scale, the mean rating of 5.39 was closer to "mildly agree" (5) than "agree" (6). Of the 576 students, 75% agreed that electronics professors were approachable, concerned, and fair.

Discussion of Research Question 3

The current findings generally agreed with Sneller's (2001) research that professors should treat all students fairly with respect to gender. The results also generally agreed with feminist pedagogy encouraging feminist teachers to promote classrooms where equality is achieved among students of different genders (Finke, 2000).

The results of this study did not support the previous literature findings that professors' differential treatment of female students lowered their self-confidence, learning ability, academic expectations, and self-esteem (Reis, 2001). The findings by Seymour and Hewitt (1997), that the inapproachability of faculty forced female students to leave SMET fields, were not supported by this study, either.

In the current study, the reason that females did not have significantly different ratings compared to males on approachability, concern, and fairness of electronics professors could be that at DeVry, in general, professors were approachable, concerned, and they promoted fair teaching environments where both males and females can learn. Although there was no mean difference between men and women students, women (SD = 1.51) had a wider total standard deviation than men (SD = 1.15). Of the 475 male and 100 female students, 20.5% of the females and 5.2% of the males disagreed that electronics professors promoted equality, 13.1% of the females and 11.3% of males disagreed that electronics professors were encouraging, and 12% of the females and 10.4% of males disagreed that electronics professors were approachable. Thus, more variability (larger total standard deviation) for females helps explain why more females thought electronics professors were unfair than males did.

Research Question 4

Research question 4 explored: (a) if there was a significant difference between the genders of students in DeVry University's electronics programs in regard to pre-college mathematics/science interest and grades; (b) if there was a significant difference between the program levels in regard to pre-college mathematics/science interest and grades; and (c) if there was an interaction between the genders of students and the program levels in regard to pre-college mathematics/science interest and grades.

Summary of Research Question 4 Findings

The results showed that there was no significant interaction between gender and program level in regard to pre-college mathematics/science interest and grades. There was no significant main effect of gender or program level on pre-college mathematics/science interest and grades, either. Males and females had almost equal mean pre-college mathematics/science interest and grades.

Discussion of Research Question 4

As seen in recent literature, there were no differences between the science grades of male and female high school students, and interest in mathematics and science was equal for both sexes (Paolucci, 2001).

The results of this research did not support the past literature findings about female interest decreasing in mathematics and science during pre-college years (Huang et al., 2000).

The reason for males and females reporting almost equal pre-college mathematics/science interest and grades could be that maybe the instrument did not have direct questions on pre-college hands-on interest in sciences, electronics, computers, construction toys, drafting, auto-mechanics, and spatial/visualization skills. The researcher did not have access to high schools and collected data from DeVry students instead in regard to pre-college mathematics/science interest and grades. It could be that the data were biased since DeVry female students in general have high pre-college mathematics/science interest and grades than the average high school female students. Or, maybe the types of males who apply to DeVry electronics programs have lower interest and grades in mathematics and science than the typical SMET male student. Note that overall there were relatively low mean scores for pre-college mathematics/science projects ($M = 3.92$), indicating low mean pre-college mathematics/science interest. Pre-college involvement with professional societies/projects could increase mathematics/science interest for both males and females, and it could increase their self-confidence and self-efficacy (Ambrose et al., 1998; CAWMSET, 2000).

Research Question 5

The research question 5 investigated: (a) if there was a significant difference between the genders of students in DeVry University's electronics programs in regard to satisfaction with electronics programs; (b) if there was a significant difference between the program levels in regard to satisfaction with electronics programs; and (c) if there was an interaction between the genders of students and the program levels in regard to satisfaction with electronics programs.

Summary of Research Question 5 Findings

The research findings showed that there was no significant interaction between gender and program levels in regard to satisfaction with electronics programs. Even though there was no significant main effect of gender, there was a significant main effect of program level on satisfaction with electronics programs. Both genders at the beginning program level had significantly higher satisfaction ratings than at the middle and end program levels, and the effect sizes were close to medium and medium, respectively.

In general, females were as satisfied as males in DeVry University's electronics programs at the Chicago area campuses. On a 0-7 Likert scale, the mean rating of 4.95 was close to "mildly agree" (5). Of the 575 students, 63.8% demonstrated some satisfaction with electronics programs.

Discussion of Research Question 5

The current findings supported the previous literature that satisfaction with SMET programs decreased for both males and females from the beginning to the end program levels (Felder et al., 1995).

The results of this study did not support the previous literature findings that women showed less satisfaction than men did in SMET programs (Felder et al., 1995; Astin & Sax, 1996; Seymour & Hewitt, 1994).

The reason there is no significant difference between males and females in regard to satisfaction maybe that the average DeVry electronics professors are more supportive, encouraging, approachable, concerned, and fair to the female students than professors in some other colleges or universities. Satisfaction can be influenced mainly by approachability, concern, and fairness of the electronics professors; self-confidence; gender; and program level. More details can be found in the discussion section of research question 12.

Research Question 6

The research question 6 explored: (a) if there was a significant difference between the genders of students in DeVry University's electronics programs in regard to years of mathematics and science in high school; (b) if there was a significant difference between the program levels in regard to years of mathematics and science in high school; and (c) if there was an interaction between the genders of students and the program levels in regard to years of mathematics and science in high school.

Summary of Research Question 6 Findings

The research findings revealed that there was no significant interaction between gender and program level in regard to years of mathematics and science in high school. There was no significant main effect of gender or program level on years of mathematics and science in high school, either.

In general, females took as many years of mathematics and science in high school as males did. On a 0-4 scale, the mean rating of 3.20 was closer to 3 than 4 years. Of the 572 students, over one-fourth (28.4%) indicated "4 years or more" of mathematics and science in high school, while 71.5% indicated "less than 4 years."

Discussion of Research Question 6

The results of this study agreed with CAWMSET's (2000) findings that males and females take the same number of upper-level mathematics and science courses. Maple and Stage's (1991) previous claim that females take fewer advanced courses in mathematics was not supported by this research. Neither did this study support the literature which indicated that women have fewer of the spatial/visualization skills that are essential in SMET fields than men, mainly because of the lack of taking courses in mathematics and sciences at secondary school (Sorby, 2001).

Average score of 3.2 years showed that perhaps there are not enough required mathematics and science courses offered in high schools for 4 years or students do not have an interest in taking them. Taking 4 years of required mathematics and science courses in high school could increase self-confidence levels specifically for females.

Research Question 7

The research question 7 examined: (a) if there was a significant difference between the genders of students in DeVry University's electronics programs at the Chicago area campuses in regard to parents' education; (b) if there was a significant difference between the program levels in DeVry University's electronics programs at the Chicago area campuses in regard to parents' education; and (c) if there was an interaction between the genders of students and the program levels in DeVry University's electronics programs at the Chicago area campuses in regard to parents' education.

Summary of Research Question 7 Findings

The research findings demonstrated that there was a significant interaction between gender and program levels on parents' education in DeVry University's electronics programs at the Chicago area campuses, and the effect size was small. A significant difference was found between male and female students in the beginning program level in terms of parents' education. Male students had significantly higher parents' education ratings than female students, and the effect size was medium. A significant difference was also found between male and female students in the middle program level in terms of parents' education. Female students had significantly higher parents' education ratings than male students, and the effect size was close medium.

On a 0-4 scale, the mean rating of 2.42 was between "H.S. degree" (2) and "some college" (3). Of the 568 participants, 35.5% reported that their parents' highest educational level was “some college” or more, while 64.4% reported less than “some college.”

Discussion of Research Question 7

Previous literature showed that parents’ education influences women’s choice of higher education (CAWMSET, 2000; Seymour & Hewitt, 1997). Parents or society in general, discourage females from entering traditionally male-dominated SMET fields (CAWMSET, 2000).

In the current research, it appears that parents’ education is related to household income; and pre-college encouragement and pre-college consideration to apply for electronics are positively correlated. Specifically, females from the beginning and end program levels reported somewhat lower parents’ education, household income and pre-college encouragement than males did. In general, it was expected that females would have similar household incomes to males, but the results revealed that females and males had similar incomes only for the end program level. Females having significantly different parents’ education in the beginning and middle program levels may be due to one or combination of the following reasons: (a) it’s by chance; (b) some students did not report their parents’ education because they did not know their parents’ education levels; (c) females might have been encouraged less in poorer families; and (d) it is difficult to interpret the parents’ education levels for the students from different countries, especially for the students from Eastern Europe.

Maybe providing students with more financial aid will help increase their enrollment, especially for females, which will increase future parents’ educational levels. Further studies are needed to explore the correlations between parents’ education, household income, pre-college encouragement, and pre-college consideration to apply for electronics.

Research Question 8

The research question 8 investigated: (a) if there was a significant difference between the genders of students in DeVry University's electronics programs in regard to professors' use of teamwork; (b) if there was a significant difference between the program levels in regard to professors' use of teamwork; and (c) if there was an interaction between the genders of students and the program levels in regard to professors' use of teamwork.

Summary of Research Question 8 Findings

The results showed that there was no significant interaction between gender and program level in regard to professors' use of teamwork. There was no significant main effect of gender or program level on professors' use of teamwork, either.

In general, both males and females reported that professors in DeVry University's electronics programs used teamwork. On a 0-7 Likert scale, the average rating of 5.36 was closer to "mildly agree" (5) than "agree" (6). Of the 575 students, 74.4% indicated that professors used teamwork, while 14.8% indicated they did not.

Discussion of Research Question 8

The reason that there was not a significant difference between males and females in the current study may be that at DeVry, in general, professors encourage teamwork especially in laboratories, both males and females can learn through cooperative effort. There are also required courses for all students to take on collaborative learning during their first trimesters at DeVry. Thus the results of this study generally were consistent with the recommendation that professors should stress the value of each student's contributions during cooperative learning sessions, so that women as well as men benefit from learning (Felder et al., 1995). The results were also consistent with Timpson and Bendel-Simso (1996) stating, "When managed effectively, groups provide a social foundation that bolsters students' critical thinking skills and creativity" (p.109).

Past research that women and second tier students respond better than males to cooperative methods of learning that emphasize teamwork rather than competition (Tobias, 1990) may well be true but doesn't seem to require any changes at DeVry. Likewise, the tendency for female students to be more comfortable than males during cooperative learning sessions that facilitate teamwork (Felder et al., 1995) doesn't seem to be a problem at DeVry.

Research Question 9

The research question 9 explored: (a) if there was a significant difference between the genders of students in DeVry University's electronics programs in regard to pre-college encouragement; (b) if there was a significant difference between the program levels in regard to pre-college encouragement; and (c) if there was an interaction between the genders of students and the program levels in regard to pre-college encouragement.

Summary of Research Question 9 Findings

The findings revealed that there was a significant interaction between gender and program levels in DeVry University's electronics programs on pre-college encouragement, and the effect size was small. There were also significant main effects of gender and program level on pre-college encouragement. A significant difference was found between male and female students in the beginning program level in terms of pre-college encouragement. Male students had significantly higher pre-college encouragement ratings than female students, and the effect size was large.

In general, both males and females reported similar ratings for the middle and end program levels, and females (M = 2.83) had significantly lower ratings than males (M = 4.48) for the beginning program level on pre-college encouragement. On a 0-7 Likert scale, the mean rating of 4.29 was closer to "neither agree nor disagree" (4) than "mildly agree" (5). Of the 575 students, 45.5% of the females and 5.6% of the males, to some degree lacked pre-college encouragement. Overall, of the 575 students, 32.5% agreed that they, to some degree, did not have pre-college encouragement.

Discussion of Research Question 9

The results of the study generally supported findings that secondary school teachers, parents, or society in general, discourage females from entering traditionally male-dominated fields such as electronics and computer technology, and other careers that require mathematics and science backgrounds (CAWMSET, 2000; Felder et al., 1995; Reis, 2001). Lack of role models can be another reason for females to get discouraged. Even the brightest females in SMET classes underestimate their abilities in math; perhaps that is due to a lack of role models in mathematics and engineering (Chan, 2000).

It was expected that the females would have lower ratings than males on pre-college encouragement throughout all program levels, and in general, results revealed that they did. Females having similar average ratings to males in the middle and end program levels may be due to one or combination of the following reasons: (a) it's by chance; (b) female perceptions could have changed so that females from the middle and end program levels remembered pre-college encouragement more favorably than females from the beginning program level; and (c) females in the beginning program level who lacked pre-college encouragement might have dropped out. Longitudinal studies are needed to explain the researcher's findings on pre-college encouragement.

Research Question 10

The research question 10 investigated: (a) if there was a significant difference between the genders of students in DeVry University's electronics programs in regard to pre-college consideration to apply for electronics; (b) if there was a significant difference between the program levels in regard to pre-college consideration to apply for electronics; and (c) if there was an interaction between the genders of students and the program levels in regard to pre-college consideration to apply for electronics.

Summary of Research Question 10 Findings

The results showed that there was no significant interaction between gender and program levels in DeVry University's electronics programs in regard to pre-college consideration to apply for electronics. Even though there was no significant main effect of program level, there was a significant main effect of gender on pre-college consideration to apply for electronics. A significant difference was found between male and female students in the end program level in terms of pre-college consideration to apply for electronics. Male students had significantly higher pre-college consideration to apply for electronics ratings than female students in the end program level, and the effect size was small.

In general, females had lower but not significantly lower ratings than males for the beginning program level, both males and females reported similar ratings for the middle program level, and females had significantly lower ratings than males for the end program level on pre-college consideration to apply for electronics. On a 0-7 Likert scale, the mean rating of 4.69 was closer to "mildly agree" (5) than "neither agree nor disagree" (4). Overall, of the 575 students, 26.3% agreed that they, to some degree, did not consider applying for electronics in their pre-college years.

Discussion of Research Question 10

The results of the study generally supported findings that society in general, discourages females from entering traditionally male-dominated SMET fields (CAWMSET, 2000; Felder et al., 1995; Reis, 2001).

Pre-college consideration to apply for electronics was related to pre-college encouragement. Lack of pre-college encouragement and low household income could result in lack of interest, confidence, and consideration to apply for electronics programs. In the current research, it was expected that females would report significantly lower ratings than males on pre-college consideration to apply for electronics throughout all program levels; but instead the results revealed a significant difference only at the end program level, and a large but not significant difference at the beginning program level. Females not having significantly different ratings in the beginning and middle program levels may be due to one or combination of the following reasons: (a) it's by chance and (b) female perceptions could have changed so that females from the beginning and middle program levels remembered pre-college consideration to apply for electronics more favorably than females from the end program level. Longitudinal studies are needed to explain the researcher's findings on pre-college consideration to apply for electronics.

Research Question 11

The research question 11 examined: (a) if there was a significant difference between the genders of students in DeVry University's electronics programs in regard to household income; (b) if there was a significant difference between the program levels in regard to household income; and (c) if there was an interaction between the genders of students and the program levels in regard to household income.

Summary of Research Question 11 Findings

The research findings revealed that there was no significant interaction between gender and program levels in DeVry University's electronics programs in regard to household income. Even though there was no significant main effect of program level, there was a significant main effect of gender on household income. Male students had significantly higher household income ratings than female students in the beginning program level, and the effect size was close to large.

In general, females had almost the same household income as the males, and they were not significantly lower except at the beginning program level. On a 0-4 scale, the mean rating of 2.05 was about "$30,000-49,000" (2). Of the 552 participants, 66.8% indicated that their household income was "$49,000 or less", which can be considered low to middle income.

Discussion of Research Question 11

Females from the beginning program level have low household incomes and lack in pre-college encouragement. In general, it was expected that females would report similar household incomes to males, but the results revealed that females and males had similar incomes only for the middle and end program levels. Females having significantly lower incomes than males in the beginning program level may be due to one or combination of the following reasons: (a) it's by chance, (b) some students did not report their incomes correctly because they consider income reporting to be a very private matter; (c) parents with low to medium incomes might have been inclined to send their daughters to study electronics or computer engineering technology; (d) economic trends might have changed over time of the study. At the beginning program level, females might have started with low income levels and realized the high cost of college tuition. During the middle program level while the courses were still relatively easy, females might have been employed and increased their household income. At the end program level, females might have continued working outside even more than the middle program level in order to meet DeVry's financial demands. During all program levels, males might have had more financial support than females because they were expected to be the future head of the households.

Providing opportunities for students to receive more financial aid could help increase their enrollment, especially for females. Further studies are needed to explore the correlations between parents' education, household income, pre-college encouragement, and pre-college consideration to apply for electronics.

Research Question 12

The research question 12 explored how well the combination of self-confidence; self-efficacy; approachability, concern, and fairness of the electronics professors; pre-college mathematics/science interest and grades; years of mathematics/science in high school; parents' education; professors' use of teamwork; pre-college encouragement; pre-college consideration to apply for a career-oriented university; household income; genders of students; and program levels predicted satisfaction with the electronics programs in DeVry University's electronics programs.

Summary of Research Question 12 Findings

The research results showed that there was a significant positive association between approachability, concern, and fairness of the electronics professors and satisfaction with the electronics programs, and the effect size was large. Students who reported high ratings in approachability, concern, and fairness of the electronics professors were likely to have high satisfaction with the electronics programs.

The study also indicated that there was a significant positive association between self-confidence and satisfaction with the electronics programs, and the effect size was large. Students who reported high self-confidence scores were likely to have high satisfaction with the electronics programs.

In addition, findings revealed that there were significant associations between self-efficacy, pre-college mathematics/science interest and grades, professors' use of teamwork, pre-college encouragement, pre-college consideration to apply for a career-oriented university, household income and program levels and satisfaction with the electronics programs; and the effect sizes varied from "close to small" to " close to medium."

Simultaneous multiple regression analysis indicated that approachability, concern, and fairness of the electronics professors; self-confidence; gender of students, and program levels combined to be the only significant predictors of satisfaction with electronics programs. Thus, the student who reported high ratings on approachability, concern, and fairness of the electronics professors, who was self-confident, female, and at the beginning program level was satisfied the most with electronics programs.

Discussion of Research Question 12

The current findings were generally consistent with the previous research that self-confidence, positive influence of professors/advisors, and influence of SMET courses are positively correlated with persistence in SMET programs (Brainard & Carlin, 1998). The results generally agreed with previous research that professors' nonresponsiveness and their poor teaching styles are negatively correlated with the satisfaction of women and minority students in SMET programs (Seymour & Hewitt, 1997).

Approachability, concern, and fairness of the electronics professors; and self-confidence combined to be the two most powerful predictor of satisfaction with electronics programs. Prediction of satisfaction became stronger with the addition of gender and program level as predictors. Self-efficacy and approachability, concern, and fairness of the electronics professors overlapped with self-confidence. Although self-efficacy was a good predictor by itself, it was not effective enough when combined with self-confidence in order to predict satisfaction with electronics programs. Gender was not strong enough predictor by itself, but with the combination of other variables it became a modestly good predictor.

Recommendations and Implications for Practice

The study revealed that in general, female self-confidence levels were close to but slightly lower than males. Even though there was no significant difference between male and female students in the beginning and middle program levels, a significant difference was found 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. The author believes that professional societies and mentors would help women raise self-confidence levels. Although there are several student organizations at DeVry for both males and females, there are not many student organizations just for females. DeVry professors and administrators can help students join mentoring organizations such as WIE, MentorNet, SWE, and ASEE. Through active involvement in these societies, females at DeVry can receive verbal and emotional support; participate in coop programs and workshops that would help them develop hands-on skills in electronics and computer engineering technology; and contribute to social and educational activities that can raise self-confidence. In the study, self-confidence was found to be positively and significantly correlated with satisfaction in electronics programs. Increase in self-confidence could help increase female satisfaction, enrollment and retention in electronics programs at DeVry.

In general, females reported that electronics professors were almost as approachable, concerned and fair as males did. Even though there was no significant difference between male and female students in terms of approachability, concern, and fairness of electronics professors, a larger percentage of females disagreed that electronics professors were approachable, concerned and fair than males did. The researcher recommends that electronics professors at DeVry improve on their applications of female-friendly teaching styles such as cooperative teaching, active learning, constructivism, problem-based teaching, feminist pedagogy, team teaching, and brain-based teaching that promote at least one of the following outcomes: (a) appreciation of male and female student contributions during cooperative learning sessions; (b) fair treatment to all by not allowing anybody to dominate class discussions and by encouraging everybody to speak; (c) connection, approachability and concern to all students; (d) success of many as opposed to success of a few; (e) relation to real-world situation; (f) reduction of competition, fear, anxiety, social rejection; and (g) increase of a comfortable learning environment for everyone. Gender equity should also be increased in DeVry's electronics classes by professors attending workshops in gender equity and applying the principles they learn. Faculty policy manual should be updated to encourage, implement, and train electronics faculty to teach with the above-mentioned teaching styles and promote gender equity in their classes. Approachability, concern, and fairness of electronics professors was found to be positively and significantly correlated with satisfaction in electronics programs. Increase in self-confidence through mentoring programs and electronics professors applying more female-friendly teaching styles could improve female satisfaction, enrollment and retention in electronics programs at DeVry.

Males and females had almost the same pre-college mathematics/science interest/grades and years of mathematics/science in high school. Even though there was no significant difference between males and females in regard to pre-college mathematics/science interest/grades and years of mathematics/science in high school, the low mean ratings on for pre-college mathematics/science projects ($M = 3.92$) suggest low mean pre-college mathematics/science interest and an average of 3.2 years of mathematics/science in high school can be increased to 4 years. The author recommends the implementation of projects similar to RMTEC in each DeVry location where elementary and secondary mathematics and science teachers can prepare "second tier" students to enter and graduate from DeVry's electronics fields successfully. DeVry should sponsor programs such as CSU's KIC where kids get exposed to and develop interest in mathematics/science at the elementary school level. Encouragement to study mathematics/science at an early age could help females resist future discouragements from parents, school, or society to pursue electronics at DeVry.

DeVry representatives, primarily professors and administrators, should visit elementary and secondary schools and encourage school children to visit DeVry in order to encourage females as well as males to take advanced mathematics/science courses, join mentoring organizations, and pursue electronics at DeVry. DeVry's involvement with pre-college mentoring organizations and pre-college professional societies/projects could also increase mathematics/science interest/grades and number of years of mathematics/science in high school. DeVry's early involvement may contribute to the increase in female self-confidence, enrollment and retention in the electronics programs. And finally, DeVry should help in the nationwide accountability implemented by a collaborative body that continues the CAWMSET's efforts at federal, state, and local government level to encourage more women and minorities to attend SMET fields as mentioned in the policy development section of the literature review.

In general, females were as satisfied as males in DeVry University's electronics programs throughout all program levels. For both genders, satisfaction ratings were significantly higher at the beginning program level than at the middle and end program levels. Self-confidence; approachability, concern, and fairness of electronics professors; gender; and program level were found to be significantly correlated with satisfaction. Increase in self-confidence; approachability, concern, and fairness of electronics professors could improve female satisfaction, enrollment and retention for all program levels in electronics.

Even though there was no significant difference between males and females, the mean ratings of females ($M = 5.31$) were slightly lower than the average ratings of males ($M = 5.37$) in regard to perceptions of the classes using teamwork. Further emphasis on teamwork by the electronics professors, specifically giving students the opportunities to solve problems in groups during discussion sessions could raise female ratings on teamwork.

A significant difference was found between male and female students, and female students had significantly lower ratings in the beginning program level in terms of pre-college encouragement. The current study showed that both males and females had pre-college encouragement, but females from the beginning program level were encouraged significantly less than males. The problem is lack of positive pre-college encouragement. The researcher recommends that elementary and secondary school teachers encourage the parents of female students to motivate their daughters to improve their mathematics and science education through pre-college mentoring organizations and programs like CSU's

KIC. DeVry's involvement in projects such as RMTEC could encourage mathematics and science teachers to prepare females to pursue electronics.

More scholarships and loans need to be provided specifically for female electronics students, since females reported significantly lower household incomes than males at least at the beginning program level. Government should also sponsor programs and finances for the parents, schools, and society to encourage females to raise their mathematics and science interests and pursue electronics. Only then perhaps the discouraging effects of male-domination and stereotyping can be minimized, and female enrollment in electronics can reach the males.

In conclusion, the author believes that lack of pre-college encouragement is the most important reason for low female enrollment in electronics programs at DeVry. If primary and secondary school teachers, parents, and society encouraged females to pursue electronics by following the above-mentioned recommendations, it could result in an increase of female self-confidence and enrollment. Other colleges and universities can benefit from the current findings, help increase their female enrollments, and help meet the work force demands of the 21st century.

Recommendations for Future Research

Further studies are needed to understand why there was a significant difference between male and female electronics students at DeVry University in regard to parents' education and household incomes. Correlations between parents' education, household incomes, pre-college encouragement, and pre-college consideration to apply for electronics should also be explored.

In order to explain why pre-college encouragement was significant at the beginning but not at the middle and end program levels, the author recommends longitudinal studies on the difference between male and female electronics students at DeVry University in terms of pre-college encouragement. Longitudinal studies are also needed that might explain why there was a significant difference at the end but not at the beginning and middle program levels in terms of pre-college consideration to apply for electronics.

The researcher did not have access to high schools, so collected data only from DeVry students in regard to pre-college mathematics/science interest and grades. A future recommendation is to collect data at the high school level and compare pre-college mathematics/science interest and grades for males and females.

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. 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.

The researcher suggests intervention studies that could be randomized experimental or quasi-experimental. Interventions can be pre-college mathematics/science teacher training similar to RMTEC, mentorship, parental encouragement, DeVry involvement, etc.

Since 28% of the responses to question 2 of the qualitative study were negative, follow-up research can be done with interviews and focus groups in order to understand the reason for the dissatisfaction.

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

COVER LETTER AND STUDENT QUESTIONNAIRE

Colorado State University

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Dear Students:

We would like to request your assistance with a research project. Mr. Agajanian is a professor at DeVry University, Chicago and also a student in the Educational Leadership Program at Colorado State University. Dr. William Timpson, a professor in the school of education at Colorado State University, is the advisor of this doctoral dissertation, titled "A Comparison of Male and Female Student Issues that Affect Enrollment and Retention in DeVry University's Electronics Programs at the Chicago Area Campuses". The main objective of this quantitative dissertation is to explore the differences between male and female students with respect to self-confidence, self-efficacy, teaching environment of the electronics professors, pre-college math and science background, pre-college interest and support in math and science, socio-economic status, satisfaction, and the impact of the above factors on enrollment and retention in DeVry University's electronics programs. By filling out the attached questionnaire you will help DeVry understand student retention in the electronics programs.

Please complete the questionnaire **anonymously** (do not write your name or professor's name on the questionnaire) to ensure the **confidentiality** of the information. Taking this survey is **voluntary,** and the information gathered for this study will remain confidential. There are no known risks involved to taking this survey. It is not possible to identify all potential risks in research procedures, but the researchers have taken reasonable safeguards to minimize any known and potential, but unknown, risks. The questionnaire will take about 10-15 minutes to complete. After completing the questionnaires please place them in individual envelopes. Please seal the envelopes before returning them to the professor. The instructor will place all the sealed envelopes in a larger envelope.

We hope that the results of this study will help to improve the student retention in the electronics programs at DeVry University. Questions about participants' rights may be directed to Celia Walker at (970) 491-1563.

Thank you for your cooperation and participation in this study.

Sincerely,

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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 1-35, 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.	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.	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 learn more from the electronics and/or computer engineering technology professors when they use teamwork or group/project work where students support and assist each other.	1	2	3	4	5	6	7
12. The electronics or computer engineering technology professors are very approachable.	1	2	3	4	5	6	7
13. The electronics or computer engineering technology professors are very encouraging and are concerned with my personal success.	1	2	3	4	5	6	7
14. The electronics and/or computer engineering technology professors promote learning environments where equality is achieved among males and females.	1	2	3	4	5	6	7
15. I was interested in mathematics and sciences during pre-college (before DeVry).	1	2	3	4	5	6	7
16. During pre-college I participated in mathematics and science-oriented projects/programs, societies or interest groups.	1	2	3	4	5	6	7

	SD	D	MD	N	MA	A	SA
17. Role models such as family members, friends, and pre-college teachers had some influence on my majoring in electronics or computer engineering technology.	1	2	3	4	5	6	7
18. During pre-college I always considered applying for electronics or computer engineering technology programs at a career-oriented university.	1	2	3	4	5	6	7
19. I can solve most problems if I invest the necessary effort.	1	2	3	4	5	6	7
20. I can remain calm when facing difficulties because I can rely on my coping abilities.	1	2	3	4	5	6	7
21. When I am confronted with a problem, I can usually find several solutions.	1	2	3	4	5	6	7
22. If I am in trouble, I can usually think of a solution.	1	2	3	4	5	6	7
23. I can usually handle whatever comes my way.	1	2	3	4	5	6	7
24. I am satisfied with the overall electronics or computer engineering technology programs at DeVry.	1	2	3	4	5	6	7
25. In general I am satisfied with the electronics or computer engineering technology professors at DeVry.	1	2	3	4	5	6	7
26. I am satisfied with the electronics or computer engineering technology career opportunities that DeVry offers.	1	2	3	4	5	6	7

27. My average grade for pre-college (before DeVry) mathematics and science was:
□ F □ D □ C □ B □ A

28. I took ____ year(s) of math in high school.
□ 1 □ 2 □ 3 □ 4

29. I took ____ year(s) of science in high school.
□ 1 □ 2 □ 3 □ 4

30. My total household income is:
□ $29,000 or less □ $30,000-49,000 □ $50,000-79,000 □ $80,000 or above

31. My father's highest educational level is:
□ Less than H.S. degree □ H.S. degree □ Some College □ B.S./B.A. or more

32. My mother's highest educational level is:
□ Less than H.S. degree □ H.S. degree □ Some College □ B.S./B.A. or more

33. Gender
□ Male □ Female

34. I am a ____ trimester student at DeVry.
□ 1st □ 2nd □ 3rd □ 4th □ 5th □ 6th □ 7th □ 8th □ 9th

35. My age category is:
□ Under 18 □ 18-21 □ 21-25 □ 26-30 □ 31-40 □ 41 and up

Please respond to the following questions in the space provided:

1. What were the most important factors in high school that led you to select an electronics or computer engineering technology field in college?

2. How has your experience at DeVry (course and/or instructor) impacted your interest in electronics or computer engineering technology?

APPENDIX B

RECRUITMENT MATERIAL – E-MAIL

E-mail to: All ECT, EET/CET faculty

Professor Agajanian is a PhD candidate in the Educational Leadership Program at Colorado State University. The title of his dissertation is "A Comparison of Male and Female Student Issues that Affect Enrollment and Retention in DeVry University's Electronics Programs at the Chicago Area Campuses". In his dissertation, professor Agajanian will explore the differences between male and female students with respect to self-confidence, self-efficacy, teaching environment of the electronics professors, pre-college mathematics and science background, pre-college interest and support in mathematics and science, socio-economic status, satisfaction, and the impact of the above factors on enrollment and retention in DeVry University's electronics programs.

We would like to request your assistance with this dissertation by setting aside about 15 minutes of class time to administer a survey to your ECT, EET, or CET students within the next two weeks.

Professor Agajanian will try to conduct all the surveys. In case he is absent, we will provide you with enough copies of the surveys with the cover letters and the envelopes, so that you can administer them and return the completed questionnaires in sealed envelopes.

Students should complete all the questionnaires **anonymously** (they should not write their names or professors' names on the questionnaires) to ensure the **confidentiality** of the information. Taking this survey is **voluntary,** and the information gathered for this study will remain confidential. There are no known risks involved to taking this survey. The questionnaire will take about 10-15 minutes to complete. The students will complete the questionnaires and place them in individual envelopes, which they themselves will seal. The researcher and/or the class instructor will place all the sealed envelopes in a larger envelope. All the instructors will return the sealed large envelopes to the researcher.

We hope that the results of this study will help to improve the student retention in the electronics programs at DeVry University.

Thank you for your cooperation and participation in this study.

Sincerely,
Aram Agajanian
Ph.D. Candidate, CSU
DeVry University
Chicago, Illinois 60618
aagajani@chi.devry.edu

Stan Lan, Ph.D.
Academic Dean - Electronics
DeVry University
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APPENDIX C

LETTER OF AGREEMENT

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December 15, 2004

Dr. William Timpson
School of Education
Colorado State University
Fort Collins, CO 80523

Dear Dr. Timpson and CSU Human Research Committee:

This is to convey to you the decision of the DeVry University Doctoral Research Review Committee to approve the data collection plan set forth in the dissertation proposal of Aram Agajanian. Since DeVry University is exclusively a teaching university, we do not have an Institutional Review Board, but have instead substituted the Doctoral Research Review Committee to perform some of the same functions, albeit on a more limited basis. The committee consists of Marilyn Cason, Senior Vice President and General Counsel, Jerry Murphy, Vice President of Operations, and me, as Vice President of Academic Affairs. DeVry University has a matrix organizational structure under which all of our campus operations report to campus presidents and they to regional vice presidents, all of whom report to Jerry Murphy. On each campus are program deans and deans of academic affairs, who have direct line responsibility for supporting and managing the faculty and academic programs, and all of these academic administrators have dotted line relationships to the program directors and the dean of curriculum, who reports to me.

In supporting Aram Agajanian's dissertation research, we understand that the questionnaire is to be administered voluntarily, with all responses to be anonymous, to students in the Electronics and Computer Technology (ECT), and Electronics Engineering Technology (EET)/Computer Engineering Technology (CET) departments at DeVry University's Chicago area campuses. The researcher and/or the class instructor will give the questionnaires to the students in classes. The students will complete the questionnaires and place them in individual envelopes, which they themselves will seal. The researcher and/or the class instructor will place all the sealed envelopes in a larger envelope. All the instructors will return the sealed large envelopes to the researcher. In conclusion, Aram Agajanian is a highly regarded professor at DeVry; we believe his project will help us continue to improve as an institution.

Sincerely,

Patrick Mayers

Patrick Mayers, Ph. D.
Vice President, Academic Affairs

cc: Marilyn Cason
Jerry Murphy