DISSERTATION

A COMPARISON OF THE ACADEMIC PERFORMANCE OF NONNATIVE ENGLISH-SPEAKING (ESL) AND NATIVE ENGLISH-SPEAKING GRADUATING SENIORS IN EET PROGRAMS ON DEVRY UNIVERSITY CHICAGO AREA CAMPUSES

Submitted by

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WE HEREBY RECOMMEND THAT THE DISSERTATION PREPARED UNDER OUR SUPERVISION BY SHI "STAN" LAN ENTITLED A COMPARISON OF THE ACADEMIC PERFORMANCE OF NONNATIVE ENGLISH-SPEAKING (ESL) AND NATIVE ENGLISH-SPEAKING GRADUATING SENIORS IN EET PROGRAMS ON DEVRY UNIVERSITY CHICAGO AREA CAMPUSES BE ACCEPTED AS FULLFILING IN PART REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY.

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ABSTRACT OF DISSERTATION

A COMPARISON OF THE ACADEMIC PERFORMANCE OF NONNATIVE ENGLISH-SPEAKING (ESL) AND NATIVE ENGLISH-SPEAKING GRADUATING SENIORS IN EET PROGRAMS ON DEVRY UNIVERSITY CHICAGO AREA CAMPUSES

This dissertation compared academic performance of nonnative English-speaking graduating seniors and native English-speaking graduating seniors in the Electronics Engineering Technology (EET) programs at DeVry University. In addition, graduating seniors with different ethnic origins (Asian, Hispanic, and other) were compared in regard to their performance measured by the DeVry EET assessment instrument and their cumulative GPAs in various course sequences. The study used 2X3 factorial analyses of variance, paired *t* tests, and multiple regression.

The actual sample was collected from the graduating classes of the EET programs on DeVry University Chicago area campuses. The sample was further divided into three nonnative English-speaking ethnic groups (Asian, Hispanic, and others) and three native English-speaking ethnic groups (Asian, Hispanic, and others). All nonnative English-speaking students came from countries where English is not the primary language spoken; they were mainly resident aliens or on student visas; many of them were remedial ESL course takers.

In general, both native English-speaking and nonnative English-speaking graduating seniors performed equally well in DeVry's practical, "hands-on" EET

programs. The study showed that, within DeVry's technology programs, students of Hispanic origin performed equally well, instead of doing poorly compared to students of other ethnic origins, as has been reported in the reviews of the literature.

The study found that native English-speakers performed better than nonnative English-speakers in oral/written communications, measured by the assessment instrument and students' GPAs in the English/humanities courses. Paired *t* tests showed that nonnative English-speaking graduating seniors' GPAs in the English/humanities course sequence were significantly lower than their GPAs in the technical course sequence.

This study also found, for graduating seniors sampled, that nonnative English-speakers had higher cumulative GPAs in the engineering technology course sequence than native English-speakers. The possible contributing factors to this finding were discussed. This research provides a better understanding of how students from different language and ethnic backgrounds are doing in college and how to facilitate their learning within practical technology programs at a career oriented for-profit university.

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DEDICATION

This dissertation is dedicated to my father, Mr. Ying Lan, a historian, researcher, and productive writer, who has been my role model in pursuing lifelong learning and research. The dissertation is a gift to his 80th birthday celebration. This dissertation is also dedicated to my mother, Mdm. Li Li, an educational leader in Shanghai adult continuing and professional education arena, to thank her for giving me the genetic heritage to become a professional educator and an educational leader. I always look forward a day that she would not keep asking me "when are you going to finish your doctoral degree?"

This dissertation is dedicated to my wife, Ms. Lan Chen, and my two sons, Joe and Michael, for their understanding and support in the past four-and-a-half years, during which I had to spend numerous Friday nights and weekends away from them to take my Ph.D. courses and to do research projects. Amazed by the length of this dissertation, my eight-year-old son Michael kept insisting, "Dad, you must teach me how to write chapters when you have time." Yes, I want be his role model, since I am sure one day he will write his "chapters" on his doctoral studies.

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I would like to thank the Colorado State University for providing this Ph.D. program to DeVry University Chicago area campuses and centers. As a busy working professional and a doctoral student prior to CSU's, I definitely appreciate the dedication of CSU faculty for making my dream become true. Needless to say, this is a rigorous Ph.D. program, and there have been many challenges. However, the well-structured curriculum, on-site courses, summer campus visits and workshops, preparation for methodology and content exams, data analysis workshops, and dissertation proposal process were all carefully designed towards the successful completion of the program.

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CHAPTER 1: INTRODUCTION

Over the past three decades there has been a continuing increase in the number of nonnative English-speaking students with different ethnic and language backgrounds studying in schools, colleges, and universities throughout the United States. Over the same period, there has also been a sizable number of nonnative English-speaking (English as a second language) students studying on DeVry University campuses all over the United States and Canada. Nonnative English-speaking students will eventually perform in a global economy and multicultural environment that demands a well-educated workforce.

Previous research results on academic participation and performance of nonnative English-speaking immigrant students have been controversial. Some research findings indicate that nonnative English-speaking (ESL) immigrant students are as likely as their native counterparts to participate in primary, middle, and high schools; they are generally more prepared for and more likely to attend colleges and universities than their native counterparts (Vernez & Abrahamse, 1996). Nonnative English-speaking students of certain specific ethnic origins, such as Asian students, are stereotypically viewed as super-achievers in academic fields (Dion & Toner, 2001; Kim & Yeh, 2002; Lee, 1996; Rigdon, 1991).

Many researchers argue that although some nonnative English-speaking (ESL) students of certain ethnic origins in the United States are doing well academically, their

success as a whole is exaggerated. Due to the combination of student personal and cultural attributes, family issues, and the factors in school and in the socio-political context, many nonnative English-speaking (ESL) students in this country are facing serious issues of school failure (Kim & Yeh, 2002; Sim, 1992). Furthermore, there exist large gaps among immigrant students with different ethnic and language origins in regard to their academic performance.

Although the population of certain ethnic minority groups, especially the Hispanics, is growing very fast in United States, their success rate in academia is lower than other ethnic groups (Baltimore, 1995; Roderick, 2002; Vernez & Abrahamse, 1996). Stereotypically the Hispanic population is viewed as having large families with many children, low family income, high attrition rates from high schools, and high failure rates at colleges. The Hispanic people in the United States, including their children, experience prejudice, discrimination, and social bias; their educational and professional opportunities are restricted due to individual and institutional isolation and racism (Baltimore, 1995; Derk, 2001; Hewitt & Seymour, 1991; Sullivan, 2002).

Bolima (2002) concluded that there were three major educational learning theories regarding immigrant students with minority cultural and language backgrounds. These three educational learning theories were the Cultural Deficit Theory, Cultural Difference Theory, and Cultural Ecological Theory. Cultural Deficit theorists believe that cultural and language minority students are intelligently inferior to culturally dominant students; Cultural Difference theorists stress that there exist cultural distinctiveness and cultural boundaries between different cultures; and Cultural Ecological Theory divides immigrant students into involuntary and voluntary groups

based on their different immigrant statuses (Bolima, 2002). These learning theories are analyzed and critiqued in chapter two.

At DeVry University, students who are nonnative speakers of English are scrutinized during the admission process. They must have proof of English proficiency, or take and pass remedial English as a second language (ESL) classes with "C" grades or better, before they are officially admitted as standard students. For many years, students who are placed in remedial ESL classes have been considered as developmental students who are academically deficient. However, many academic administrators actually observed that nonnative English-speaking students have better academic performance, retention, and graduation rates than their native counterparts. Some administrators even suggest that the English entrance standards be lowered for nonnative speakers of English if they score high enough in mathematics subjects. However, there is no formal research done at DeVry University to compare the academic performance of nonnative English-speaking students and native English-speaking students.

The purpose of this dissertation is to conduct a comparative research study on the academic performance of nonnative English-speaking (ESL) graduating seniors versus native English-speaking graduating seniors in DeVry University's engineering technology programs. It is to explore specifically whether there are statistically significant differences between nonnative English-speaking (ESL) graduating seniors and native English-speaking graduating seniors in the Electronics Engineering Technology programs at DeVry University, in regard to their academic performance in the areas of experimentation skills, programming skills, design skills, oral/written communication skills, team skills, and information literature/life-long learning skills, measured by the

DeVry University EET assessment instrument and their cumulative GPAs in various course sequences. The dissertation further divides graduating seniors into different ethnic groups, and explores whether there exist significant differences among students with different ethnic origins, for both nonnative English-speaking and native English-speaking groups, in regard to their academic performance. The dissertation also studies the differences and intercorrelations among nonnative English-speaking graduating seniors' academic performance in English/humanities, in mathematics/science, and in technical subjects, and investigates if there is a combination of their cumulative GPAs in general education and in mathematics and science that predict their GPAs in the technical course sequence.

. The research population of this study is undergraduate graduating seniors in Electronics Engineering Technology (EET) graduating classes on the Chicago area campuses of DeVry University. Specific research factors are the categories of students' native language backgrounds (nonnative speakers of English versus native speakers of English), and students' ethnic backgrounds (Asian, Hispanic, or other ethnic origins). Traditionally Chicago area campuses of DeVry University admit undergraduate applicants based on the following three entrance standards: the first, a computerized placement test (CPT) administered prior to admission; the second, transfer status from other accredited colleges and universities; and the third, ACT/SAT scores. Applicants who bring enough transfer credits from other colleges and universities, or who pass minimal required ACT/SAT/CPT scores, are admitted to standard classes without being required to take developmental classes.

DeVry University has an operational definition to categorize students as nonnative speakers of English (DeVry University Academic Policy Manual, 1998). As an essential part of that definition, this dissertation defines nonnative English-speaking (ESL) students as those *who were originally from countries where English is not the primary language spoken.*

Therefore, students who were originally from countries where English is the primary language spoken are defined as native speakers of English. The actual English competency of individuals in either group is not studied in this research.

Applicants who are categorized into the nonnative English speaker (ESL) group must have the proof of English proficiency for admission. Nonnative English speakers who don't have the proof of English proficiency must take and pass the ESL entrance test before they are eligible to take CPT for admission. Students who do not pass ESL entrance test will be placed in different levels of remedial ESL classes based on their ESL test scores. All nonnative English-speaking (ESL) students must achieve minimum English proficiency to continue in standard academic programs. At DeVry, almost all native English-speaking (non-ESL) students were born in the United States.

Definition of Academic Performance

Traditionally, student academic performance is measured by a wide range of indicators, which reflect how much they accomplish after certain learning processes. According to Checchi, Franzoni, Ichino, and Rustichini (1999), academic performance is considered as the amount of human capital obtained during students' academic career, which includes "both elements of quantity (how many courses attended) and quality (which marks obtained in passing the exams)" (p. 2). They further stated that academic

performance was also reflected by several factors, such as student's talent, prior preparation, effort, and future employment performance; performance indicators were the product of average grades and the speed of academic progress (Checchi et al., 1999).

Academic performance is also impacted by school characteristics, school environment, social factors, and family socio-economic status (Kim & Yeh, 2002; Moscoso, 2000; Vernez & Abrahamse, 1996). A comprehensive literature review in chapter two will further discuss these factors.

Based on the DeVry University assessment process, the academic performance of graduating seniors in the EET programs is evaluated in the areas of experimentation skills, programming skills, design skills, oral/written communication skills, team skills, and information literature/life-long learning skills. These skills are evaluated during students' senior projects, which are assumed to reflect student's overall academic performance for their university career at DeVry. Student academic performance is also reflected by their course grades, their semester (term) GPAs, their GPAs in specific course sequences, their academic progress determined by number of credit hours earned within a certain period of time, and their cumulative GPAs at a point of time, and at their graduation.

Purpose of the Study

The primary purpose of this dissertation is to make research comparisons of nonnative English-speaking (ESL) graduating seniors and native English-speaking graduating seniors in terms of their academic performance using quantitative research methodology. This study will further divide nonnative English-speaking and native

English-speaking graduating seniors into similar ethnic groups, and compare their academic performance.

The sample is limited to the students who are graduating from the EET programs on DeVry University Chicago area campuses, because the researcher believes that this sample would present relevant outcomes that can be generalized to other DeVry University campuses, and to the engineering/engineering technology programs at other comparable career-oriented higher education institutions.

The research may result in the following three possible scenarios:

(1) the level of academic performance of nonnative English-speaking (ESL) graduating seniors is significantly lower than native English-speaking graduating seniors;

(2) the level of academic performance of nonnative English-speaking graduating seniors is significantly higher than native English-speaking graduating seniors; and

(3) there is no statistically significant difference in regard to the academic performance between these two groups.

No matter what scenario the research findings fall into, the researcher believes that the findings of this research can be utilized to improve the institutional awareness of cultural differences and to foster a learning environment that enhances multiculturalism.

The study encourages an increased sensitivity to the diverse student population. The research findings will address the possible weak areas in educational services for students in the United States as a whole, and for cultural and language minority students in particular. The "Significance of the Study" and the "Researcher's Perspectives"

sections will further discuss in detail how this study will benefit DeVry University and contribute to the American higher education.

Research Questions

The research in this dissertation focuses on the seven specific research questions listed as follows.

Research question 1 contains the following four parts:

(1a) Is there a statistically significant difference between nonnative English-speaking (ESL) graduating seniors and native English-speaking graduating seniors in regard to their academic performance in terms of their competency ratings?

(1b) Are there statistically significant differences among graduating seniors with Hispanic origin, graduating seniors with Asian origin, and graduating seniors with other ethnic origins in regard to their competency ratings?

(1c) Is there an *interaction* of students' native language backgrounds (nonnative speakers of English versus native speakers of English) and their ethnic backgrounds (Asian versus Hispanic versus others) in regard to their competency ratings?

(1d) For each ethnic group studied in this research, is there a statistically significant difference between nonnative English-speaking graduating seniors and native English-speaking graduating seniors in regard to their academic performance in terms of their competency ratings?

The competency ratings include the ratings in the areas of (a) experimentation skills, (b) programming skills, (c) design skills, (d) oral/written communication skills, (e) team skills, and (f) information literature/life-long learning skills measured by the DeVry University assessment instrument in DeVry University's EET programs.

Research question 2 includes the following four parts:

(2a) Is there a statistically significant difference between nonnative English-speaking (ESL) graduating seniors and native English-speaking graduating seniors in regard to their cumulative composite GPAs at graduation from DeVry University's EET programs?

(2b) Are there statistically significant differences among graduating seniors with Hispanic origin, graduating seniors with Asian origin, and graduating seniors with other ethnic origins in regard to their cumulative composite GPAs?

(2c) Is there an *interaction* of students' native language backgrounds and their ethnic backgrounds in regard to their cumulative composite GPAs?

(2d) For each ethnic group studied in this research, is there a statistically significant difference between nonnative English-speaking graduating seniors and native English-speaking graduating seniors in regard to their cumulative composite GPAs at graduation from DeVry University's EET programs?

Research question 3 consists of the following four parts:

(3a) Is there a statistically significant difference between nonnative English-speaking (ESL) graduating seniors and native English-speaking graduating seniors in regard to their academic performance in general education measured by their cumulative GPAs in the English/humanities course sequence at graduation from DeVry University's EET programs?

(3b) Are there statistically significant differences among graduating seniors with Hispanic origin, graduating seniors with Asian origin, and graduating seniors with other

ethnic origins in regard to their cumulative GPAs in the English/humanities course sequence?

(3c) Is there an *interaction* of students' native language backgrounds and their ethnic backgrounds in regard to their cumulative GPAs in the English/humanities course sequence?

(3d) For each ethnic group studied in this research, is there a statistically significant difference between nonnative English-speaking graduating seniors and native English-speaking graduating seniors in regard to their cumulative GPAs in the English/humanities course sequence in DeVry University's EET programs?

Research question 4 has the following four parts:

(4a) Is there a statistically significant difference between nonnative English-speaking (ESL) graduating seniors and native English-speaking graduating seniors in regard to their academic performance in mathematics and science measured by their cumulative GPAs in the mathematics and science course sequence at graduation from DeVry University's EET programs?

(4b) Are there statistically significant differences among graduating seniors with Hispanic origin, graduating seniors with Asian origin, and graduating seniors with other ethnic origins in regard to their cumulative GPAs in the mathematics and science course sequence?

(4c) Is there an *interaction* of students' native language backgrounds and their ethnic backgrounds in regard to their cumulative GPAs in the mathematics and science course sequence?

(4d) For each ethnic group studied in this research, is there a statistically significant difference between nonnative English-speaking graduating seniors and native English-speaking graduating seniors in regard to their cumulative GPAs in the mathematics and science course sequence in DeVry University's EET programs?

Research question 5 contains the following four parts:

(5a) Is there a statistically significant difference between nonnative English-speaking (ESL) graduating seniors and native English-speaking graduating seniors in regard to their academic performance in technical subjects measured by their cumulative GPAs in the engineering technology course sequence at graduation from DeVry University's EET programs?

(5b) Are there statistically significant differences among graduating seniors with Hispanic origin, graduating seniors with Asian origin, and graduating seniors with other ethnic origins in regard to their cumulative GPAs in the engineering technology course sequence?

(5c) Is there an *interaction* of students' native language backgrounds and their ethnic backgrounds in regard to their cumulative GPAs in the engineering technology course sequence?

(5d) For each ethnic group studied in this research, is there a statistically significant difference between nonnative English-speaking graduating seniors and native English-speaking graduating seniors in regard to their cumulative GPAs in the engineering technology course sequence at graduation from DeVry University's EET programs?

Research question 6 includes the following two parts:

(6a) For nonnative English-speaking graduating seniors in the sample, is there a significant difference between their GPAs in the general education course sequence and their GPAs in the technical course sequence?

(6b) For nonnative English-speaking graduating seniors in the sample, is there a significant difference between their GPAs in the mathematics/science course sequence and their GPAs in the technical course sequence?

Research question 7 is presented as:

(7) For nonnative English-speaking graduating seniors, is there a combination of their cumulative GPAs in general education and in mathematics and science that predict their GPAs in the technical course sequence better than either one alone?

Significance of the Study

DeVry University at Chicago is the only campus among university's twenty-four undergraduate campuses and forty-three university centers offering an ESL program. Each term the university admits many students who are nonnative speakers of English. According to university admissions, on the Chicago campus there are close to 10% of the engineering technology students who are admitted with remedial ESL course needs; some other DeVry University campuses may admit more nonnative speakers of English students each term.

Generally speaking, nonnative English-speaking students encounter more cultural, socio-economical, and language difficulties than their native counterparts in pursuing their academic goals. In order to help nonnative English-speaking students to overcome their cultural and language disadvantages, the educational processes should contribute to

the development of fair attitudes and practice towards these students' academic experience. It is extremely important in the design of these educational processes to believe philosophically that all students, including those who come from different cultural and language backgrounds, can eventually do equally well in their learning endeavors and make equal contributions to the society.

Another significance of this research is to conduct comparative studies on academic performance of cultural and language minority students in such educational institutions as DeVry University, where the main mission is to provide practical, career-oriented academic programs. The research will contribute to the needs for a better understanding of whether nonnative English-speaking students with minority ethnic and language backgrounds will perform differently in such practical, career-oriented academic institutions. The research will help to understand how DeVry's career-focused technology programs are doing for students with specific ethnic backgrounds to accomplish their academic goals.

The ultimate significance of this study is to encourage all educational policy makers, designers, researchers, and practitioners to make efforts in providing learners with all different cultural and language backgrounds with equal learning opportunities, so that all learners can participate and achieve academic goals together, and perform in a globalized economy.

Researcher's Perspectives

The research may result in the following possible scenarios in regard to students' academic performance measured by various assessment and GPA indicators:

(1) the level of academic performance of nonnative English-speaking (ESL) graduating seniors is significantly lower than native English-speaking graduating seniors;

(2) the level of academic performance of nonnative English-speaking (ESL) graduating seniors is significantly higher than native English-speaking graduating seniors; and

(3) the academic performance between the two groups is statistically the same in general, with differences in particular competency areas measured by specific assessment ratings or cumulative GPAs in various course sequences.

If the research findings fell into the first scenario, university admissions, faculty, and staff would be faced with challenges to better understand the issues and solutions to improve the services to nonnative English-speaking (ESL) students as a special population. It would be necessary to increase the awareness of the difficulties that nonnative English-speaking students encounter, and to provide resources to help these students in order for them to learn and perform in a more supportive environment. The university administration would also be required to re-look into its service system to improve staffing, curricula, and instructional methods for nonnative English-speaking students. Policy makers would have to consider creating better assessment and placement measures, improved school climate for nonnative English-speaking students, and inclusive curricula that are sensitive to diverse student populations.

If the research findings fell into the second scenario, however, the American higher education as a whole may be faced with a serious issue. Since admittedly nonnative English-speaking students with minority ethnic and language backgrounds

encounter more difficulties with language barriers, cultural incompatibility, institutional and societal discriminations, and financial struggles, and their educational and professional opportunities are obviously more restricted than native English-speaking students with the mainstream cultural and language background, it would be hard to find excuses to explain why the academic performance of nonnative English-speaking graduating seniors would be better than that of native English-speaking graduating seniors. The educational policy makers and university administration must seriously consider improving policies, curricula, and instructional methods, so that the children who grew up in the American education system would not fall behind.

If the research findings fell into the third scenario, the study would contribute to the sub-categories where differences in academic performance were found. In analyzing the differences of sub-categories of the academic performance between nonnative English-speaking and native English-speaking graduating seniors, contributions would be made to DeVry University and the American higher education by addressing the issues in the competency areas measured by the DeVry University assessment instrument and GPA indicators.

Since many current studies on students of different ethnic groups do not differentiate immigrant students (nonnative English speakers) and U.S.-born counterparts for the same ethnic group, the actual value of the findings from these studies is questionable. The researcher of this dissertation believes that the statistical analysis on comparable nonnative English-speaking (ESL) and native English-speaking students with the same ethnic background, such as immigrant (nonnative English-speaking) Asian and native born Asian students, immigrant (nonnative English-speaking) Hispanic and native

born Hispanic students, etc., will contribute to a holistic understanding of the issues encountered by American higher education institutions to better serve students in both groups. As a recent immigrant ESL student, the researcher believes such research is valuable and will benefit American higher education institutions.

Definition of Terms

In order to be consistent and to facilitate clear interpretation of the key concepts used in this dissertation, the following terms are defined:

(1) Nonnative English-speaking (English as a second language) students

This dissertation defines nonnative English-speaking (ESL) students as those *who were originally from countries where English is not the primary language spoken* (DeVry University Academic Policy Manual, 1998).

(2) Native English-speaking students

Students who were originally from countries where English is the primary language spoken.

(3) Graduating Seniors

Students who are in graduating classes to finish up their program of studies in the pursuit of their Bachelor's degrees.

(4) Students with both minority cultural and language backgrounds

Also known as *cultural and language minority students.* Immigrant students from countries where English is not the primary language spoken, whose cultural backgrounds are non-American mainstream.

(5) Computerized Placement Test

Known as CPT; the Accuplacer Test developed by the Educational Testing Service (ETS) jointly with the College Board in Princeton, New Jersey.

(6) Developmental students

Those who are admitted to DeVry University academic programs with one or more remedial needs; those who are not placed as "standard students" due to the failure of passing one or more entrance tests.

(7) EET Competency Evaluation Sheet

DeVry University Electronics Engineering Technology program assessment instrument, adopted by the faculty of the EET programs as a standard measure of core student competencies covering all EET general education and technical courses.

(8) Cultural Deficit Theory

Belief that ethnic, racial, and language minority students are culturally and intelligently inferior to others, particularly to the mainstream students who are culturally in charge.

(9) Cultural Difference Theory

School of thought that assumes that when different societies separate from each other, there exist cultural distinctiveness and boundaries. There is always a clear dividing line between different cultures.

(10) Cultural Ecological Theory

Theory that takes the social and historical experiences of voluntary and involuntary immigrant minority students into account, to explain students' academic performance.

Assumptions of this Study

The researcher based this study on the following assumptions, to investigate the comparisons of academic performance between nonnative English-speaking graduating seniors and native English-speaking graduating seniors in the EET programs at DeVry University.

1. Students' GPAs in the technical, math/science, and general education sequences are reflective of their academic performance in these subject areas.
2. Students' overall cumulative GPAs are truly reflective of their academic achievements in general during their academic career at DeVry University.
3. The assessment instrument, *EET Competency Evaluation Sheet*, that is used to evaluate student academic competencies, accurately measures the student's competencies in the areas of experimentation skills, programming skills, design skills, oral/written communication skills, team skills, and information literature/life-long learning skills.
4. The instrument, methodologies, and the approach used in this research are as objective as possible.

Delimitations

In this study the researcher has limited the research population to include the students in graduating EET classes on Chicago area campuses of DeVry University. The researcher further limited the nonnative English-speaking student group to DeVry's nonnative speakers of English (ESL) student category who were originally from countries where English is not the primary language spoken.

Students whose first language is English, or who emigrated from countries where English is the primary language spoken are categorized in native speakers of English student group. DeVry University's Academic Policy Manual has a list of countries being considered as English-speaking countries (DeVry University Academic Policy Manual, 1998).

Limitations

There are factors in this dissertation that the researcher is not able to control. In reading and interpreting the research results, the following limitations should be kept in mind:

1. Not all nonnative English-speaking and native English-speaking students admitted into DeVry University's EET program are included in the sample. The population sampled are nonnative English-speaking and native English-speaking students in electronics engineering technology graduating classes, since the EET assessment is only conducted to the senior projects right before graduation. Therefore, the external validity and generalizability of the study were influenced to some extent.
2. Since there is a small number of female students enrolled in EET programs, the researcher does not use gender as an independent variable.
3. The researcher is not able to further divide ethnic groups in addition to Hispanic, Asian, and "all others," since there are many other ethnic groups with small numbers of students enrolled in the program.
4. For students who are placed into the nonnative English speaker (ESL) category, there is no measure to determine their communications skills in their

native languages that may have impact on their learning of English as a second language, and therefore on their academic performance in the later part of their DeVry career. This may affect the internal validity of the study findings to some extent.

5. All assessment ratings, though many are from multiple raters, inevitably include subjectivities. The researcher is trying to keep the subjectivities to the minimal.

CHAPTER 2: LITERATURE REVIEW

This chapter presents a comprehensive review of literature in the areas of research studies on academic performance of students with immigrant and nonnative English language (English as a second language) background. The literature review lays the foundation for the study of this dissertation, and draws a conceptual map connecting the sections of this review with the variables of this dissertation. It first looks into the literature on the definitions of academic performance factors, since many researchers use these factors as dependent variables in various research studies. The chapter then reviews the literature of comparative studies on academic performance of immigrant and nonnative English-speaking (ESL) students at different learning stages, including certain relevant learning theories. In order to benefit the quantitative analysis of this dissertation, the chapter reviews the comparative studies and issues regarding academic performance of students with Asian and Hispanic ethnic backgrounds, and briefly synthesizes the common factors influencing their academic performance. Finally, the chapter discusses the gaps and the research subjects being addressed in this dissertation, or for future studies. The literature review covers an in-depth investigation of books, journals, periodicals, research articles, dissertations, and online materials on the topics of academic performance of students with minority ethnic and language backgrounds. The chapter integrates the research questions and variables presented in chapter one, and the

research design to be discussed in chapter three, to help formulate a structured dissertation framework.

Academic Performance

Student academic performance is defined as the amount of knowledge they learn after a learning process. The academic performance is measurable using a wide range of means and tools. Checchi et al. (1999) state that the academic performance is evaluated by the amount of human capital obtained during and after students' certain academic experience, which includes quantitative components such as the number of courses attended, and qualitative components such as the grades they receive in the courses. They further stress that the academic performance is differentiated by student attributes, prior academic experiences, and learning effort. Performance indicators include the average grades, the speed of academic progress, and future employment status (Checchi et al., 1999).

Much literature uses academic performance measures as dependent variables, and the student personal attributes, language competency, prior academic experience, school characteristics, social and cultural context, and family socio-economic statuses as independent or predictor variables (Moscoso, 2000).

Performance of Immigrant and Nonnative English-speaking Students at Different Learning Stages

This section reviews critically the literature on participation and performance of nonnative English-speaking (ESL) and immigrant students at different learning stages in U.S. educational systems.

Transitioning into English-speaking World

The dramatic growth in enrollment of students with nonnative English-speaking (ESL) background presents an increasing challenge and opportunity to all levels of the U.S. educational systems. How to assist this special population with their first transition into the English-speaking world continues to be a complicated practice. Study reveals that the greatest and the most outstanding barrier nonnative English-speaking students encountered was inadequate English language skills (Gray, Rolph, & Melamid, 1996). Spellman (1997) addressed the special transitioning needs for two primary groups of nonnative English-speaking students in U.S. educational institutions: resident students (resident aliens and citizens whose primary languages were other than English) and visa students (international students who came to attend U.S. colleges and universities).

According to Spellman (1997), resident students might illustrate better abilities in personal communications, such as listening and sometimes speaking comprehension, but they were less proficient in reading or writing skills. Visa students, on the other hand, might have better comprehension in reading, but were often less successful in listening, speaking and writing. Spellman (1997) further stated that the present reality was that although many students with limited English competency had graduated from high schools in America, they might still have developmental English needs even they were placed into mainstream classes; helping these students to achieve high level of English communication proficiencies is the key to their ultimate success in academics (Spellman, 1997).

Some community programs are helpful for students with minority ethnic and language backgrounds in their transitioning to the English-speaking world. These

programs include mixing immigrant students with their U.S. – born counterparts to create an environment for mutual enrichment; while other programs include assigning counselor with similar ethic and language background to students who need English language support, and incorporating English teaching in various settings, such as classrooms, playgrounds, social activities, and leisure events, since the transition to a new language environment can be best done in a variety of dynamic circumstances (Anstrom, 1998; Siu, 1996).

Performance in Primary and Secondary Schools

Immigrant students with minority ethnic and language backgrounds are as likely as their native counterparts to participate in primary and middle schools in the United States. However, their participation rate is somewhat lower than natives to attend high school. This difference is primarily caused by the low participation of youths of Hispanic origin in high schools (Vernez & Abrahamse, 1996). Vernez & Abrahamse (1996) indicated that some youths from poor areas of their home countries did not go to high schools either by choice, because of their lack of academic confidence in catching up with others of their age or their native counterparts, or by financial situation because they had to find employment to make ends-meet.

According to Vernez and Abrahamse (1996), immigrant students with minority ethnic and language backgrounds in high schools were generally more likely to plan to pursue higher education, and studied hard to reach their academic goals. The parents of students with minority cultural and ESL backgrounds expected higher educational achievement for their children than their native counterparts did, although there was a significant decline in the educational expectation of parents with Hispanic origin.

Pursuing Higher Education and Performance in Colleges

Percentage wise, there are more immigrant high school graduates attending colleges than their native counterparts. Immigrant students have higher retention rates than their native counterparts through four years of college; and the higher retention rates of immigrant students in higher education hold true across racial and ethnic groups in general (Vernez & Abrahamse, 1996). The American Council on Education's 19th Annual Status Report on Minorities in Higher Education (2001-2002) reported that college enrollment among students of color had increased by more than 48 percent during the past decade, including a gain of nearly 15 percent since 1995. For the most recent year when the report was written, minority students registered an enrollment gain of 3.3 percent (The Nineteenth Annual Status Report on Minorities in Higher Education, 2001-2002).

Immigrant students with minority ethnic and nonnative English language backgrounds experience various difficulties in adjusting to the language and cultural norms of this country during different learning stages. In addition to learning the language, they have to cope with emotional stresses due to new social environment, war at home, family separations, and financial difficulties (McDonnell & Hill, 1993; Sim, 1992). Studies of Asian immigrant students at college level indicate that these students possess significantly higher levels of test anxiety than students from Anglo or European ethnic backgrounds (Dion & Toner, 2001). Asian students are less likely to seek help for emotional problems than other students, which is another factor negatively impacting anxiety levels (Kinoshita & Bowman, 1998). Despite the difficulties these immigrant

students encounter, their academic achievements have equaled if not exceeded that of native children and youths (Gray et al., 1996; Vernez & Abrahamse, 1996). The high school graduation rate of immigrant students with nonnative English language background is about the same as the graduation rate of their native counterparts, with Asians have the highest graduation rate, followed by whites, blacks, and Hispanics (Vernez & Abrahamse, 1996).

In a multivariate analysis on individual attributes, family characteristics, motivation, and expectations, Vernez and Abrahamse (1996) found that the individual and family factors associated with college-going were generally the same for immigrant students with minority language background and their native counterparts across racial and ethnic groups. High school graduates whose parents have higher levels of financial income, educational attainment, and academic expectations for their children are more likely to pursue college education than others (Vernez & Abrahamse, 1996).

While immigrant students are more consistent than their native counterparts in pursuing college education, they are assumed to be more likely to follow an academic track and specialize in mathematics and science majors. Research suggests that ethnic and language minority students may do better by choosing certain academic majors to compensate their disadvantages in English language (Vernez and Abrahamse, 1996). Gray et al. (1996) reported that "immigrant students tended to cluster in a small set of majors" (p. 63). However, Hewitt and Seymour (1991) argued that although Asian students in their studies all maintained good GPAs in all coursework and generally performed extremely well in mathematics, some felt that they were "pushed" into science the mathematics fields by well-intentioned teachers who connected Asian culture with

built-in mathematical talents. According to Vernez and Abrahamse (1996), Asian students in general performed best on indicators of preparation for college, followed by white and black students; students with Hispanic background performed the lowest on nearly all indicators of college preparation.

In conclusion, literature suggests that students with minority ethnic and nonnative English language backgrounds are as likely as their native counterparts to participate in primary and middle schools. Their participation rate is somewhat lower than natives to attend high school, primarily due to the low participation of youths of Hispanic origin. Students with minority ethnic and language backgrounds in high schools are generally more likely to pursue higher education, and there are more immigrant high school graduates attending colleges than their native counterparts, although both groups have about the same high school graduation rate. Students with minority cultural and language backgrounds are more likely to follow an academic track, especially in mathematics or science. Although immigrant students encounter more language, socio-economical, and cultural difficulties, their academic achievements *generally* equal if not exceed native-born students. Meanwhile, there exist large gaps among immigrant student groups with different ethnic and nationality origins in terms of their academic participation and performance.

Relevant Learning Theories

Although historically educators and researchers found many different educational learning theories during periods of ups and downs of immigration and civil rights movements, Bolima (2002) concluded that there were three major educational learning

theories within the frames of reference. These three educational learning theories were the Cultural Deficit Theory, Cultural Difference Theory, and Cultural Ecological Theory.

Cultural Deficit Theory

The philosophical origin of Cultural Deficit Theory is Genetic Deficit Theory and Darwinism; a school of thought that has been highly controversial since early 1900's (Bolima, 2002). Cultural Deficit theorists believe that ethnic, racial, and language minority (ESL) students are culturally and intelligently inferior to others, particularly to the mainstream students who are culturally in charge. Therefore, even the most pedagogically advanced strategies are ineffective in the hands of educators if they are the believers of Cultural Deficit Theories (Trueba & Bartolome, 1997).

Under the influence of Cultural Deficit Theory, cultural and language minority students are considered as intellectually retarded and linguistically handicapped. They are generally described as students "at risk" (Trueba & Bartolome, 1997). The inherited differences of cultural and linguistic origins among different ethnic groups are the factors determining their intellectual capabilities and their academic achievement in learning process.

Bolima (2002) concluded that most cultural deficit studies blamed the students' social, cultural or economic environment as being "depraved and deprived" of the elements necessary to achieve success. Bereiter and Engelmann (1966) stressed how "cultural deprivation" theories reinforced the concept that social, cultural, and emotional "deficiencies" negatively impacted the academic performance of students in school systems. They believed that these deficiencies would make it impossible for culturally deprived students to succeed in their learning process. Therefore, Cultural Deficit

theorists consider cultures, environments, and linguistic characteristics outside of dominant Anglo-American mainstream as inherently inferior.

The Cultural Deficit Theory has been criticized by many researchers as ethnocentric and invalid. Heath (1983) compared groups of students with substantial cultural and linguistic differences, and showed when appropriate teaching methodologies were employed, these students could make equal academic achievements. More studies suggest that it is time to change the blame from individual student's cultural, environmental, and linguistic backgrounds to seriously look into the educational process in our school systems (Trueba & Bartolome, 1997).

Nicholls (1990) illustrated that students in traditionally organized educational environment were usually overly concerned with how they were doing in comparison with their peers; thus, their personal potentials were somewhat limited. Labov (1966, 1969, 1970) challenged the fundamental premises of Cultural Deficit Theories, and argued that some earlier research studies were biased due to researchers' lack of knowledge and understanding of other cultural groups. He further stated that the cultural varieties were legitimate and in no way any culture was inferior (Labov, 1969).

Cultural Difference Theory

The Cultural Difference Theory is originated with the idea to shift the focus of cultural deficiencies to cultural differences that generate different barriers in learning. According to Bolima (2002), the fundamental assumption of the Cultural Difference Theory is that when different societies separate from each other, there exist cultural distinctiveness and boundaries. There is always a cultural border between different cultures. If a person from a specific culture wants to function culturally and achieve

academically to become a part of another culture, this person is assumed to essentially depart from his/her own original culture (Delgado-Gaitan & Trueba, 1991). However, as Erickson (1997) indicated, the cultural border was just a symbol of power that determines which culture would be included or excluded by the dominant side. "A border is a social construct that is political in origin" (Erickson, 1997, p. 42).

Heath (1983) studied three groups of students with different cultural, social, and linguistic backgrounds to explore the microelements of communication differences. Heath's research findings suggested that educators should improve their teaching methodologies so that the different "ways with words" could be communicated, and most importantly, to be understood. The participants in the study agreed that they all learned from each other in the process of inter-cultural cross-communications (Heath, 1983). The research promoted interaction among different cultures to produce transformational learning.

Every person is both cultural and multicultural. Everyone is cultural in that all people adopt a set of principles to lead their daily lives and operations, while multicultural in the sense of being able to function and make achievements (including learning) in multiple macro- or micro-cultural societies (Chang, 1999).

Obviously cultures are not bounded by physical lands or societies as some researchers think. People are moving across different lands and places. They bring their cultures, languages, and ideologies with them, adopt other cultures and ideologies, and sometimes create new cultures and ideologies (Chang, 1999). When an individual culture interacts with a different culture, they are both exposed to a different set of standards, through which new standards may be incorporated and both cultures will be more

multicultural (Chang, 1999). Bempechat (1999) indicated that students who studied in multiculturally cooperative settings were less worried about how intelligent they were relative to others and more focused on their actual learning achievements. This multicultural learning environment will eventually enable learners to perform in a true globalized economy.

Cultural Ecological Theory

Nearly twenty-five years ago Ogbu (1978) put forward the theory regarding the variability among students with minority ethnic and language backgrounds, and their variance in school performance and unequal educational outcomes. The cultural ecological theory did not deny cultural differences, but more focused on different minority statuses. In early and subsequent studies, Ogbu (1978, 1987) declared that there were three different groups of minorities: autonomous, immigrant and caste-like. Autonomous minorities are defined as those who have possessed racial, linguistic or cultural identity; they are not subordinating to other racial groups in terms of social, economic or political statuses. Caste-like minorities, however, are those incorporated into the American society involuntarily and whose perspectives reflect a history of oppression. Immigrant minorities come to United States by their own choice and may not encounter the same difficulties in achieving academic success as caste-like or involuntary minorities (Ogbu & Simons, 1998). Ogbu (1987) indicated that the involuntary minorities were subject to "secondary cultural differences" and were skeptical that the educational system controlled by the dominant culture would ever help them to move upward. This generated a "why try" perspective, which might be the

reason that some involuntary immigrants were less successful academically than other groups of students (Bolima, 2002).

Voluntary minorities believe that academic success in the United States will provide chances for them to move upward. Although these new immigrants may also experience unfair treatments and discriminations due to their cultural differences and language disadvantage, they take them as their portion of the "dues" that they have to pay (Bigler, 2002). These immigrant minority students may achieve higher academic accomplishments than their American-born peers, even though they may actually differ culturally and linguistically from students in the dominant culture more than native-born later generations of involuntary minorities (Bigler, 2002). Ogbu's Cultural Ecological Theory takes the social and historical experiences of voluntary and involuntary immigrant minority students into account, which is obviously a significant theoretical move-forward from the Cultural Difference Theory in explaining student academic performance in U.S. educational institutions (Bigler, 2002).

In conclusion, there are three main educational learning theories regarding immigrant students with minority cultural and language backgrounds. Cultural Deficit theorists believe that cultural and language minority (ESL) students are intelligently inferior to culturally dominant students. Cultural Difference theorists emphasize that there exist cultural distinctiveness and cultural boundaries between different cultures. If a person wants to achieve in a different cultural environment, she or he must abandon her/his own original culture. Cultural Ecological Theory divides immigrant students into different immigrant statuses. Students in the involuntary category have negative attitude since they are skeptical about the educational system controlled by the dominant culture.

On the other hand, voluntary minorities believe that academic success in the United States would provide chances for them to be successful. The research population in this dissertation will not be divided into different immigration statuses since it includes nonnative English-speaking immigrant students who mainly come to this country voluntarily.

Performance of Students with Asian Ethnic Background

Asians today constitute about 3% of the total population in the United States. Students of Asian ethnic origin are viewed as super-achievers in academic fields (Dion & Toner, 2001; Kim & Yeh, 2002; Lee, 1996; Rigdon, 1991). Despite all discriminations that Asian people have experienced for more than a century in all aspects in their lives, they struggle hard to improve their educational profile. Among all ethnic groups, Asian American students have the highest graduation rate and the highest percentage of people with at least an undergraduate degree (The Nineteenth Annual Status Report on Minorities in Higher Education, 2001-2002; Vernez & Abrahamse, 1996).

According to Rigdon (1991), although Asian students in the United States are "a tremendous success story," their success is "vastly overrepresented" (p. 2). Rigdon (1991) further indicated that not all of the Asian students in this country fit into the success model. The fact is that there are many Asian students in this country who are not doing well academically; many of them face serious issues of school failures (Kim & Yeh, 2002).

To address personal, family, school and socio-political issues that cause school failure for students with Asian ethnic background, it is apparent that better service systems, including staffing, curricula, and instructional methods, should be established to

serve various needs of Asian students in this country. These needs include better assessment and placement tools, improved racial climate in schools, better trained teachers, inclusive curricula that are sensitive to diverse cultures, and improved supporting services to link academic studies with real world career opportunities, and to engage students and parents with the bigger society; other services may also include effective bilingual instruction, and flexible instructional modes and schedules to accommodate students' learning needs (Siu, 1996; Stanley, Rohdieck, & Tang, 1999).

Comparative Data for Asian Students as a Special Population

Among the Asian population, the largest ethnic group is the Chinese; the second largest is the Filipino, and then Japanese, Indian, Korean, Vietnamese, Cambodian, Laotian, Thai, and Hmong (Siu, 1996). In the United States, students of Asian ethnic origin are considered outperforming their peers in academics at the high school and university levels. Asian students are always stereotyped as super-achievers in academic fields (Dion & Toner, 2001; Kim & Yeh, 2002; Lee, 1996; Rigdon, 1991).

For many years, people of Asian ethnic origin have been treated with prejudice, harassment, and sometimes with violence. For more than a century, people of Asian background have experienced severe discriminatory treatment in immigration, employment, housing, education, naturalization, marriage, and other aspects in their lives. Despite these discriminations, people who emigrated from Asia have taken the opportunities, since the World War II and with the changes in immigration laws, to pursue their education and professional advancement. More and more immigrants from Asia become well-trained professionals; and the educational profile of Asian Americans has been largely improved (Siu, 1996).

The American Council on Education's 12th Annual Status Report on Minorities in Higher Education (as cited in Siu, 1996) reported that the number of Asian students in the nation's colleges had increased almost 100% from 1980's to 1990's. According to Vernez and Abrahamse (1996), students of Asian ethnic origin had the highest college retention rate among all ethnic groups. Among all ethnic groups, Asian students in this country had the highest graduation rate and the highest percentage of people with at least an undergraduate degree (Vernez & Abrahamse, 1996).

However, not all Asian students in this country fit into the generalized success model; many are in fact at-risk students; many students of Asian ethnic origin face serious issues of school failures (Rigdon, 1991; Siu, 1996). Educational Testing Services (as cited in Kim & Yeh, 2002) found that students from six major Asian ethnic groups had significant variations in their educational achievements. One important indicator for school failure is that students perform poorly on reading and mathematics tests. According to Bradby and Owings (1992), 23% of Asian American students were not able to achieve the basic level in mathematics, and 24% were not able to achieve the basic level in reading. Contrarily to the general research findings, some research study indicates that youths who are not American-born are twice as likely as their native born counterparts to fall into the category of being not able to achieve the minimal academic levels. Foreign-born students with low English language competencies, or students who live at or below poverty level, perform poorly in academics (Siu, 1996; Toppo, 2002).

Issues Impacting Academic Success

To analyze school performance of students with Asian ethnic background, the following issues and constraints should be addressed: (a) the English language skills; (b)

previous academic experience; (c) cultural and social environment; and (d) other factors such as family, emotional, motivational, and self-determination issues. School performance of this special population is impacted by the combination of these factors (Sim, 1992).

Prior English skills. Research suggests that students with poor English language skills perform poorly in all academic areas. Schools of large student population with low English proficiency usually have low retention rates (Nguy, 1999). The common belief is that since U.S.-born Asian students, Filipino, and Asian Indian immigrant students have the advantage of better English exposure, they typically perform well in academics. Generally immigrant students may take five to seven years to acquire adequate skills in English before going into mainstream environment to deal with academic subjects without language barriers (Anstrom, 1998; Mestre & Royer, 1991). Asian students studying at several different universities stated that that there was a strong relationship between students with limited English skills and students with good English skills in regard to their self-determination and self-confidence in their academic abilities (personal communication, February 3-12, 2003). Students who were weaker in English skills were more likely to feel self-inadequate (Siu, 1996).

Prior academic experience. The previous education of students of Asian ethnic background is also an important factor influencing their academic performance. Studies indicate that the previous schooling of many students of Asian origin is either very limited or is unstable. Many students from Vietnam, Laos, and Cambodia did not complete their basic education due to the wars. Some immigrant students were taught in refugee camps by untrained volunteers (Kim & Yeh, 2002; Sim, 1992). Generally

speaking, students from rural China and Southeast Asia have less academic preparation than students from Taiwan, Hong Kong, and urban China (Kim & Yeh, 2002; Sim, 1992).

School and socio-cultural issues. One issue in educational institutions is the lack of accurate and consistent process of assessment and placement for students with Asian ethnic background (Siu, 1996). If students are inaccurately assessed and placed into classes at wrong levels, they will either face unrealistically high academic expectations, or feel that they are not given enough academic challenges. Another issue is that students with English as a second language background are sometimes placed into a program for learning disabled, or categorized as developmental students, even though they may have higher GPAs than their native counterparts (Lan, 2002).

Other school related issues include: (a) the severe shortage of professional bilingual instructors and counselors; (b) the lack of understandings of Asian culture among school teachers, staff, and administrative personnel; (c) failure to adapt curricula to cultural differences; and (d) the lack of efforts in utilizing students' cultural strength to enhance their learning (Stanley et al., 1999). Due to school related issues discussed above, the learning process for students with Asian ethnic background may become ineffective, and sometimes may result in school dropout or academic failure (Siu, 1996).

Many students with Asian ethnic background feel that other students treat them with prejudice and discrimination. Chin (1993) reported that the racially polarized school and social environment and the incidents of racial harassment had marginalized Asian participation in student life both in academic settings and outside academics. Chin (1993) further indicated, "An Asian American is now more than twice as likely to be a

victim of racist violence than an African American" (Chin, 1993, p. 3). Due to the insensitivity of school personnel, students with Asian background feel a sense of disengagement in school settings. Not only is there tension among different racial groups, new immigrant Asian students also experience discrimination from U.S.-born Asian American students, since there exist differences in cultural beliefs and behaviors (Chin, 1993).

Other factors. Vernez and Abrahamse (1996) found that students whose parents had lower levels of financial income, educational attainment, and academic expectations for their children were more likely to perform poorly in education than others. Hu (1989) indicated that although some Asians were considered being wealthy, many were at the poverty level. Asian students from families with low-income levels may not be encouraged by their parents to study hard or to finish their education. Sim (1992) indicated that because of financial pressures, these parents requested their older children, especially those who were not doing well academically, to dropout schools and get full-time employment.

Students of Southeast Asian background have emotional difficulties due to their sad experience in wars, refugee camps, and political instabilities. The loss of lives of their friends and relatives, emotional depression, cultural shock, and psychological adjustment make it difficult for these students to perform well in academic settings (Nguy, 1999).

Many parents of Asian immigrant students come to this country with limited knowledge of American educational systems. Some parents have very little previous education; or they have previous education in very different cultural and structural

settings. These parents have had difficult times in preparing their children for schools here, and have not been able to provide useful advice and assistance for their children's learning success (U.S. Commission on Civil Rights, 1992).

Political issues with the "Model Minority" stereotype. Why in American society are Asian people generalized as "Model Minority" despite the fact that there are many Asian students in this country who are not doing well academically; and many are at-risk students? Lee (1996) pointed out that the "Model Minority" theory was not an accurate representation of this group. Instead, the "Model Minority" theory was used by the dominant culture to maintain racial hierarchy. The "Model Minority" theory served its political purposes to deny the needs of other minorities, and to legitimize the injustice of social inequality. The exaggeration of the achievement of Asian Americans also serves the following political agenda: (a) to deny the issues of underemployment and underpayment of Asian Americans; (b) to find excuse for not providing the educational services for Asian Americans; and (c) to let-down non-Asian Americans who are lack of educational opportunities. This stereotype is one of the socio-political factors that prohibit the growth of services provided to Asian students in this country; it prevents Asian students in the United States to seek academic assistance since they do not want to be considered as being not lived up to the standard (Chin, 1993; Grace, 1997; Kim & Yeh, 2002; Lee, 1996; Rigdon, 1991).

Performance of Students with Hispanic Ethnic Background

Hispanics as a minority ethnic group are different from non-Hispanic whites and many other minority ethnic groups in family income, place of living, language

proficiency, community support, existence of role models, orientation toward the dominant culture, and statuses in the academic world (Derk, 2001).

Many Hispanic groups, especially those from Mexico or Puerto Rico, are categorized into a lower socio-economic minority profile (Baltimore, 1995). Although the Hispanics are the fastest-growing minority group in the United States, their general success in academia is lower than other ethnic groups (Baltimore, 1995; Roderick, 2002; Vernez & Abrahamse, 1996). The Hispanic population is stereotypically characterized by larger and younger families, high rates of poverty, high attrition rates from high schools, and the low graduation rates from colleges (Sullivan, 2002). The Hispanic people constantly experience prejudice, discrimination, and social bias; their educational and professional opportunities are limited due to individual and institutional racism (Baltimore, 1995; Derk, 2001).

Comparative Data for Hispanic Students as a Special Population

Among minority groups in the United States, Hispanic group has been growing at the fastest pace. The Hispanic population in the United States has quickly increased for the past several decades; in 2000, over half of the foreign-born population came from Latin America (Pong, 2003). In 1990, about 60% of all Hispanic children were members of the first or second generation (Pong, 2003). Hispanic as a general ethnic group includes sub-ethnicities from 20 different countries; Hispanic culture contains rich and colorful varieties (Derk, 2001, Sullivan, 2002).

According to Derk (2001), the financial status, geographic location, educational background, and academic achievements of Hispanic people and their children are various. The Hispanic population is younger than either the non- Hispanic White

population or the African American population in the United States. Hispanic families in the United States tend to be larger than typical American families and consist of a younger generation (Sullivan, 2002).

Literature strongly suggests that there exist large gaps in academic performance between Hispanic students and non-Hispanic students throughout all stages of schooling (Vernez & Abrahamse, 1996). There is a large gap in mathematics performance levels between White and Hispanic students (Derk, 2001; Roderick, 2002). Derk (2001) reported that although Hispanics now represent 35% of the student body in the public schools, they are twice as likely to be required to take remedial math classes as Whites, and that young Hispanic students were half as likely as Whites to have the desired reading level for their age group.

General research findings indicate that the Hispanic students in American high schools have very high attrition rate (Derk, 2001). In 1994, only 53% of the Hispanic adults in the United States graduated from high school or higher, and 9% had a Bachelor's degree or higher (Sullivan, 2002). Hispanic students are not considered academically successful in the American educational system (Vernez & Abrahamse, 1996). Among all ethnic minority groups in the United States, Hispanics are rated highest on poverty levels and the lowest on educational achievement (Garcia, 1999).

Despite the fact the Hispanics are the fastest-growing minority group in the United States, they are severely under-represented in American higher educational institutions (Baltimore, 1995). In 1988, 8.2 percent of the college-age population were Hispanic youth, but only 4.3 percent of young Hispanics actually enrolled in higher education institutions (Baltimore, 1995). According to Valencia and Aburto (1991), only

one out of four Hispanic high school seniors was enrolled in college preparatory curricula; 38 percent of Hispanics dropped out from high school and over 50 percent of Hispanic students who enrolled in colleges did not graduate. The Hispanic population characterized by larger and younger families, high rates of poverty, high attrition rates from high schools, the low graduation rates from colleges is faced with tremendous challenges in American educational systems. Although the majority of research has tried to understand why a large percentage of Hispanic population in the United States is performing poorly within the educational systems, there is a lack of research that actually explores the effective as well as ineffective instructional methodologies and educational institutions for helping Hispanic students academically.

Issues Impacting Academic Success

Language and cultural barriers. Language barrier and cultural incompatibilities for newer immigrants have made young Hispanic students extremely difficult to advance in academic pursuance. A large number of Hispanic families live in metropolitan areas and keep the usage of their native language. The Hispanic immigrants keep their native tongue to a greater degree than other ethnic groups (Baltimore, 1995). The Hispanic students' poor academic performance is partially due to the fact that these young students are not given enough time, opportunity, and life experience to develop adequate English proficiency before they enter the mainstream classes in a monolingual environment (Mestre & Royer, 1991). The language barrier makes it almost impossible for the Hispanic parents to communicate effectively with school personnel, which negatively impacts the academic success of the Hispanic students (Baltimore, 1995).

Prior academic experience. Generally speaking, Hispanics earn less salary than people of other ethnic backgrounds. Many Hispanic employees work on blue-collar jobs making minimum wage; and large percentage of Hispanic people live below the poverty level (Sullivan, 2002). Due to difficult financial situation, the Hispanic families rarely have the opportunity to participate in preschool for their children. Although Hispanic population is the fastest growing minority group among all minority groups with the highest population of young children, Hispanic students enter American educational systems with very limited preparation to learn and to be successful academically. When progressing to high schools, Hispanic students are substantially less equipped with necessary fundamental preparations to handle the academic work at high school levels (Roderick, 2002). Students from low-income families are seven times as likely to not finish high school when compared with students from median- to high-income families; meanwhile, Hispanic students receive the least amount of economic aid in the United States (Derk, 2001; Nieto, 2000). Many Hispanic families expect their children to gain employment after high school to support their families (Rendon & Valadez, 1993).

Obviously, success in colleges and universities depends on students' success in their previous schools. According to Hewitt and Seymour (1991), Hispanic students form high schools that did not provide them with an adequate academic preparation felt they started college already well behind their peer students. Even these Hispanic students who were receiving good grades in their science and engineering courses still experienced feelings of inadequacy and low self-esteem (Hewitt & Seymour, 1991). There is an urgent need for Hispanic students from cultural and language minority families to have systematic nurturing and support at the prenatal, early childhood, preschool, elementary

and secondary levels, in order for them to develop physical health and academic competencies to be successful in pursuing higher education (Baltimore, 1995).

School and societal issues. Many Hispanic students attend very crowded schools where the educational instructions are poorly prepared and delivered, due to the issues with funding; these schools are short with qualified instructors, staff, facilities, and other educational resources (Institute for Urban and Minority Education, 2000). Many Hispanic youth do not envision and believe that staying in schools will financially improve their lives in the future, since they are used to living in the most economically distressed locations of the United States, where they have seen that their parents and grandparents are always having limited employment opportunities (Institute for Urban and Minority Education, 2000). Since they were born or immigrated into this country, they have been experiencing constant prejudice, discrimination, and social bias; "Individual and institutional racism and stereotyping also affect opportunity for Hispanic students" (Baltimore, 1995, p. 68).

Minority students of Hispanic origins experience extremely high level of separation, loneliness, and isolation; they encounter stereotypic expectations and performance evaluation, are alienated from the dominant culture, and are powerless in self-controlling over the fates in their lives (Hewitt & Seymour, 1991; Loo & Rolison, 1986). Since they are constantly in a lower socio-economic situation where there is no support or stimulation, and the world of academia is often alien, frustrating, and hostile to them, they seldom feel confident that they are capable of obtaining the results that they desire (Baltimore, 1995; Henriksen, 1995; Hewitt & Seymour, 1991).

The Hispanic immigrants once were able to migrate into America and found blue-collar jobs to advance their socio-economical status. However, it becomes more and more difficult for current Hispanic immigrants to get a job without an education. The number of jobs that require minimal level of education is decreasing rapidly; and they are replaced with jobs that require more education (Garcia, 1999). This reality further limits the Hispanics' ability to earn necessary financial means to fund their education.

Gaps and Subjects for Further Research

One major gap is the lack of reliable statistical data and comparative research on academic performance of ethnic and language minority students in educational institutions providing practical, career-oriented academic programs, such as DeVry's engineering technology programs, where "hands-on," experiential learning is an important integral component to help students to be successful. The current research and literature on Asian and Hispanic students are predominantly concerned with their general academic performance in traditional, mainstream academic settings. Specific studies are needed to investigate if cultural and language minority students, specifically those with Asian and Hispanic ethnic backgrounds, will perform differently in such practical, career-oriented academic institutions. This kind of research will help to understand if DeVry University's career-oriented programs are more suitable, or motivational, for students with nonnative English-speaking and minority ethnic backgrounds.

Due to the fact that Asian Americans only constitute 3% of the U.S. population, Asian students in the United States are either not counted in national statistics or are counted together with other ethnic groups (U.S. Commission on Civil Rights, 1992).

Since some immigrant students from Asia have low English proficiency, they do not have the ability to take standardized tests, and therefore are not even included in national statistics. Based on this inaccurate database, the secondary researches have resulted in highly controversial findings (Siu, 1996). This dissertation used DeVry's statistical data to address this controversy within the paradigm of DeVry's technology programs.

Literature reveals that due to financial constraints, Hispanic students usually are not able to be on the "fast academic track." Many of them have to take part-time schedules. Without certain degrees of flexibilities in course delivery and scheduling, these students will have no alternatives but to dropout. More research must be done to address the needs for making universities more flexible in delivery modes and schedules, and more available with supporting systems, to provide these students opportunities for success in higher education (Baltimore, 1995). Although the majority of research has been tried to understand why a large percentage of Hispanic population in the United States is performing poorly within the educational systems, there is a lack of research that actually explores the effective as well as ineffective instructional methodologies and educational institutions for helping Hispanic students academically. This dissertation attempted to investigate these research topics within DeVry's scenario.

Another major gap in research is that the majority of studies on Asian and Hispanic students are focused on general ethnic groups to address their performance in academics. Many statistical studies do not differentiate nonnative English-speaking (ESL) immigrant and native English-speaking U.S.-born students for the same ethnic group, thus decrease the value of the research findings. This dissertation conducted statistical analyses on comparable nonnative English-speaking (ESL) Asian and native

English-speaking Asian students, nonnative English-speaking (ESL) Hispanic and native English-speaking Hispanic students, etc., to investigate their academic performance.

The current research on cultural and language minority students is predominantly quantitative using students' GPAs and test scores. There is very little research conducted using other curriculum assessment instruments to investigate performance breakdowns in students' design skills, experimentation skills, oral and written communications skills, life-long learning skills, etc., due to the labor-intensity of such studies. Extensive research in these specific areas should be conducted, especially in engineering technology programs, to find out the areas for improvement in particular curriculum areas so that the appropriate learning environment will be provided to students of all different cultural and language backgrounds to best achieve their academic goals. This dissertation attempted to make contributions to the breakdown studies in various competency areas.

Further studies are also needed on how to design inclusive curricula that are sensitive to diverse cultures, how to improve supporting services to link academic studies with real world career opportunities for cultural and language minority students, and how to engage cultural and language minority students and parents with the larger society (Siu, 1996; Stanley et al., 1999).

Summary

This chapter presents a review of comparative studies on the participation and performance of students with minority cultural and language backgrounds at different learning stages. The chapter also reviews the literature on different learning theories relating to students with immigrant backgrounds.

A review of literature reveals that although students of Asian ethnic origin are viewed as super-achievers in academic fields, their success as a whole is exaggerated (Dion & Toner, 2001; Kim & Yeh, 2002; Lee, 1996; Rigdon, 1991). School failure of this special population is largely due to the combination of student personal attributes, and the factors in school, family, socio-cultural, and political context (Kim & Yeh, 2002).

The chapter reviews the literature on academic performance of Hispanic students as a cultural and language minority ethnic group. The literature indicates that Hispanics are different from many other minority ethnic groups in their statuses in the academic world, language proficiency, place of living, community support, existence of role models, orientation toward the dominant culture, and family income (Baltimore, 1995; Sullivan, 2002). Although Hispanics are the fastest-growing minority group in the United States, their success in academia is lower than other ethnic groups (Baltimore, 1995; Roderick, 2002; Vernez & Abrahamse, 1996). The Hispanic people constantly experience prejudice, discrimination, and social bias. Their educational and professional opportunities are limited due to individual and institutional racism (Baltimore, 1995; Derk, 2001).

The chapter finally addresses the gaps and suggests subjects for further research. One gap is the lack of reliable comparative research on academic performance of cultural and language minority students in career-oriented educational institutions, where "hands-on" learning is an important tool to help students' success. Another gap is that the secondary researches on academic performance of students with Asian ethnic background have been very controversial, due to inaccurate database and contradictory statistical

findings (Siu, 1996). This dissertation addressed these research topics within the paradigm of DeVry's technology programs.

Although the majority of research has been tried to understand why a large percentage of Hispanic population in the United States is performing poorly within the educational systems, there is a lack of research that actually explores the effective or less effective instructional methodologies and educational institutions for helping Hispanic students' success academically. This dissertation attempted to investigate these research topics using DeVry's statistical data.

The majority of current studies on Asian and Hispanic students do not differentiate nonnative English-speaking (ESL) immigrant and native English-speaking U.S.-born students for the same ethnic groups. This dissertation conducted statistical analyses on comparable nonnative English-speaking (ESL) Asian and native English-speaking Asian students, nonnative English-speaking (ESL) Hispanic and native English-speaking Hispanic students, etc., to investigate their academic performance.

The current research on cultural and language minority students is predominantly quantitative using students' GPAs and standard test scores. There is very little research conducted using curriculum assessment instruments, to study performance breakdowns in students' design skills, experimentation skills, oral and writing communications skills, life-long learning skills, etc. This dissertation attempted to make contributions to the breakdown studies in various competency areas.

CHAPTER 3: METHODOLOGY

Research Approach and Rationale

The primary purpose of this research was to make statistical comparisons of nonnative English-speaking (ESL) graduating seniors and native English-speaking graduating seniors in terms of their academic performance using quantitative research methodology. The research divided both nonnative English-speaking (ESL) and native English-speaking graduating seniors into comparable ethnic groups, and compared their academic performance. The research finally investigated the differences and intercorrelations of students' GPAs in the English/humanities course sequence, in the mathematics/science course sequence, and in the technical course sequence, for nonnative English-speaking graduating seniors in the sample.

This chapter presents the research procedures employed in this dissertation. The chapter describes in detail the participants, sampling process, sampling design, independent and dependent variables, instrument and its validity and reliability, data collection, statistical analysis, and Human Research Committee approval process.

Participants

Population

The target population for this research includes all graduating seniors in engineering technology programs at universities across the United States of America. These graduating seniors are finishing up their program of study in the pursuit of their

Bachelor of Science degree in electronics engineering technology. As an important part of DeVry's operational definition, this dissertation defined the group of students *who were originally from countries where English is not the primary language spoken* as nonnative English-speaking (ESL) students (DeVry University Academic Policy Manual, 1998). Students who did not fall into this category were native English-speaking students. The target population of this study included both graduating seniors with nonnative English language backgrounds and with native English language backgrounds as defined in this dissertation.

Although the research population might include all graduating seniors from engineering technology programs across DeVry University campuses throughout the United States and Canada, the actual sample was limited to the students in graduating classes of the Electronics Engineering Technology programs on DeVry University Chicago area campuses, due to the considerations of the factors of cost, time, and effectiveness (Gliner and Morgan, 2000). According to McDonnell and Hill (1993), the Chicago area is one of the five districts in the United States that enroll the vast majority of immigrant students. Since DeVry University Chicago area campuses include the first campus in DeVry history offering electronics programs and admit high number of nonnative English-speaking students into its ESL and regular programs, the researcher believed that this sample would present relevant outcomes that could be generalized to other DeVry University campuses across North America, and to the engineering/engineering technology programs at other comparable higher education institutions. The schematic diagram of the sampling process is illustrated in Figure 3.1.

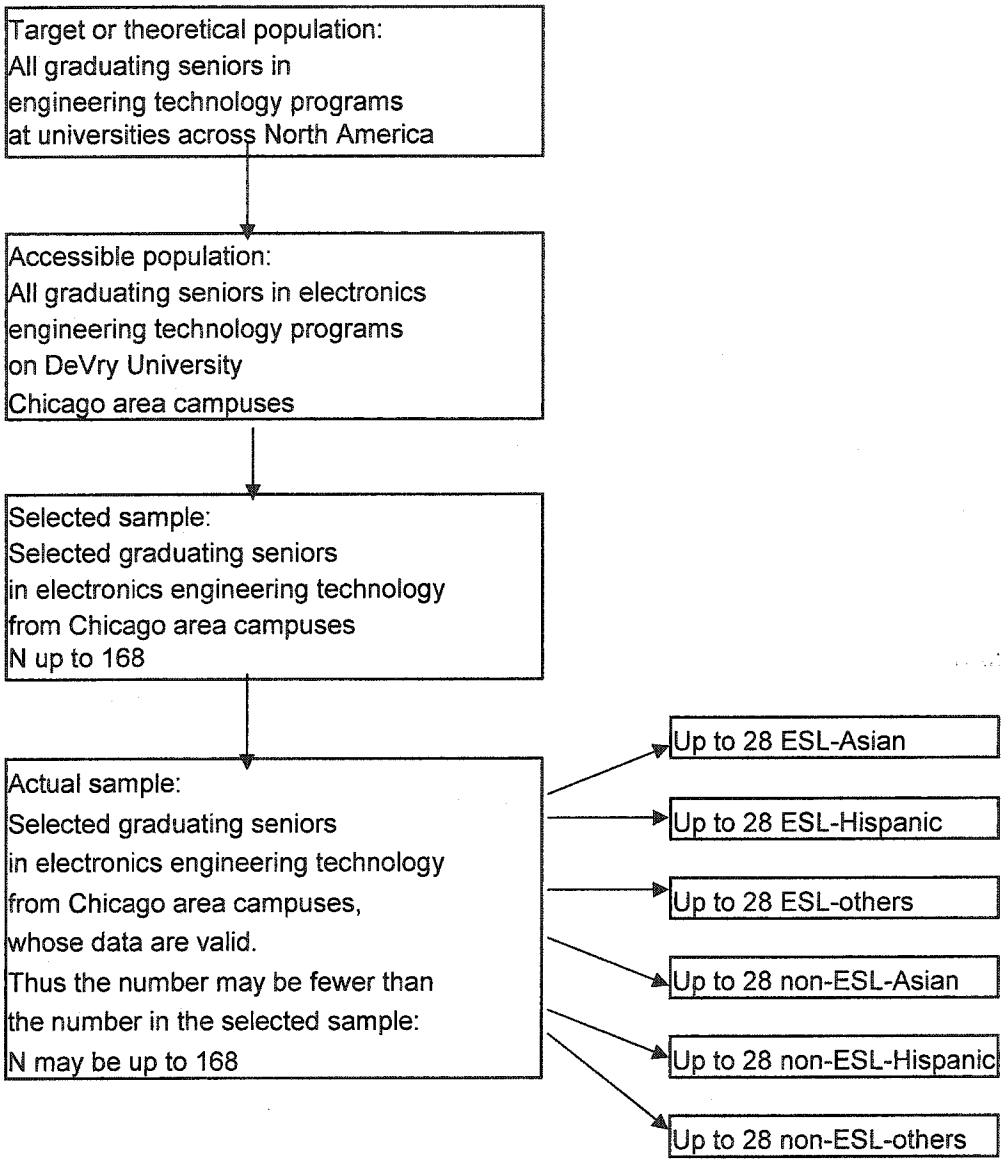

Figure 3.1. The schematic diagram of the sampling process (ESL = nonnative English speakers; non-ESL = native English speakers).

First, the population for the present research included graduating seniors on DeVry Chicago metro area's EET programs in recent years. From the list of graduating students, those who fit into the nonnative English-speaking (ESL) definition were sorted out based on their admission information sheets. Graduates who did not fit into nonnative English speakers' definition were in the native English-speakers' category. Both graduating

seniors who were in nonnative English-speakers' and those in the native English-speakers' categories were further divided into ethnic sub-groups for comparative study.

Since the participants were all selected from the graduating classes of DeVry EET programs, it was assumed that their attributes such as age, gender, and entrance admissions statuses, were similar. It was also assumed that both nonnative English-speakers and native English-speakers were generally experiencing similar environmental factors such as learning materials, laboratory settings, and teaching staff.

Sampling Procedures

The sample was selected using the following procedures:

1. From senior project advisors and/or assessors, the researcher obtained the list of all students who participated in and completed their senior projects to fulfill their graduation requirements for their Bachelor's degrees.
2. The research recorded the students' DeVry Student identification numbers (DSI numbers) created for each student randomly when they were admitted.
3. The researcher identified students who fit into the nonnative English speaker (ESL) category defined in this dissertation and their ethnic origins (Asian, Hispanic, or others) with the assistance of the Admissions Office, the Registrar, and DeVry staff not related to the research. When the list was made with students' demographic data, the names were all removed to protect the confidentiality.
4. Graduating seniors who were not identified as nonnative English-speakers were in the native English-speaking category.

5. Twenty-four nonnative English-speaking (ESL) graduating seniors with Hispanic origin, twenty-five nonnative English-speaking (ESL) graduating seniors with Asian origin, and twenty-seven nonnative English-speaking (ESL) graduating seniors with other ethnic origins were selected. The number of graduating seniors with valid assessment or GPA data was slightly less than the number originally intended for each group.
6. Meanwhile, twenty-four native English-speaking graduating seniors with Hispanic ethnic origin, twenty-six native English-speaking graduating seniors with Asian ethnic origin, and twenty-eight native English-speaking graduating seniors with other ethnic origins were selected. The number of graduating seniors with valid assessment or GPA data was slightly less than the number originally intended for each group.

The sample came from Chicago area campuses rather than the whole target DeVry population, because of the factors of cost, time, and effectiveness, so in that sense it was a convenience sample (Gliner & Morgan, 2000). The number of nonnative English-speaking (ESL) students and native English-speaking students were sampled from the disproportional sample pool (i.e., the number of graduating seniors who fell into nonnative English-speaking category was much less than that of native English-speaking graduating seniors).

All nonnative English-speaking graduating seniors of Hispanic, Asian, and "other" origins with complete available assessment and GPA data in the accessible sample were included; and all native English-speaking graduating seniors of Asian origin with complete available assessment and GPA data in the accessible sample were

included. Twenty-four native English-speaking graduating seniors of Hispanic origin and twenty-eight native English-speaking graduating seniors of "other" origins were sampled from their respective larger strata. The number of African Americans was equal to the number of nonnative English-speaking graduating seniors of Black African origin in the sample, which represented 29% of the students of "other" origins. Other than those from Black African countries, almost all nonnative English-speaking students in the "other" category were from East European countries. The sampling approach in this study was stratified with different proportions (Gliner & Morgan, 2000). It is not uncommon to use such approach in comparative research when the study includes minority groups (Gliner & Morgan, 2000). Figure 3.2 illustrates the schematic diagram of the sampling method. .

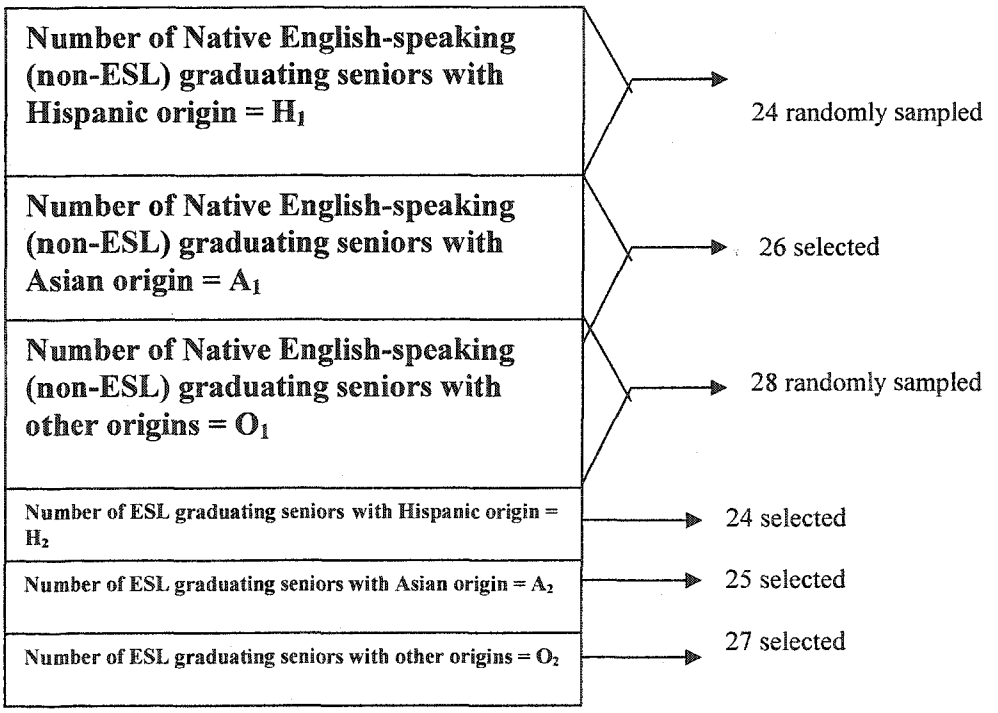

Figure 3.2. Schematic diagram of the sampling methods. Non-ESL = native English speakers; ESL = nonnative English speakers. A_1, H_2, A_2, and O_2 included all participants in the accessible sample with either available assessment or GPA data

To identify whether the entrance status in algebra was somewhat matched between nonnative English-speaking (ESL) students and native English-speaking students in the sample, chi-square tests were performed to determine if there was significant differences between nonnative English-speaking (ESL) graduating seniors and native English-speaking graduating seniors for each ethnic group, in regard to their algebra entrance test scores. Students admitted with algebra transfer credits, adequate ACT/SAT algebra scores, or CPT algebra scores 80 or above were categorized as having "High Scores; " while students admitted with CPT algebra scores lower than 80 were categorized as having "Passing Scores." Table 3.1 shows the Pearson chi-square results and indicates that there were no significant differences between Asian nonnative speakers of English and native speakers of English with Asian ethnic background ($\chi^2 = .41$, $df = 1$, $N = 49, p = .52$), or between Hispanic nonnative speakers of English and native speakers of English with Hispanic ethnic background ($\chi^2 = 1.65$, $df = 1, N = 52, p = .20$), or between nonnative speakers of English and native speakers of English both with other ethnic backgrounds ($\chi^2 = 1.08$, $df = 1, N = 54, p = .30$), in regard to their algebra entrance test scores. The algebra entrance scores of nonnative speakers of English-speaking and that of native speakers of English in the sample were not statistically different.

The general observation in the literature review is that immigrant high school graduates are more likely than their native counterparts to stay continuously through four years of college (Vernez & Abrahamse, 1996). Retention rates were analyzed comparing the total number of graduates and the total number of nonnative English-speaking graduates who were placed in remedial English as a second language classes on DeVry

University Chicago campus. During the years of 1993 and 1997, the total number of DeVry Chicago graduates was 2,400, while the number of nonnative English-speaking graduates who were placed in remedial ESL classes was 238. Nonnative English-speaking graduates who were placed in remedial ESL classes represented 10% of the total number of graduates (EFL Department, 1998). At the entrance, the number of freshmen who were placed into remedial ESL classes was lower (EFL Department, 1998) than, but close to 10% of the total freshmen enrollment (according to DeVry Chicago Admissions) during the period. Thus, the graduation rate of nonnative English-speaking graduates who were placed in remedial ESL classes was about the same, if not a little higher, than the general graduation rate.

Table 3.1

Chi-square Analyses of Algebra Entrance Scores Between Nonnative English-speaking (ESL) Students and Native English-speaking Students for Each Ethnic Group

Variable	*n*	Language Backgrounds: Nonnative Eng-spking	Language Backgrounds: Native Eng-spking	χ^2	*p*
Asian Students				.41	.52
High Scores	39	19	20		
Passing Scores	10	6	4		
Hispanic Students				1.65	.20
High Scores	39	20	19		
Passing Scores	13	4	9		
Students of Other Ethnicity				1.08	.30
High Scores	50	24	26		
Passing Scores	4	3	1		
Totals	155	76	79		

Variables

In this research, there were two independent variables (IV). The first independent variable, the student native language background, had two categories. The first category was the group of graduating seniors who fell into the nonnative English-speaking (ESL) student definition used in this dissertation, while the second category was the group of graduating seniors who were defined as native English-speaking students in this dissertation. Two categories were mutually exclusive by definition.

The second independent variable, student ethnic background, had three categories. Since many of the DeVry Chicago area's nonnative English-speaking (ESL) students were from Hispanic origin and Asian origin, and others were from all different ethnic origins with much lower numbers, this second independent variable was divided into Hispanic, Asian, and "other" ethnic origins (three sub-groups) for both nonnative English-speaking (ESL) and native English-speaking (non-ESL) categories. In doing so, this research would not only be more relevant to DeVry Chicago area students' ethnic composition, but would also make sense in comparing nonnative English-speaking and native English-speaking students with the same comparable ethnic origins. There were multiple dependent variables (DV) describing student academic performance, including graduating seniors' overall composite GPAs, their cumulative GPAs in the general education course sequence, in the mathematics/science course sequence, in the technical course sequence, and their assessment competency ratings at the point of graduation.

The two independent variables in the study might interact. The specific statistical analysis and a detailed discussion of the treatment of the possible interaction is discussed in the data analysis and research design section of this chapter. The data format

describing all independent and dependent variables for each research question is attached in Appendix A.

Instrument

EET Competency Evaluation Sheet (ECEV)

The primary instrument used in the DeVry Electronics Engineering Technology assessment program was the EET Competency Evaluation Sheet. The EET Competency Evaluation Sheet adopted by the faculty of the Electronics Engineering Technology programs is used as a DeVry standard measure of core student competencies covering all EET courses. The EET Competency Evaluation Sheet consists of six performance measures completed by the students' instructor(s): student experimental skills, student programming skills, student design skills, student communication skills, student team skills, and student lifelong learning skills. Each measure is represented by a Likert type scale that provides the following response options toward stated issues: 0 – Fail (evidence of poor quality incomplete work); 1 – Poor: outcome poorly achieved and with significant number of errors (evidence of poor quality completed work); 2 – Fair: outcome achieved and demonstrated with occasional errors (evidence of mediocre quality completed work); 3 – Good: outcome achieved and demonstrated with no significant errors (evidence of good quality completed work); and 4 – Outstanding: outcome achieved and demonstrated with no errors (evidence of high quality completed work) (Agajanian, Kyriazopoulos, Lan, & Loggins, 2000).

The first measure, student experimental skills, consists of five indexes; each index is rated 0 to 4: 1) performs needs analysis, effectively defines program to be solved; 2) states goals and objectives of the experiment; 3) identifies resources to conduct

experiment (parts, equipment, datasheets, etc; 4) develops a procedure for the experiment and collects data effectively; and 5) analyzes test results and draws conclusions effectively.

The second measure, student programming skills, consists of four indexes; each index is rated 0 to 4: 1) analyzes the problem logically; 2) designs the solution; 3) implements the solution; and 4) tests and debugs the software.

The third measure, student design skills, consists of six indexes; each index is rated 0 to 4: 1) selects and design s meaningful problem; 2) devises process to solve problem; 3) uses appropriate technological tool in designing and analyzing alternative problem solutions; 4) identifies key issues in designing and building a prototype; 5) builds and tests prototype; and 6) troubleshoots and optimizes prototype.

The fourth measure, student communication skills, consists of two indexes, each index is rated 0 to 4; 1) communicates effectively in writing; and 2) communicates effectively orally.

The fifth measure, student team skills, consists of two indexes, each index is rated 0 to 4: 1) exhibits good dialoguing skills; and 2) as part of a small group project, when assigned roles, performs effectively.

The sixth measure, student lifelong learning skills, consists of two indexes; each is rated 0 to 4: 1) recognizes the need to know information beyond one's own expertise and has the ability to gather and synthesize the necessary information into the solution of a problem; 2) uses engineering problem-solving methodology in solving problems.

The complete instrument is attached as Appendix B.

Validity. The EET Competency Evaluation Sheet (ECEV) was developed by a group of EET faculty members from different curriculum areas at the beginning of the year of 1999. Before it was officially adopted on the DeVry University campuses, the instrument was evaluated by a selected group of EET core professors from all DeVry University campuses. Outside experts from industry and peer academic institutions were also invited to judge whether the instrument was accurately measuring the competency skills expected of DeVry University BSEET graduates (Agajanian et al., 2000).

This instrument has been in use since 1999, when it was first piloted on the DeVry University Chicago campus. Presently, approximately more than 1000 EET graduating students are assessed using the instrument each year at the twenty-four DeVry campuses in the United States and Canada. The adoption of the instrument by the twenty-four campuses further supported its content validity.

Students' GPAs were used to measure criterion validity. It was found that the correlation coefficient between the composite assessment rating of the instrument and the GPA as the external criterion was $r = .61$ (Agajanian et al., 2000).

Reliability. Since the assessment instrument has several constructs, and each construct consists of sub-items that are summed to make a composite score or summated scale for the specific construct, the most commonly used and appropriate type of measure to determine internal consistency is Cronbach's coefficient alpha for each assessment construct (Leech, Barrett, & Morgan, 2004). Gliner and Morgan (2000) indicate that this measure of reliability takes only one administration, and is a suitable method for multiple-choice insturments such as the Likert scales used in the EET Competency

Evaluation Sheet (ECEV). In preparing the research proposal, the researcher performed a preliminary test on a group of pilot assessment data.

Table 3.2 presents a summary of the test results of Cronbach's alphas for the EET Competency Evaluation Sheet. In the table, the first column lists the summated scales measuring the competency skills; and the second column illustrates their respective Cronbach's alphas. The alphas range from 0.78 to 0.90, showing that all assessment items have good to very good internal consistency.

Table 3.2

Internal Reliability Analysis – Cronbach's Alphas

Competency Skills	Cronbach's Alphas
Experimental	.88
Programming	.87
Design	.90
Communications	.85
Team	.78
Lifelong Learning	.85

The actual test results on Cronbach's alphas are attached as Appendix C. The test results showed that corrected item-total correlation of all assessment items range from 0.62 to 0.78. Based on this range, the assumption can be made that for each assessment scale, all the measurement items are considered to be very well correlated with most of the other items and will make good components of the summated rating scales for that specific item (Leech et al., 2004).

GPA Measurement

In this research, students' GPAs, including their overall composite GPAs, their cumulative GPAs in general education courses, their cumulative GPAs in mathematics/science courses, and their cumulative GPAs in technical courses, were used

as dependent variables. Since GPA measurement has been widely used in all types of academic institutions for many decades, and it measures what has been learned as outcomes, it is considered to be achievement test score. The validity and reliability of GPA measurement have been studied in previous education literatures and will not be discussed here.

Date Collection Procedure

The first step in the data collection process started with the sampling process. After the sampling process was completed (refer to Figure 3.2. Schematic diagrams of the sampling methods), a list of graduating seniors with their DeVry student identification numbers (DSI numbers), and their demographic data on language and ethnics backgrounds were collected. The actual student names were all removed from the list when these data are recorded for the researcher to protect the confidentiality. This first step not only collected such demographic data as nonnative English-speaking Asian, nonnative English-speaking Hispanic, nonnative English-speaking other-ethnic, native English-speaking Asian, native English-speaking Hispanic, native English-speaking others, but also included students' algebra entrance status. Student names were all removed from the data sheets.

The second step was to collect the assessment ratings measured by the DeVry EET assessment instrument at the end of their senior projects for these graduating students in the sample. Some data were synthesized from the raw data on the EET Competency Evaluation Sheets (ECEV); some had already been synthesized by the senior project advisor(s) who supervised the senior projects. The assessment ratings evaluated experimental skills, programming skills, design skills, communication skills,

team skills, and lifelong learning skills for each EET graduating student in the sample. When assessment data were recorded for the researcher, the names were all removed from the data sheets.

The next step was to collect students' GPA data with the help of the Registrar's Office and the DeVry staff not related to the research. For each graduating senior sampled, his or her curriculum history and term records were printed and synthesized. From the curriculum history and the term records, students' cumulative composite GPAs, cumulative GPAs in the English/humanities course sequence, cumulative GPAs in the mathematics and science course sequence, and their cumulative GPAs in the electronics engineering technology course sequence at graduation from DeVry University's EET program were collected, calculated, and synthesized into data sheets. In the collection and analysis process, student names were all removed from their curriculum records; student GPA data were recorded and calculated without any association with their names.

Finally, all data collected were entered into the SPSS data editor with all data and variables defined. Student names were not included in the SPSS codebook. All data were only associated with numeric numbers generated by the SPSS data editor. The codebook with all research variables is attached as Appendix A.

Data Analysis and Research Design

The overall research type for this study was 2X3 factorial design, since in the research there were two categories for the first independent variable (nonnative English speakers versus native English speakers) and three categories for the second independent variable (Hispanic, Asian, and others). All dependent variables were scale normally

distributed data. It was appropriate to use 2X3 two-way factorial ANOVA as the inferential statistic (Morgan, Leech, Gloeckner, & Barrett, 2004).

The research first investigated if language backgrounds and the ethnic backgrounds interact. It then examined the main effects of students' language backgrounds and of students' ethnic backgrounds on their academic performance.

If, after the analysis, the interaction was not statistically significant, the two main effects (language backgrounds and the ethnic backgrounds) would be examined one at a time. On the other hand, if the interaction was statistically significant, the interaction will be examined first, followed by the examination of the main effects by analyzing the differences between cell means (Morgan et al., 2004). One-way ANOVA and Tukey tests would be used to run the post hoc analysis. Planned simple cell contrast tests were performed to find out whether there were significant differences in regard to academic performance between nonnative English speakers versus native English speakers while both groups are of the Hispanic origin, or while both groups are of the Asian origin, etc.

Two paired *t* tests were performed to determine whether there were significant differences between nonnative English speakers' GPAs in the general education course sequence and their GPAs in the technical course sequence, and between their GPAs in the mathematics/science course sequence and their GPAs in the technical course sequence. Multiple regression was conducted to determine whether there was a combination of nonnative English speakers' cumulative GPAs in general education and in mathematics/science that predict their GPAs in the technical course sequence better than either one alone.

After the statistical results were obtained, the confidence intervals and effect size measures were discussed to avoid an "all-or-none" conclusion. The direction of the effect and the direction of the association of the correlation results were also discussed.

Human Research Approval

Since data related to human subjects were used in this dissertation, the researcher submitted the Application to Use Human Subjects form (H-100, Rev 10/2000) to the Colorado State University Human Research Committee. The application was approved by the HRC before the data collection process actually started.

During the period when the dissertation proposal was prepared, the researcher submitted a letter to the presidents of DeVry University Chicago area campuses, requesting their permission to use DeVry student data in this research. The presidents responded with their approvals and the letters of support.

Summary

The primary purpose of this research was to make statistical comparisons of nonnative English-speaking (ESL) graduating seniors and native English-speaking graduating seniors in regard to their academic performance using quantitative research methodology. The research also divided nonnative English-speaking (ESL) graduating seniors and native English-speaking graduating seniors into comparable ethnic sub-groups, and compared their academic performance. The differences and intercorrelations were investigated among nonnative English speakers' GPAs in the English/humanities course sequence, in the mathematics/science course sequence, and in the technical course sequence.

Although the target population for this research included all graduating seniors in engineering technology programs at universities across North America, the actual sample of the research population was limited to the students in graduating classes of the Electronics Engineering Technology programs at DeVry University Chicago area campuses. The researcher believed that this sample would present relevant outcomes that could be generalizable.

There were two independent variables in this research. The first independent variable had two categories (nonnative English speakers and native English speakers). The second independent variable had three categories (Hispanic, Asian, and others). There were multiple dependent variables describing student academic performance.

The primary instrument used in the DeVry EET assessment program was the EET Competency Evaluation Sheet. The instrument is believed to have good content validity. The criterion validity was measured using students' GPAs, and was found $r = 0.61$ (Agajanian et al., 2000). The Cronbach's alpha test of the EET Competency Evaluation Sheet showed that all assessment items had good to very good internal consistency.

The data collection procedure included collecting student demographic data, their assessment ratings, and their GPA data. In the data collection and analysis process, student names were all removed from the records to protect confidentiality.

2X3 factorial ANOVA was used as the main inferential statistic in this research (Morgan et al., 2004). Two paired *t* tests and the multiple regression were used to explore whether there were statistically significant differences and intercorrelations for nonnative English-speaking (ESL) graduating seniors among their GPAs in general education, mathematics and science, and technical subjects.

Since data related to human subjects were used in this dissertation, the Application to Use Human Subjects form (H-100, Rev 10/2000) was submitted to and approved by the Colorado State University Human Research Committee.

CHAPTER 4: FINDINGS

This chapter presents the findings of statistical analyses that tested the comparisons between language backgrounds among different ethnic groups, in regard to graduating seniors' academic performance in terms of their competency assessment ratings measured by the DeVry University assessment instrument, and their cumulative GPAs in various course sequences. The chapter is organized to address each research question raised in chapter one in the same order.

Research Question 1

The first research question was to investigate: (a) whether there was a statistically significant difference between nonnative English-speaking (ESL) graduating seniors and native English-speaking graduating seniors in regard to their academic performance in terms of their competency ratings; (b) whether there were statistically significant differences among graduating seniors with Hispanic origin, graduating seniors with Asian origin, and graduating seniors with other ethnic origins in regard to their competency ratings; (c) whether there was an *interaction* of students' native language backgrounds (nonnative speakers of English versus native speakers of English) and their ethnic backgrounds (Asian versus Hispanic versus others) in regard to their competency ratings; and (d) for each ethnic group studied in this research, whether there was a statistically significant difference between nonnative English-speaking graduating seniors and native English-speaking graduating seniors in regard to their academic performance in terms of

their competency ratings. The competency ratings included the ratings in the areas of (a) experimentation skills, (b) programming skills, (c) design skills, (d) oral/written communication skills, (e) team skills, and (f) information literature/life-long learning skills measured by the DeVry University assessment instrument in DeVry University's EET programs.

This research question contained two independent variables. The first independent variable, the graduating seniors' native language backgrounds, had two categories. The first category was the group of graduating seniors who fell into the nonnative speakers of English definition used in this dissertation, while the second category was the group of graduating seniors who were native speakers of English defined in this dissertation. The two categories were mutually exclusive by definition.

The second independent variable, student ethnic backgrounds, had three categories. These three categories were Asian, Hispanic, and other ethnic origins for both nonnative English-speaking (ESL) and native English-speaking graduating seniors. There were multiple dependent variables (DV) describing student academic performance, including the following six competency ratings measured by the DeVry University assessment instrument:

1. Experimentation skills
2. Programming skills
3. Design skills
4. Oral/written communications skills
5. Team skills
6. Life-long learning skills

Six two-way ANOVAs (analyses of variance) were executed to determine whether there were significant differences and/or a significant interaction among the three ethnic groups and two language groups (native speakers of English and nonnative speakers of English). Planned contrast tests were also run to identify which simple effects of language backgrounds (native speakers of English versus nonnative speakers of English) for each category of ethnic background (Asian, Hispanic, and others) were statistically significant in each competency area.

Competency Ratings in Experimentation Skills

A two-way ANOVA (analysis of variance) was executed to determine whether there were significant differences and/or a significant interaction among the three ethnic groups and two language groups (native speakers of English and nonnative speakers of English). Table 4.1a illustrates the descriptive statistics for the competency ratings in experimentation skills measured by the DeVry University assessment instrument. Table 4.1b shows the two-way analysis of variance for assessment ratings in experimentation skills as a function of language and ethnic backgrounds.

Table 4.1a

Descriptive Statistics for the Competency Ratings in Experimentation Skills Measured by the DeVry University assessment instrument

	Native English Speakers			Nonnative English Speakers			Total	
Ethnic Group	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*
Asian	3.06	.58	25	2.94	.50	24	3.00	.54
Hispanic	3.03	.56	23	3.00	.46	23	3.02	.51
Others	2.67	.87	27	3.02	.65	26	2.84	.78
Total	2.91	.71	75	2.99	.54	73	2.95	.63

Table 4.1b

Two-Way Analysis of Variance for Assessment Ratings in Experimentation Skills as a Function of Language and Ethnic Backgrounds

Variance and Source	*df*	*MS*	*F*	η^2
Experimentation Skills				
Language background	1	.15	.37	.00
Ethnic background	2	.47	1.20	.02
Langbgrd × Ethnbgrd	2	.78	2.00	.03
Error	142	.39		

The two-way ANOVA test showed that there was not a significant interaction effect of language backgrounds and ethnic backgrounds. Neither were there significant main effects for language backgrounds, or ethnic backgrounds, in this competency area measured by the DeVry University assessment instrument.

Although there were no significant main effects for language backgrounds, or ethnic backgrounds, on this competency area measured by the DeVry University assessment instrument, further investigations were performed to look at which simple effects of language backgrounds (native speakers of English versus nonnative speakers of English) for each category of ethnic backgrounds (Asian, Hispanic, and others) were statistically significant in this competency area. Three simple cell contrast tests indicated that there was a significant difference between nonnative English-speaking (ESL) graduating seniors of other ethnic groups and native English-speaking graduating seniors of other ethnic origins on competency ratings in experimentation skills. The nonnative English-speaking (ESL) graduating seniors of other ethnic groups had significantly higher average competency ratings in experimentation skills measured by the DeVry University assessment instrument than native English-speaking graduating seniors of

other ethnic origins did, t (142) = 1.99, $p < 0.05$. Since the mean difference (MD) was 0.35 and the pooled standard deviation was approximately .76, therefore d = .35/.76 = .46, which was close to medium effect size according to Cohen (1988). There were no statistically significant differences between native English-speaking Asian and nonnative English-speaking Asian, or between native English-speaking Hispanic and nonnative English-speaking Hispanic, in terms of experimentation skills measured by the DeVry University assessment instrument in this sample.

A visual inspection of the profile plot in Figure 4.1 displays the differences between native English speakers and nonnative English speakers for each ethnic group, which specifically displays a large difference between nonnative English-speaking (ESL) graduating seniors of other ethnic groups and native English-speaking graduating seniors of other ethnic origins in regard to their competency ratings in experimentation skills measured by the DeVry University assessment instrument.

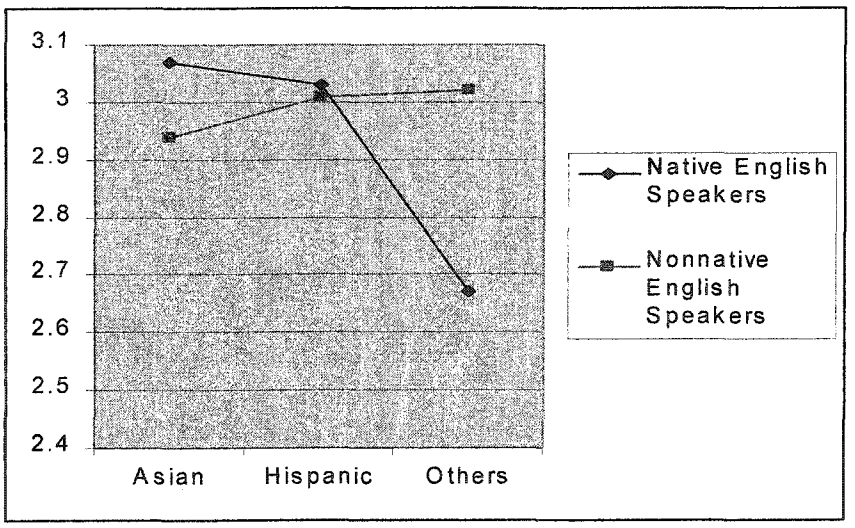

Figure 4.1. Plot of three simple effects on competency ratings in experimentation skills.

Competency Ratings in Programming Skills

The two-way ANOVA test demonstrated that there was not a significant interaction effect of language backgrounds and ethnic backgrounds. There were neither significant main effects for language backgrounds nor ethnic backgrounds on programming skills measured by the DeVry University assessment instrument. Table 4.2a shows the descriptive statistics for the competency ratings in programming skills measured by the DeVry University assessment instrument. Table 4.2b demonstrates the two-way analysis of variance for assessment ratings in programming skills as a function of language and ethnic backgrounds.

Table 4.2a

Descriptive Statistics for the Competency Ratings in Programming Skills Measured by the DeVry University assessment instrument

	Native English Speakers			Nonnative English Speakers			Total	
Ethnic Group	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*
Asian	2.97	.68	25	2.78	.56	24	2.88	.62
Hispanic	2.97	.55	23	2.79	.58	23	2.88	.57
Others	2.77	.66	27	2.79	.81	26	2.78	.73
Total	2.90	.63	75	2.79	.66	73	2.84	.64

Three simple cell contrast tests illustrated that there were no statistically significant simple cell differences between native English-speaking Asian and nonnative English-speaking Asian, between native English-speaking Hispanic and nonnative English-speaking Hispanic, or between native English-speaking graduating seniors of other origins and nonnative English-speaking graduating seniors of other ethnic origins,

on competency ratings in programming skills measured by the DeVry University assessment instrument in this sample.

Table 4.2b

Two-Way Analysis of Variance for Assessment Ratings in Programming Skills as a Function of Language and Ethnic Backgrounds

Variance and Source	*df*	*MS*	*F*	η^2
Programming Skills				
Language background	1	.45	1.07	.01
Ethnic background	2	.17	.40	.01
Langbgrd × Ethnbgrd	2	.17	.40	.01
Error	142	.42		

Competency Ratings in Design Skills

The two-way ANOVA test indicated that there was not a significant interaction effect of language backgrounds and ethnic backgrounds. Neither were there significant main effects for language backgrounds, or ethnic backgrounds, on the design competency ratings measured by the DeVry University assessment instrument. Table 4.3a shows the descriptive statistics for the competency ratings in design skills measured by the DeVry University assessment instrument. Table 4.3b demonstrates the two-way analysis of variance for assessment ratings in design skills as a function of language and ethnic backgrounds.

Three simple cell contrast tests were executed to determine whether there was statistically significant difference between nonnative English-speaking graduating seniors and native English-speaking graduating seniors for each ethnic group in regard to their competency ratings in design skills. The contrast tests demonstrated that there were no

statistically significant simple cell differences between native English-speaking Asian and nonnative English-speaking Asian, between native English-speaking Hispanic and nonnative English-speaking Hispanic, or between native English-speaking graduating seniors of other origins and nonnative English-speaking graduating seniors of other ethnic origins in design skills measured by the DeVry University assessment instrument in this sample.

Table 4.3a

Descriptive Statistics for the Competency Ratings in Design Skills Measured by the DeVry University assessment instrument

	Native English Speakers			Nonnative English Speakers			Total	
Ethnic Group	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*
Asian	2.94	.67	25	2.89	.61	24	2.92	.64
Hispanic	3.06	.54	23	2.99	.42	23	3.03	.48
Others	2.80	.80	27	2.97	.78	26	2.88	.78
Total	2.93	.69	75	2.95	.61	73	2.94	.65

Table 4.3b

Two-Way Analysis of Variance for Assessment Ratings in Design Skills as a Function of Language and Ethnic Backgrounds

Variance and Source	*df*	*MS*	*F*	η^2
Design Skills				
Language background	1	.01	.02	.00
Ethnic background	2	.29	.67	.01
Langbgrd × Ethnbgrd	2	.26	.61	.01
Error	142	.43		

Competency Ratings in Oral/written Communications Skills

Table 4.4a shows the means and standard deviations among the ethnic groups by language backgrounds (native English speakers versus nonnative English speakers), for the oral/written communications competency ratings measured by the DeVry University assessment instrument. Table 4.4b indicates that there was not a significant interaction between language backgrounds (native English speakers and nonnative English speakers) and ethnic backgrounds (Asian versus Hispanic versus others) on the competency ratings in oral/written communication skills measured by the DeVry University assessment instrument ($p = .87$). Because the interaction was not significant, the profile plot shows that the lines for both native speakers of English and the nonnative speakers of English are approximately parallel (see Figure 4.2).

Table 4.4a

Means and Standard Deviations among the Ethnic Groups by Language Background for Communications Competency Ratings Measured by Assessment Instrument

	Native English Speakers			Nonnative English Speakers			Total	
Ethnic Group	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*
Asian	2.78	.83	25	2.53	.67	24	2.66	.76
Hispanic	3.15	.65	23	2.86	.40	23	3.01	.55
Others	3.00	.76	27	2.85	.61	26	2.92	.69
Total	2.98	.76	75	2.75	.59	73	2.86	.69

However, further looking at the main effect of language backgrounds, there was a significant difference between the native speakers of English and nonnative speakers of English on the competency ratings in oral/written communication skills, $F(1,142) = 4.37$. Native English-speaking graduating seniors had higher average rating in communication

skills than nonnative English-speaking graduating seniors by approximately 0.23 in this sample (see Table 4.4a). Eta for language backgrounds (native English speakers and nonnative English speakers) was about 0.17, which according to Cohen (1988) was between small and medium effect size.

Table 4.4b

Two-Way Analysis of Variance for Assessment Ratings in Oral/Written Communications Skills as a Function of Language and Ethnic Backgrounds

Variance and Source	*df*	*MS*	*F*	η^2
Communications Skills				
Language background	1	1.97	4.37*	.03
Ethnic background	2	3.21	3.55*	.05
Langbgrd × Ethnbgrd	2	0.06	.14	.00
Error	142	.452		

*$p < .05$

Table 4.4b also illustrates that the result from the two-way ANOVA showed a significant difference among three ethnic groups on the competency ratings in oral/written communication skills, $F(2,142) = 3.55$. Since the result of Levene's test of equality of error variances showed an insignificant value, the Tukey HSD test was chosen as the post hoc test for multiple comparisons. Results of Tukey HSD revealed that the graduating seniors with Hispanic ethnic background were rated significantly higher than graduating seniors with Asian background in regard to oral/written communications skills. The mean difference was 0.35. There were no significant differences found between graduating seniors with Asian ethnic background and graduating seniors with other ethnic backgrounds, or between graduating seniors with Hispanic ethnic

background and graduating seniors with other ethnic backgrounds. The 95% confident interval indicated that the mean difference between graduating seniors with Hispanic ethnic background and graduating seniors with Asian background in the population was probably between 0.02 and 0.67. Since the mean difference was 0.35 and the pooled standard deviation was approximately 0.66, the effect size (*d*) was approximately equal to 0.53, which was medium according to Cohen (1988).

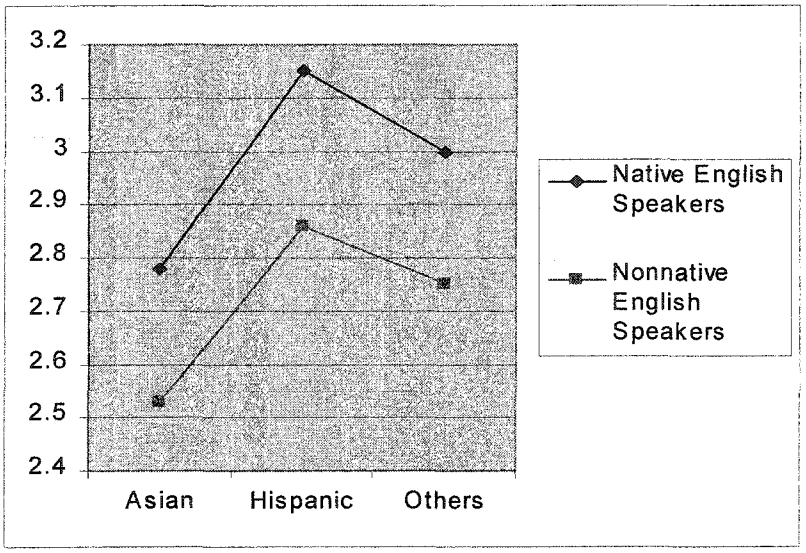

Figure 4.2. Plot of effects on competency ratings in communications skills measured by the DeVry University assessment instrument.

Though there were significant main effects for language backgrounds, and ethnic backgrounds, on the competency ratings in oral/written communication skills measured by the DeVry University assessment instrument, three simple cell contrast tests illustrated that there were no statistically significant simple cell differences between native English-speaking Asian and nonnative English-speaking Asian, between native English-speaking Hispanic and nonnative English-speaking Hispanic, or between native English-speaking

graduating seniors of other origins and nonnative English-speaking graduating seniors of other ethnic origins, in terms of competency ratings in oral/written communications skills measured by the DeVry University assessment instrument in this sample.

Competency Ratings in Team Skills

The two-way ANOVA test indicated that there was not a significant interaction effect of language backgrounds and ethnic backgrounds. There were neither significant main effects for language backgrounds nor ethnic backgrounds on the team skills measured by the DeVry University assessment instrument. Table 4.5a shows the descriptive statistics for the competency ratings in team skills measured by the DeVry University assessment instrument. Table 4.5b illustrates the two-way analysis of variance for assessment ratings in team skills as a function of language and ethnic backgrounds.

Table 4.5a

Descriptive Statistics for the Competency Ratings in Team Skills Measured by the DeVry University assessment instrument

	Native English Speakers			Nonnative English Speakers			Total	
Ethnic Group	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*
Asian	3.06	.63	25	3.03	.61	24	3.05	.62
Hispanic	3.40	.58	23	3.22	.54	23	3.31	.56
Others	3.05	.94	27	3.15	.73	26	3.10	.84
Total	3.16	.75	75	3.13	.63	73	3.15	.69

Three simple cell contrast tests also demonstrated that there were no statistically significant simple cell differences between native English-speaking Asian and nonnative

English-speaking Asian, between native English-speaking Hispanic and nonnative English-speaking Hispanic, or between native English-speaking graduating seniors of other origins and nonnative English-speaking graduating seniors of other ethnic origins, in team skills measured by the DeVry University assessment instrument in this sample. These differences might become significant if the sample size in each cell were larger.

Table 4.5b

Two-Way Analysis of Variance for Assessment Ratings in Team Skills as a Function of Language and Ethnic Backgrounds

Variance and Source	*df*	*MS*	*F*	η^2
Team Skills				
Language background	1	.05	.11	.00
Ethnic background	2	.91	1.88	.03
Langbgrd × Ethnbgrd	2	.25	.51	.01
Error	142	.48		

Competency Ratings in Lifelong Learning Skills

The two-way ANOVA test showed that there was not a significant interaction effect of language backgrounds and ethnic backgrounds on this competency area. Neither were there significant main effects for language backgrounds, or ethnic backgrounds, on the lifelong learning skills measured by the DeVry University assessment instrument. Table 4.6a illustrates the descriptive statistics for the competency ratings in lifelong learning skills measured by the DeVry University assessment instrument. Table 4.6b shows the two-way analysis of variance for assessment ratings in lifelong learning skills as a function of language and ethnic backgrounds.

Three simple cell contrast tests also showed that there were no statistically significant simple cell differences between native English-speaking Asian and nonnative

English-speaking Asian, between native English-speaking Hispanic and nonnative English-speaking Hispanic, or between native English-speaking graduating seniors of other origins and nonnative English-speaking graduating seniors of other ethnic origins, in lifelong learning skills measured by the DeVry University assessment instrument in this sample.

Table 4.6a

Descriptive Statistics for the Competency Ratings in Lifelong Learning Skills Measured by the DeVry University assessment instrument

	Native English Speakers			Nonnative English Speakers			Total	
Ethnic Group	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*
Asian	2.94	.75	25	2.98	.65	24	2.96	.70
Hispanic	3.02	.63	23	3.05	.49	23	3.04	.56
Others	2.81	.95	27	3.03	.79	26	2.92	.87
Total	2.92	.79	75	3.02	.65	73	2.97	.73

Table 4.6b

Two-Way Analysis of Variance for Assessment Ratings in Life-long Learning Skills as a Function of Language and Ethnic Backgrounds

Variance and Source	*df*	*MS*	*F*	η^2
Lifelong Learning Skills				
Language background	1	.32	.57	.00
Ethnic background	2	.17	.32	.00
Langbgrd × Ethnbgrd	2	.14	.26	.00
Error	142	.54		

Research Question 2

The second research question was to explore: (a) whether there was a statistically significant difference between nonnative English-speaking (ESL) graduating seniors and native English-speaking graduating seniors in regard to their cumulative composite GPAs at graduation from DeVry University's EET programs; (b) whether there were statistically significant differences among graduating seniors with Hispanic origin, graduating seniors with Asian origin, and graduating seniors with other ethnic origins in regard to their cumulative composite GPAs; (c) whether there was an *interaction* of students' native language backgrounds and their ethnic backgrounds in regard to their cumulative composite GPAs; and (d) for each ethnic group studied in this research, whether there was a statistically significant difference between nonnative English-speaking graduating seniors and native English-speaking graduating seniors in regard to their cumulative composite GPAs at graduation from DeVry University's EET programs.

The second research question had the same two independent variables as in the first research question. The first independent variable was students' native language backgrounds; and the second one was students' ethnic backgrounds. The dependent variable was their cumulative composite GPAs at graduation from DeVry University's EET programs.

Table 4.7a illustrates the descriptive statistics for students' cumulative composite GPAs. Table 4.7b shows the two-way analysis of variance for students' cumulative composite GPAs as a function of language and ethnic backgrounds. The two-way ANOVA test showed that there was no significant interaction effect of language backgrounds and ethnic backgrounds in regard to students' cumulative GPAs at the

graduation from EET programs. There were no significant main effects for language backgrounds, or ethnic backgrounds, on students' cumulative composite GPAs either.

Table 4.7a

Descriptive Statistics of Composite GPAs

	Native English Speakers			Nonnative English Speakers			Total	
Ethnic Group	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*
Asian	3.09	.58	25	3.08	.52	24	3.08	.55
Hispanic	3.20	.47	22	3.17	.44	20	3.19	.45
Others	3.05	.47	27	3.30	.58	25	3.17	.55
Total	3.11	.51	74	3.19	.52	69	3.14	.51

Table 4.7b

Two-Way Analysis of Variance of Composite GPAs as a Function of Language and Ethnic Backgrounds

Variance and Source	*df*	*MS*	*F*	η^2
Composite GPAs				
Language background	1	.18	.69	.01
Ethnic background	2	.16	.60	.01
Langbgrd × Ethnbgrd	2	.32	1.20	.02
Error	137	.27		

Three simple cell contrast tests were executed and showed that there were no statistically significant simple cell differences between native English-speaking Asian and nonnative English-speaking Asian, between native English-speaking Hispanic and nonnative English-speaking Hispanic, or between native English-speaking graduating

seniors of other origins and nonnative English-speaking graduating seniors of other ethnic origins in regard to their cumulative composite GPAs.

Research Question 3

The third research question was to identify: (a) whether there was a statistically significant difference between nonnative English-speaking (ESL) graduating seniors and native English-speaking graduating seniors in regard to their academic performance in general education measured by their cumulative GPAs in the English/humanities course sequence at graduation from DeVry University's EET programs; (b) whether there were statistically significant differences among graduating seniors with Hispanic origin, graduating seniors with Asian origin, and graduating seniors with other ethnic origins in regard to their cumulative GPAs in the English/humanities course sequence; (c) whether there was an *interaction* of students' native language backgrounds and their ethnic backgrounds in regard to their cumulative GPAs in the English/humanities course sequence; and (d) for each ethnic group studied in this research, whether there was a statistically significant difference between nonnative English-speaking graduating seniors and native English-speaking graduating seniors in regard to their cumulative GPAs in the English/humanities course sequence in DeVry University's EET programs.

The third research question contained the same two independent variables as in the first and second research questions. The dependent variable was students' cumulative GPAs in the English/humanities course sequence in DeVry University's EET programs.

Table 4.8a shows the means and standard deviations among the ethnic groups by language backgrounds (native English speakers versus nonnative English speakers), for the cumulative GPAs in the English/humanities course sequence. Table 4.8b indicates

that there was not a significant interaction between language backgrounds (native English speakers and nonnative English speakers) and ethnic backgrounds (Asian versus Hispanic versus others) on the cumulative GPAs in the English/humanities course sequence (p = .53).

Table 4.8a

Means and Standard Deviations among the Ethnic Groups by Language Background for the Cumulative GPAs in General Education Course Sequence

	Native English Speakers			Nonnative English Speakers			Total	
Ethnic Group	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*
Asian	3.20	.61	25	2.68	.64	24	2.94	.67
Hispanic	3.00	.74	22	2.79	.45	20	2.90	.62
Others	3.25	.47	27	2.84	.91	25	3.05	.74
Total	3.16	.61	74	2.77	.70	69	2.97	.68

Table 4.8b

Two-Way Analysis of Variance for the Cumulative GPAs in General Education Course Sequence as a Function of Language and Ethnic Backgrounds

Variance and Source	*df*	*MS*	*F*	η^2
GPA in General Education				
Language background	1	5.15	11.95**	.08
Ethnic background	2	.28	.65	.01
Langbgrd × Ethnbgrd	2	.27	.64	.01
Error	137	.43		

**$p < .005$

However, the main effect of language backgrounds showed a significant difference between the native speakers of English and nonnative speakers of English on

the cumulative GPAs in the English/humanities course sequence, $F(1, 137) = 11.95$. Native English-speaking graduating seniors had higher mean GPAs in the English/humanities general education course sequence than nonnative English-speaking graduating seniors by approximately 0.39 in this sample (see Table 4.8a). Eta for language backgrounds (native English speakers versus nonnative English speakers) was about 0.28, which according to Cohen (1988) was a medium effect size.

Table 4.8b illustrates that the result from the two-way ANOVA showed an insignificant difference among three ethnic groups on the cumulative GPAs in the English/humanities course sequence. To further identify which simple effects of language backgrounds (native speakers of English versus nonnative speakers of English) for each category of ethnic backgrounds (Asian, Hispanic, and others) were statistically significant, three simple cell contracts were performed. The simple effects analyses revealed that native English-speaking Asian had significantly higher mean cumulative GPAs in the English/humanities course sequence than nonnative English-speaking Asian, $t(46.61) = 2.94$, $p < 0.005$, with a mean GPA difference (MD) being equal to 0.52. Since the pooled standard deviation was approximately .63, therefore $d = .52/.63 = .83$, which was a large effect size according to Cohen (1988). There were no statistically significant simple cell differences between native English-speaking Hispanic and nonnative English-speaking Hispanic graduating seniors. Although the difference between native English-speaking graduating seniors of other ethnic origins and nonnative English-speaking graduating seniors of other origins was not statistically significant, $t(35.36) = 2.03$, $p = 0.05$, it might become significant if n was increased.

The inspection of the profile plot in Figure 4.3 gives a visual illustration on the differences between native English speakers and nonnative English speakers for each ethnic group. It specifically illustrates the large difference between native English-speaking Asian and nonnative English-speaking Asian, in regard to their cumulative GPAs in the English/humanities course sequence.

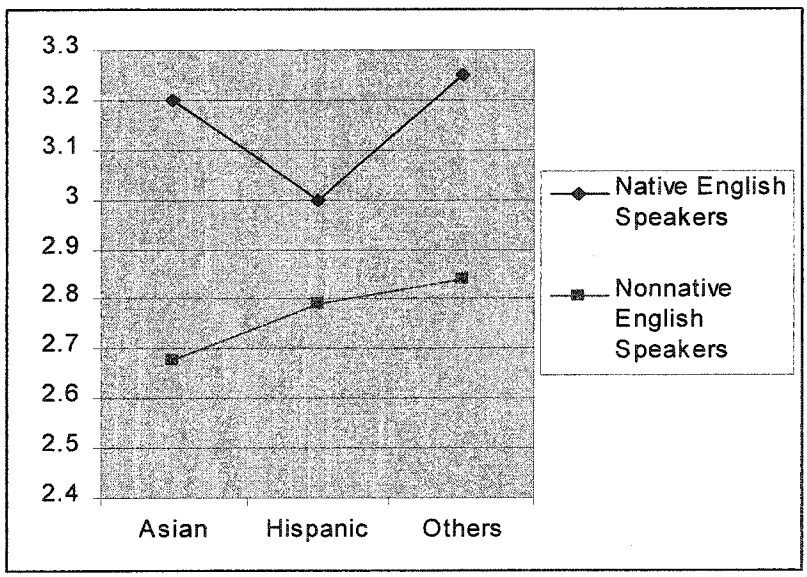

Figure 4.3. Plot of three simple effects on cumulative GPAs in the English/humanities course sequence.

Research Question 4

The fourth research question was to determine: (a) whether there was a statistically significant difference between nonnative English-speaking (ESL) graduating seniors and native English-speaking graduating seniors in regard to their academic performance in mathematics and science measured by their cumulative GPAs in the mathematics and science course sequence at graduation from DeVry University's EET programs; (b) whether there were statistically significant differences among graduating seniors with Hispanic origin, graduating seniors with Asian origin, and graduating seniors

with other ethnic origins in regard to their cumulative GPAs in the mathematics and science course sequence; (c) whether there was an *interaction* of students' native language backgrounds and their ethnic backgrounds in regard to their cumulative GPAs in the mathematics and science course sequence; and (d) for each ethnic group studied in this research, whether there was a statistically significant difference between nonnative English-speaking graduating seniors and native English-speaking graduating seniors in regard to their cumulative GPAs in the mathematics and science course sequence in DeVry University's EET programs.

For the fourth research question, the two independent variables were the same as for the first three research questions. The dependent variable was students' cumulative GPAs in the mathematics and science course sequence in DeVry University's EET programs.

Table 4.9a shows the descriptive statistics for the cumulative GPAs in mathematics and science course sequence. Table 4.9b demonstrates the two-way analysis of variance for students' cumulative GPAs in the mathematics and science course sequence as a function of language and ethnic backgrounds. The two-way ANOVA demonstrated that there was not a significant interaction effect of language backgrounds and ethnic backgrounds. There were neither significant main effects for language backgrounds nor ethnic backgrounds on the cumulative GPAs in the mathematics and science course sequence.

Although there were no significant main effects for language backgrounds, or ethnic backgrounds, on the cumulative GPAs in the mathematics and science course sequence, further investigations using three simple cell contrast tests indicated that there

was a statistically significant difference between nonnative English-speaking (ESL) graduating seniors of other ethnic groups and native English-speaking graduating seniors of other ethnic origins in regard to their cumulative GPAs in the mathematics and science course sequence, $t\,(137) = 2.48$, $p < 0.05$. Since the mean difference was .40 and the pooled standard deviation was approximately .54, therefore $d = .40/.54 = .74$, which was close to large effect size according to Cohen (1988). Nonnative English-speaking (ESL) graduating seniors of other ethnic groups had significantly higher mean cumulative GPAs in the mathematics and science course sequence than native English-speaking graduating seniors of other ethnic. There were no statistically significant differences between native English-speaking Asian and nonnative English-speaking Asian, or between native English-speaking Hispanic and nonnative English-speaking Hispanic in regard to the cumulative GPAs in the mathematics and science course sequence in this sample.

Table 4.9a

Descriptive Statistics for the Cumulative GPAs in Mathematics and Science Course Sequence

	Native English Speakers			Nonnative English Speakers			Total	
Ethnic Group	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*
Asian	3.21	.70	25	3.16	.63	24	3.19	.66
Hispanic	3.28	.50	22	3.25	.53	20	3.26	.51
Others	3.14	.56	27	3.54	.52	25	3.33	.57
Total	3.21	.59	74	3.32	.58	69	3.26	.59

The profile plot in Figure 4.4 displays the differences between native English speakers and nonnative English speakers for each ethnic group, which especially illustrates a large difference between nonnative English-speaking (ESL) graduating seniors of other ethnic groups and native English-speaking graduating seniors of other

ethnic origins in regard to their cumulative GPAs in the mathematics and science course sequence.

Table 4.9b

Two-Way Analysis of Variance for Students' Cumulative GPAs in Mathematics and Science Courses as a Function of Language and Ethnic Backgrounds

Variance and Source	*df*	*MS*	*F*	η^2
GPAs in Math/Science				
Language background	1	.36	1.06	.01
Ethnic background	2	.28	.82	.01
Langbgrd × Ethnbgrd	2	.84	2.49	.04
Error	137	.34		

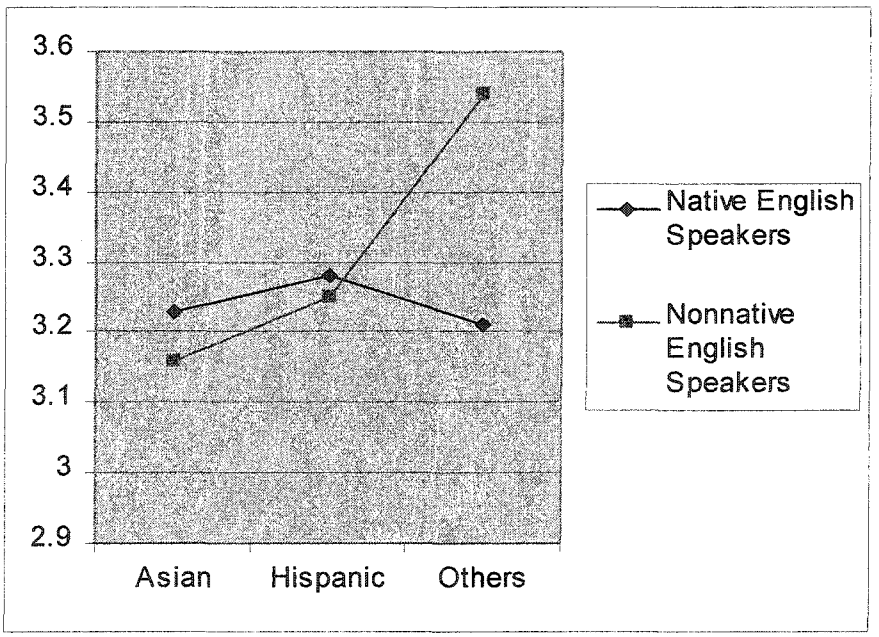

Figure 4.4. Plot of three simple effects on cumulative GPAs in the mathematics and science course sequence.

Research Question 5

The fifth research question was to investigate: (a) whether there was a statistically significant difference between nonnative English-speaking (ESL) graduating seniors and native English-speaking graduating seniors in regard to their academic performance in technical subjects measured by their cumulative GPAs in the engineering technology course sequence at graduation from DeVry University's EET programs; (b) whether there were statistically significant differences among graduating seniors with Hispanic origin, graduating seniors with Asian origin, and graduating seniors with other ethnic origins in regard to their cumulative GPAs in the engineering technology course sequence; (c) whether there was an *interaction* of students' native language backgrounds and their ethnic backgrounds in regard to their cumulative GPAs in the engineering technology course sequence; and (d) for each ethnic group studied in this research, whether there was a statistically significant difference between nonnative English-speaking graduating seniors and native English-speaking graduating seniors in regard to their cumulative GPAs in the engineering technology course sequence at graduation from DeVry University's EET programs.

The fifth research question contained the same independent variables as in the previous research questions. The dependent variable was students' cumulative GPAs in the engineering technology course sequence.

Table 4.10a shows the means and standard deviations among the ethnic groups by language backgrounds (native English speakers versus nonnative English speakers), for the cumulative GPAs in the electronics engineering technology course sequence. Table 4.10b indicates that there was not a significant interaction between language

backgrounds (native English speakers and nonnative English speakers) and ethnic backgrounds (Asian versus Hispanic versus others) on the cumulative GPAs in the technical course sequence (p=0.15). Analyzing the main effect of language backgrounds, there was a significant difference between the native speakers of English and nonnative speakers of English in regard to the cumulative GPAs in the EET technical course sequence, $F(1, 137) = 4.32, p < .05$. Nonnative English-speaking graduating seniors had higher average GPAs in the technical course sequence than native English-speaking graduating seniors by approximately 0.24 in this sample (see Table 4.10a). Eta for language backgrounds (native English speakers and nonnative English speakers) was about 0.18, which according to Cohen (1988) is between small and medium effect size.

The results from the two-way ANOVA illustrated in Table 4.10b shows that there were no significant differences among the three ethnic groups in regard to the cumulative GPAs in the technical course sequence, $F(2, 137) = 0.60$. Hence there was no need to perform the Tukey HSD test.

Table 4.10a

Means and Standard Deviations among the Ethnic Groups by Language Background for the Cumulative GPAs in Technical Course Sequence

	Native English Speakers			Nonnative English Speakers			Total	
Ethnic Group	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*
Asian	2.89	.72	25	3.02	.65	24	2.95	.68
Hispanic	3.09	.66	22	3.12	.52	20	3.10	.59
Others	2.76	.61	27	3.28	.66	25	3.01	.68
Total	2.90	.67	74	3.14	.62	69	3.02	.65

Table 4.10b

Two-Way Analysis of Variance for the Cumulative GPAs in Technical Course Sequence as a Function of Language and Ethnic Backgrounds

Variance and Source	*df*	*MS*	*F*	η^2
GPAs in Technical Courses				
Language background	1	1.77	4.32*	.03
Ethnic background	2	.25	.60	.01
Langbgrd × Ethnbgrd	2	.78	1.90	.03
Error	137	.41		

*$p < .05$

Three simple cell contrast tests were performed and revealed that nonnative English-speaking (ESL) graduating seniors of other ethnic groups had significantly higher cumulative GPAs in the technical course sequence than native English-speaking graduating seniors of other ethnic origins did, t (137) = 2.88, $p < 0.05$. Since the mean difference was .52 and the pooled standard deviation was approximately .64, therefore d = .52/.64 = .81, which was a large effect size according to Cohen (1988). There were no statistically significant differences between native English-speaking Asian and nonnative English-speaking Asian, or between native English-speaking Hispanic and nonnative English-speaking Hispanic in regard to their cumulative GPAs in the technical course sequence in this sample. The profile plot in Figure 4.5 displays the differences between native English speakers and nonnative English speakers for each ethnic group, which especially displays a large difference between nonnative English-speaking graduating seniors of other ethnic groups and native English-speaking graduating seniors of other ethnic origins in regard to their cumulative GPAs in the technical course sequence. Nonnative English-speaking graduating seniors of other ethnic groups had a significantly

higher mean cumulative GPAs in the technical course sequence than native English-speaking graduating seniors of other ethnic origins.

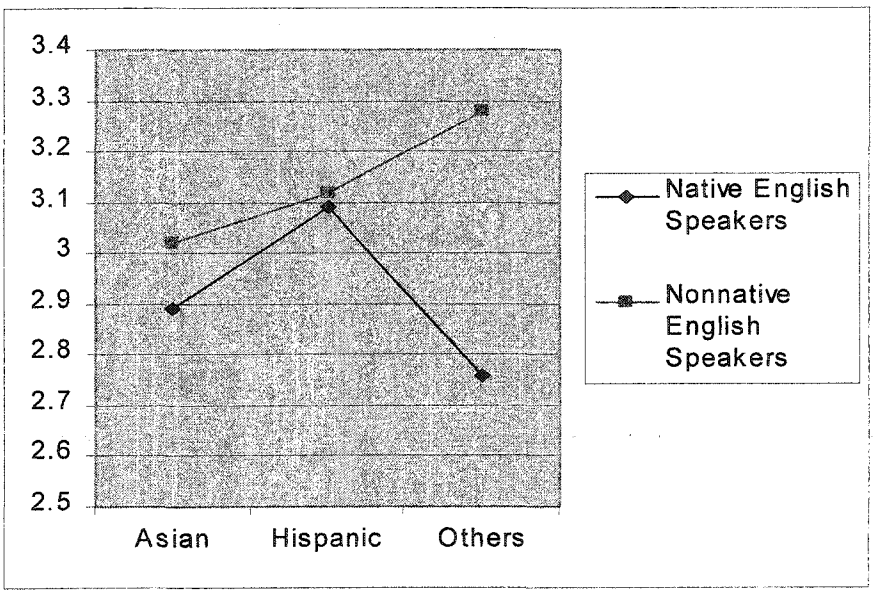

Figure 4.5. Plot of three simple effects on cumulative GPAs in the technical course sequence.

Research Question 6

The sixth research question was to investigate: (a) for nonnative English-speaking graduating seniors in the sample, whether there was a significant difference between their GPAs in the general education course sequence and their GPAs in the technical course sequence; and (b) for nonnative English-speaking graduating seniors in the sample, whether there was a significant difference between their GPAs in the mathematics and science course sequence and their GPAs in the technical course sequence.

Two paired *t* tests were performed to determine whether there were significant differences between nonnative English speakers' GPAs in the general education course sequence and their GPAs in the technical course sequence, and between their GPAs in the mathematics/science course sequence and their GPAs in the technical course sequence.

Difference Between GPAs in the General Education Sequence and GPAs in the Technical Course Sequence

The paired *t* test result for nonnative English speakers' GPAs in the general education course sequence and their GPAs in the technical course sequence is presented in Table 4.11. The table shows that nonnative English speakers' GPAs in the general education course sequence was .37 lower than their GPAs in the technical course sequence and this difference was significant, $t\ (68) = -5.3$, $p < .001$. The 95% confident interval indicated that the mean difference was probably between .23 and .51. The approximate effect size (*d*) was computed using the formula *d* = Mean Difference/SD of the difference. In this case the mean difference was .37 and the standard deviation of the difference was .58. Thus $d = .37/.58 = .64$, which was a medium to large effect size according to Cohen (1988).

Table 4.11

Paired t Test for Nonnative English Speakers' GPAs in the General Education and their GPAs in the Technical Course Sequence

	M	SD	t (68)	*p*
GPAs GenEd Courses	2.77	.70	-5.3	<.001
GPAs in Tech Courses	3.14	.62		

Difference Between GPAs in the Mathematics/Science Course Sequence and GPAs in the Technical Course Sequence

The paired *t* test result for nonnative English speakers' GPAs in the mathematics/science course sequence and their GPAs in the technical course sequence is presented in Table 4.12. The table shows that there was a significant difference, t (68) = 3.9, p <.001. Nonnative English speakers' average GPAs in the mathematics/science course sequence was .18 higher than their GPAs in the technical course sequence. The 95% confident interval indicated that the mean difference was probably between .09 and .27. Since the mean difference was .18 and the standard deviation of the difference was .38, therefore d = .18/.38 = .47, which was a medium to large effect size according to Cohen (1988).

Table 4.12

Paired t Test for Nonnative English Speakers' GPAs in the Mathematics/Science and their GPAs in the Technical Course Sequence

	M	SD	t (68)	*p*
GPAs Math/Sci Courses	3.32	.58	3.9	<.001
GPAs in Tech Courses	3.14	.62		

Research Question 7

The seventh research question was to explore whether there was a combination of nonnative English speakers' cumulative GPAs in general education and in

mathematics/science that predict their GPAs in the technical course sequence better than either one alone.

Multiple regression was conducted to determine how well the combination of students' GPAs in the general education course sequence and GPAs in the math/science sequence would predict their GPAs in their technical course sequence. Table 4.13a shows the means, standard deviations, and intercorrelations for nonnative English speakers among their academic performance (GPAs) in general education, mathematics and science, and technical subjects, which demonstrates how each variable is related to all the others. Table 4.13b demonstrates the simultaneous multiple regression analysis summary for nonnative English-speaking graduating seniors among their academic performance (GPAs) in general education, mathematics and science, and technical subjects. The high correlations illustrated in Table 4.13a indicated the presence of multicollinearity.

Table 4.13a

Means, Standard deviations, and Intercorrelations for Nonnative English Speakers among their GPAs in General Education, Math/Science, and Technical Subjects

Variable	M	SD	GPAs GenEd	GPAs Math
GPAs Tech Courses	3.14	.62	.62**	.80**
Predictor variable				
1. GPAs in GenEd	2.77	.70	--	.51**
2. GPAs in Math/Sci	3.32	.58	--	--

**$p < .001$

Table 4.13a indicated that there was a significant association between nonnative English speakers' GPAs in the general education course sequence and their GPAs in technical course sequence, r (69) = .62, p < .001. The direction of the association was positive, which meant that students who received high GPAs in the general education course sequence were very likely to receive high GPAs in the technical course sequence, or visa versa. Using Cohen's (1988) guidelines, the r indicated a large effect size. The r-squared (r^2) indicated that 38% of the variance in nonnative English speakers' GPAs in the technical course sequence could be predicted from their GPAs in general education course sequence.

Table 4.13b

Simultaneous Multiple Regression Analysis Summary for Nonnative English Speakers' Academic Performance (GPAs) in Technical Subjects from their GPAs in General Education and Mathematics/Science

Variable	B	SEB	β
GPAs in GenEd	.26	.07	.29**
GPAs Math/Sci	.69	.08	.65**
Constant	.14	.25	

Note. R^2 = .687; F (2, 68) = 75.52, p < .001
**p < .001

Table 4.13a indicated that there was a significant association between nonnative English speakers' GPAs in the mathematics/science course sequence and their GPAs in technical course sequence, r (69) = .80, p < .001. The direction of the association was also positive, which implied that students who received high GPAs in the mathematics/science course sequence tended to obtain high GPAs in the technical course sequence, or visa versa. Based on Cohen's (1988) guidelines, the r indicated a very large

effect size. The *r*-squared (r^2) indicated that 64% of the variance in nonnative English speakers' GPAs in the technical course sequence could be predicted from their GPAs in the mathematics/science course sequence.

Table 4.13a also shows, for the nonnative English-speaking graduating seniors sampled, adjusted $R^2 = .687$, which indicated that 68.7% of the variance in students' GPAs in the technical course sequence could be predicted from the combination of students' GPAs in the general education course sequence and GPAs in the math/science sequence. Table 4.13b indicates that both betas (β) significantly contribute to the prediction of students' GPAs in the technical course sequence. The result confirmed that the combination of cumulative GPAs in the general education sequence and in the mathematics/science sequence would predict the cumulative GPAs in the technical course sequence better than either factor alone.

The result showed that the overall indication of the combination was statistically significant, $F(2, 68) = 75.52$, $p < .001$. When the combination of students' GPAs in the general education course sequence and GPAs in the mathematics/science sequence is used to predict their GPAs in their technical course sequence, GPA Tech = 0.142 + 0.69*GPA Math&Sci + 0.26*GPA GenEd. Since the adjusted *R*-squared was .69, this was a very large effect according to Cohen (1988).

Summary Tables

The following tables summarize the research findings presented in this chapter. Tables 4.14 and 4.15 illustrate the research findings of comparisons of main and simple effects on assessment ratings; while Tables 4.16 and 4.17 present the research findings of comparisons of main and simple effects on students' cumulative GPAs. Finally, Table

4.18 shows the relationships among GPAs in different course sequences for nonnative English speakers.

Table 4.14

Comparisons of Main Effects on Assessment Ratings

Dependent variables	Main Effects		
	Language	Ethnicity	Interaction
Assessment Ratings			
Experimentation Skills	NS	NS	NS
Programming Skills	NS	NS	NS
Design Skills	NS	NS	NS
Communications Skills	*	**	NS
Team Skills	NS	NS	NS
Lifelong Learning Skills	NS	NS	NS

NS: Non-significant effect.
* Native English-speakers were rated higher.
** Hispanics were rated higher than Asians.

Table 4.15

Comparisons of Simple Effects on Assessment Ratings

Dependent variables	Simple Effects Nonnative English-speakers vs. Native English-speakers		
	Asian	Hispanic	Others
Assessment Ratings			
Experimentation Skills	NS	NS	+
Programming Skills	NS	NS	NS
Design Skills	NS	NS	NS
Communications Skills	NS	NS	NS
Team Skills	NS	NS	NS
Lifelong Learning Skills	NS	NS	NS

NS: Non-significant effects.
+ Nonnative English-speakers were rated higher than native English-speakers.

Table 4.16

Comparisons of Main Effects on Cumulative GPAs

Dependent variables	Main Effects		
	Language	Ethnicity	Interaction
Cumulative GPAs			
Overall Composite GPAs	NS	NS	NS
English/humanities Sequence	*	NS	NS
Math/science Sequence	NS	NS	NS
Technical Course Sequence	**	NS	NS

NS: Non-significant effect.
* Native speakers of English had higher GPAs.
** Nonnative speakers of English had higher GPAs.

Table 4.17

Comparisons of Simple Effects on Cumulative GPAs

Dependent variables	Simple Effects Nonnative English-speakers vs. Native English-speakers		
	Asian	Hispanic	Others
Cumulative GPAs			
Overall Composite GPAs	NS	NS	NS
English/humanities Sequence	-	NS	NS
Math/science Sequence	NS	NS	+
Technical Course Sequence	NS	NS	+

NS: Non-significant effect.
- Nonnative speakers of English had lower GPAs than native speakers of English.
+ Nonnative speakers of English had higher GPAs than native speakers of English.

Table 4.18

Relationships between Predictor Variables and GPAs in the Technical Course Sequence for Nonnative English-speaking Graduating Seniors

Predictors	Correlation	Difference
GPAs in General Education Sequence	+	*
GPAs in Math/science Sequence	+	*

+ Positive correlation with GPAs in the technical course sequence.
* Statistically significant difference, general education lower but math/science higher than the GPAs in the technical courses.

CHAPTER 5: DISCUSSON

The Purpose

The primary purpose of the present study was to conduct comparative research on academic performance of nonnative English-speaking (ESL) graduating seniors versus native English-speaking graduating seniors in the Electronics Engineering Technology programs at DeVry University. The study was specifically designed to explore whether there were statistically significant differences between nonnative English-speaking graduating seniors and native English-speaking graduating seniors, and among graduating seniors with different ethnic backgrounds, in the Electronics Engineering Technology programs at DeVry University, in regard to their academic performance in terms of their competency ratings measured by the DeVry University EET assessment instrument and their cumulative GPAs in various course sequences. The dissertation explored whether there existed statistical interactions between students' ethnic backgrounds and language backgrounds, in regard to their academic performance.

This research further investigated whether there were significant differences between nonnative English-speaking graduating seniors and native English-speaking graduating seniors, for each of the three ethnic groups identified, in regard to their academic performance measured by the competency assessment ratings and cumulative GPAs in various course sequences. Finally, the dissertation studied the differences and intercorrelations among nonnative English speaking graduating seniors' academic

performance in general education, mathematics/science, and technical subjects, and to find out whether there was a combination of their cumulative GPAs in general education and in mathematics and science that would predict their GPAs in the technical course sequence better than either one alone.

The Academic Performance Data and the Student Sample

The study was primarily based on the academic performance data including students' assessment ratings measured by the DeVry University assessment instrument in their senior projects during their graduation terms, over the years of 2000 to 2004. The academic performance data also included graduating seniors' cumulative composite GPAs, their cumulative GPAs in general education courses, mathematics and science courses, and in their technical courses over the same time period. The actual sample in this study was limited to the students in graduating classes of the Electronics Engineering Technology programs on DeVry University Chicago area campuses. The final sample included twenty-five nonnative English-speaking graduating seniors with Asian ethnic background, twenty-six native English-speaking graduating seniors with Asian ethnic background, twenty-four nonnative English-speaking graduating seniors with Hispanic ethnic background, twenty-four native English-speaking graduating seniors with Hispanic ethnic background, twenty-seven nonnative English-speaking graduating seniors with other ethnic backgrounds (e.g., East Europeans and Black Africans), twenty-eight native English-speaking graduating seniors with other ethnic backgrounds (e.g., Caucasian Americans and African Americans). All nonnative English-speaking students came from countries where English is not the primary language spoken; the majority of them were resident aliens or on student visas; and many of them were remedial ESL course takers.

The sample accurately reflected Spellman's two primary groups of immigrant nonnative English-speaking students in U.S. educational institutions: resident students (resident aliens and citizens whose primary languages were other than English) and visa students (Spellman, 1997).

In order to identify whether the entrance status in algebra were somewhat matched between nonnative English speakers and native English speakers in the sample, chi-square tests were performed to determine if there was significant difference between nonnative English speakers and native English speakers for each ethnic group in this research, in regard to whether they had "passing" or "high" algebra entrance test scores. The test results showed that the algebra entrance scores of nonnative English speakers and that of native English speakers in the sample were not statistically different.

Retention rates were analyzed using the comparison of the total number of graduates and the total number of nonnative English-speaking graduates who were once placed in remedial ESL classes on DeVry University Chicago campus. During the years of 1993 and 1997, nonnative English-speaking graduates who were placed in remedial ESL classes represented 10% of the total number of graduates (EFL Department, 1998). At the time of entrance the number of freshmen who were placed into remedial ESL classes was lower than, but close to 10% of the total freshmen enrollment (according to DeVry Chicago Admissions) during the period. Thus, the graduation rate of nonnative English-speaking graduates who were placed in remedial ESL classes was about the same, if not a little higher, than the general graduation rate.

Research Question 1

Research question 1 was to investigate whether there were statistically significant differences between nonnative English-speaking (ESL) graduating seniors and native English-speaking graduating seniors, and/or among graduating seniors with Hispanic origin, graduating seniors with Asian origin, and graduating seniors with other ethnic origins in regard to their academic performance in terms of their competency ratings, and to investigate whether there was an *interaction* of students' native language backgrounds (nonnative speakers of English versus native speakers of English) and their ethnic backgrounds (Asian versus Hispanic versus others) in regard to their competency ratings. Further, research questions 1 was to test, for each ethnic group studied in this research, whether there was a statistically significant difference between nonnative English-speaking graduating seniors and native English-speaking graduating seniors in regard to their competency ratings. The competency ratings included (a) experimentation skills, (b) programming skills, (c) design skills, (d) oral/written communication skills, (e) team skills, and (f) information literature/life-long learning skills measured by the DeVry University assessment instrument in DeVry University's EET programs.

Summary of Research Question 1 Results

Experimentation skills. The research result showed that there was not a significant difference between language backgrounds, or among ethnic backgrounds, in regard to the experimentation competency area. A significant difference was found between nonnative English-speaking (ESL) graduating seniors of other ethnic origins and native English-speaking graduating seniors of other ethnic origins on competency ratings in experimentation skills. The nonnative English-speaking (ESL) graduating seniors of

other ethnic origins had significantly higher average competency ratings in experimentation skills than native English-speaking graduating seniors of other ethnic origins.

Programming skills. The research result demonstrated that there was not a significant difference between language backgrounds, or among ethnic backgrounds in regard to programming skills. There was no significant difference between native English-speaking and nonnative English-speaking graduating seniors for any of the three ethnic groups studied in this research in regard to their competency ratings in programming skills.

Design skills. The research result indicated that there was not a significant difference between language backgrounds, or among ethnic backgrounds, in regard to the design skills. There was no significant difference between native English-speaking and nonnative English-speaking graduating seniors for any of the three ethnic groups in regard to their competency ratings in design skills.

Oral/written communications skills. The study indicated that there was a significant difference between the native speakers of English and nonnative speakers of English in regard to the competency ratings in oral/written communications skills. Native English-speaking graduating seniors had higher average ratings in communications skills than nonnative English-speaking graduating seniors.

Significant differences were also found among three ethnic groups on the competency ratings in oral/written communications skills. The graduating seniors with Hispanic ethnic background were rated significantly higher than graduating seniors with Asian background in regard to oral/written communications skills. Interestingly, no

significant difference was found between native English-speaking and nonnative English-speaking graduating seniors for any of the three ethnic groups in regard to their competency ratings in oral/written communications skills.

Team skills. The research result showed that there was not a significant difference between language backgrounds, or among ethnic backgrounds, in regard to the team skills. No significant difference was found between native English-speaking and nonnative English-speaking graduating seniors for any of the three ethnic groups in regard to their competency ratings in team skills.

Lifelong learning skills. The study demonstrated that there was not a significant difference between language backgrounds, or among ethnic backgrounds, in regard to the lifelong learning skills. No significant difference was identified between native English-speaking and nonnative English-speaking graduating seniors for any of the three ethnic groups studied in this research in regard to their competency ratings in life-long learning skills.

Discussion of Research Question 1

The general conclusion from this research was that in general both native English-speaking graduating seniors and nonnative English-speaking graduating seniors performed equally well in DeVry University's EET programs, assessed by the DeVry University assessment instrument. On a 0-4 assessment rating scale, their average ratings were 2.95 in experimentation skills, 2.84 in programming skills, 2.94 in design skills, 2.86 in oral/written communications skills, 3.15 in team skills, and 2.97 in lifelong learning skills. The graduating students of different language and ethnic backgrounds from DeVry University's career oriented, practical EET programs were not rated

differently in general, except for communications skills. There was also a significant difference between nonnative English-speaking graduating seniors of other ethnic origins and native English-speaking graduating seniors of other ethnic origins in terms of their experimentation ratings.

Native English-speakers were found to perform better than nonnative English-speakers in regard to the assessment ratings in oral/written communications competency skills; and the graduating seniors with Hispanic ethnic background were rated significantly higher than graduating seniors with Asian background in regard to oral/written communications skills. On the other hand, nonnative English-speaking graduating seniors of other ethnic origins were rated better than native English-speaking graduating seniors of other ethnic origins in experimentation skills.

In addition to the historical reasons that nonnative English-speaking students grew up in a non-English-speaking environment and experienced difficulties in reading and speaking proficiencies as first generation immigrants (Pong, 2003), these students might also experience disadvantages in goal definition, idea presentation, technical terminology, appropriate English syntax, problem statement, proper wording, and effective response to questions, which were essential parts in the preparation and presentation of their technical reports in their senior projects to be assessed by the DeVry University assessment instrument.

The finding that the graduating seniors with Hispanic ethnic background were rated significantly higher than graduating seniors with Asian background in regard to oral/written communications skills might be due to the following possible factors: (a) there were very different orthography and literary traditions between Western languages

and Asian languages, so it might be more difficult for students with Asian ethnic and language background to grasp English communications skills than students from the Western world (Siu, 1996); and (b) according to the literature, Asian students tended to miss the opportunities to improve their English skills by choosing courses that require minimal English language skills (Gray et al., 1996). More discussions can be found in the *Implications* section of this chapter.

Since experimentation skills are generally considered as an integral part of students' skills in technical competency areas, the analysis on the difference between nonnative English-speaking graduating seniors of other ethnic origins and native English-speaking graduating seniors of other ethnic origins in regard to their experimentation skills will be included in the comprehensive discussions on students' performance in the technical subjects to avoid redundancy.

Research Question 2

Research question 2 was to explore whether there were statistically significant differences between nonnative English-speaking (ESL) graduating seniors and native English-speaking graduating seniors, and/or among graduating seniors with Hispanic origin, graduating seniors with Asian origin, and graduating seniors with other ethnic origins in regard to their cumulative composite GPAs at graduation from DeVry University' EET programs, and whether there was an *interaction* of students' native language backgrounds and their ethnic backgrounds in regard to their cumulative composite GPAs. Research question 2 further explored, for each ethnic group studied in this research, whether there was a statistically significant difference between nonnative

English-speaking graduating seniors and native English-speaking graduating seniors in regard to their cumulative composite GPAs at graduation from DeVry University's EET programs.

Summary of Research Question 2 Results

The research results showed that there was no significant difference between language backgrounds, or among ethnic backgrounds, in regard to students' cumulative composite GPAs. Contrast tests did not find any significant difference between native English-speaking and nonnative English-speaking graduating seniors for any of the three ethnic groups, in regard to their cumulative composite GPAs.

Discussion of Research Question 2

Again, the general conclusion from this research was that both native English-speaking graduating seniors and nonnative English-speaking graduating seniors performed equally academically in DeVry University's EET programs, measured by their average cumulative composite GPAs. On a 0-4 GPA scale, their average cumulative GPA was equal to $M = 3.15$. The graduating students of different language and ethnic backgrounds from DeVry University's career oriented, practical EET programs were doing equally well in terms of their cumulative composite GPAs. The practice implemented in DeVry University's EET programs is discussed in the *Implications* section of this chapter.

Research Question 3

The third research question identified whether there were statistically significant differences between nonnative English-speaking (ESL) graduating seniors and native

English-speaking graduating seniors, and/or among graduating seniors with Hispanic origin, graduating seniors with Asian origin, and graduating seniors with other ethnic origins in regard to their cumulative GPAs in the English/humanities course sequence, and whether there was an *interaction* of students' native language backgrounds and their ethnic backgrounds in regard to their cumulative GPAs in the English/humanities course sequence. Research question 3 further identified, for each ethnic group studied in this research, whether there was a statistically significant difference between nonnative English-speaking graduating seniors and native English-speaking graduating seniors in regard to their cumulative GPAs in the English/humanities course sequence in DeVry University's EET programs.

Summary of Research Question 3 Results

Research results showed that there was a significant difference between the native speakers of English and nonnative speakers of English in regard to their cumulative GPAs in the English/humanities course sequence. Native English-speaking graduating seniors had higher mean GPAs in the English/humanities course sequence than nonnative English-speaking graduating seniors.

The study did not find significant differences among three ethnic groups on the cumulative GPAs in English/humanities course sequence. Contrast tests revealed that native English-speaking Asian had significantly higher mean cumulative GPAs in the English/humanities course sequence than nonnative English-speaking Asian. Also the difference between native English-speaking graduating seniors of other ethnic origins and nonnative English-speaking graduating seniors of other ethnic origins was close to statistically significant.

Discussion of Research Question 3

This research question was to determine whether there was a statistically significant difference between nonnative English-speaking (ESL) graduating seniors and native English-speaking graduating seniors in regard to their academic performance in general education measured by their cumulative GPAs in the English/humanities course sequence. Native English-speakers were found to perform better academically in their English and humanities courses.

This finding was generally supported by the previous studies that the greatest and the most outstanding barrier nonnative English-speaking students encountered was inadequate English language skills (Gray et al., 1996). The obvious reason was that nonnative English-speaking students grew up in a different language environment. As discussed in the *Discussion of Research Question 1*, nonnative English-speaking students might experience disadvantages in idea presentation, appropriate technical and presentational terminology, clear and proper wording, and effective response to questions, which were essential parts in obtaining good GPAs in English and humanities courses. The less obvious reasons might be that since some nonnative English-speaking students were from different cultures than mainstream American culture, or from the cultural background that were considered "passive," introverted, and reflective, they disliked to "stand-out" and overt displays of their views and opinions (Rao, 2001). These reasons might account for their weaker performance in English and humanities courses, which sometimes require aggressive communication and presentation styles to obtain good grades. As Gray et al. (1996) indicated, the weak English skills of some students

with nonnative English background might be the most serious impediment to their pursuit in higher education.

Research Question 4

The fourth research question determined whether there were statistically significant differences between nonnative English-speaking (ESL) graduating seniors and native English-speaking graduating seniors, and/or among graduating seniors with Hispanic origin, graduating seniors with Asian origin, and graduating seniors with other ethnic origins in regard to their cumulative GPAs in the mathematics and science course sequence, and whether there was an *interaction* of students' native language backgrounds and their ethnic backgrounds in regard to their cumulative GPAs in the mathematics and science course sequence. Research question 4 further determined, for each ethnic group studied in this research, whether there was a statistically significant difference between nonnative English-speaking graduating seniors and native English-speaking graduating seniors in regard to their cumulative GPAs in the mathematics and science course sequence in DeVry University's EET programs.

Summary of Research Question 4 Results

The research results demonstrated that there was not a significant difference between language backgrounds, or among ethnic backgrounds, in regard to the cumulative GPAs in the mathematics and science course sequence. However, the results indicated that there was a statistically significant difference between nonnative English-speaking (ESL) graduating seniors of other ethnic origins and native English-speaking graduating seniors of other ethnic origins in regard to their cumulative GPAs in the mathematics and science course sequence. Nonnative English-speaking (ESL)

graduating seniors of other ethnic groups had significantly higher mean cumulative GPAs in the mathematics and science course sequence than native English-speaking graduating seniors of other ethnic origins.

Discussion of Research Question 4

The conclusion from the this study indicated that in general both native English-speaking graduating seniors and nonnative English-speaking graduating seniors performed equally well in regard to their GPAs in mathematics and science courses in DeVry University's EET programs. On a 0-4 GPA scale, their average cumulative GPA in the mathematics and science courses was equal to $M = 3.26$.

The finding that nonnative English-speaking (ESL) graduating seniors of other ethnic groups had significantly higher mean cumulative GPAs in mathematics and science course sequence than native English-speaking graduating seniors of other ethnic origins might be attributed to the fact that these nonnative English-speaking students came from the countries where the fundamental mathematics and science education might be more rigorous. The alarming result from the Third International Mathematics and Science Study indicated that U.S. eighth graders were significantly below the international mean in mathematics; while U.S. 12^{th}-grade achievement was among the lowest when compared to students in other countries who were in their final year of secondary schools (Educational Issues Policy Brief, 1999). Other factors might include (a) more effective teaching methods; (b) more knowledgeable teachers; (c) better quality academic programs and more focused curricula; and (d) better alignment of textbooks with more rigorous content in these countries that better prepared the mathematical skills for their students in secondary schools (Educational Issues Policy Brief, 1999).

Although the chi-square tests did not show significant difference between nonnative English speakers of other ethnic origins and native English speakers of other ethnic origins in regard to their entrance algebra scores, since nonnative English-speaking students took the entrance tests in their second language before they were admitted to the university, their weaker English skills might have negatively impacted their true entrance ability in mathematics. Furthermore, these entrance tests were primarily designed and developed for students with the majority language and cultural background, and were "necessarily reflect the value and culture of both those who design the instruments and the mainstream population" (Mestre & Royer, 1991, p. 45).

For this particular sample, the research result did not support the general observation that immigrant Asians were super achievers in mathematics and science subjects (Zhou & Bankston, 1996). Neither did the research support, within DeVry University's career-oriented technology programs, the observations that Hispanic students performed poorly in nearly all indicators, including mathematics subjects (Roderick, 2002; Vernez & Abrahamse, 1996).

Research Question 5

Research question 5 investigated whether there were statistically significant differences between nonnative English-speaking (ESL) graduating seniors and native English-speaking graduating seniors, and/or among graduating seniors with Hispanic origin, graduating seniors with Asian origin, and graduating seniors with other ethnic origins in regard to their cumulative GPAs in the engineering technology course sequence, and whether there was an *interaction* of students' native language backgrounds and their ethnic backgrounds in regard to their cumulative GPAs in the engineering

technology course sequence. Research question 5 further investigated, for each ethnic group studied in this research, whether there was a statistically significant difference between nonnative English-speaking graduating seniors and native English-speaking graduating seniors in regard to their cumulative GPAs in the engineering technology course sequence at graduation from DeVry University's EET programs.

Summary of Research Question 5 Results

The research results indicated that there was a significant difference between the native speakers of English and nonnative speakers of English in regard to the cumulative GPAs in the EET technical course sequence. Nonnative English-speaking graduating seniors had higher average GPAs in the technical course sequence than native English-speaking graduating seniors. There were no significant differences found among three ethnic groups in regard to the cumulative GPAs in the technical course sequence.

The research results also revealed that nonnative English-speaking (ESL) graduating seniors of other ethnic groups had significantly higher cumulative GPAs in the technical course sequence than native English-speaking graduating seniors of other ethnic origins.

Discussion of Research Question 5

Although the general conclusion was that both native English-speaking graduating seniors and nonnative English-speaking graduating seniors performed equally well in DeVry University's EET programs measured by their average cumulative composite GPAs, this study found that nonnative English speakers had higher cumulative GPAs in the engineering technology course sequence than native English-speakers in this sample, which was opposite to the finding that native English-speakers were performing

better academically in their English and humanities course sequence, as concluded in the previous section. Detailed analyses on the possible contributing factors are discussed in the *Implications* section of this chapter.

Research Question 6

The sixth research question found out, within nonnative English speaker's group in this study, whether there was a significant difference between their GPAs in the general education course sequence and their GPAs in the technical course sequence; and whether there was a significant difference between their GPAs in the mathematics/science course sequence and their GPAs in the technical course sequence.

Summary of Research Question 6 Results

The research result showed that nonnative English speakers' GPAs in the general education course sequence was significantly lower than their GPAs in the technical course sequence, and that their GPAs in the mathematics/science course sequence was significantly higher than their GPAs in the technical course sequence.

Discussion of Research Question 6

The conclusion was that nonnative English-speaking graduating seniors obtained significantly better grades in technical courses than they did in general education courses; and they received significantly better grades in mathematics/science courses than their grades in technical courses. This conclusion somewhat implies, from a different angle, that nonnative English-speaking graduating seniors are performing significantly better in mathematics/science and technical subjects than their performance in general education courses. This conclusion again supports the general institutional responses that

immigrant nonnative English-speaking students are doing well in academics except for their English communications areas (Gray et al., 1996)

Research Question 7

Research question 7 looked at variables within nonnative English speaker's group, and found out whether there was a combination of cumulative GPAs in general education and in mathematics and science that predict their GPAs in the technical course sequence better than either one alone.

Summary of Research Question 7 Results

The research result showed that there was a significant positive association between nonnative English speakers' GPAs in the general education course sequence and their GPAs in the technical course sequence. Graduating seniors who obtained high GPAs in the general education course sequence were very likely to receive high GPAs in the technical course sequence. The study also indicated that there was a positive association between nonnative English speakers' GPAs in the mathematics/science course sequence and their GPAs in the technical course sequence, meaning that graduating seniors who received high GPAs in the mathematics/science course sequence tended to get high GPAs in the technical course sequence.

The research result also demonstrated that for the nonnative English-speaking graduating seniors sampled, the combination of cumulative GPAs in general education and in mathematics/science would predict the cumulative GPAs in the technical course sequence better than either factor alone.

Discussion of Research Question 7

Conclusions can be made that for nonnative English-speaking graduating seniors, their GPAs in general education courses and in mathematics/science courses are good individual predictors for their GPAs in the technical course sequence. Further, the combination of their GPAs in general education courses and in mathematics/science courses would predict their GPAs in the technical course sequence better than either factor alone. However, caution should be taken when interpreting these results. One way to look at it is that good students do well regardless of the content area.

Implications

In general, the graduating students of different language and ethnic backgrounds performed equally well in academics in DeVry University's career-oriented EET programs, with a few exceptions.

Comparison of General Academic Performance

One major research gap in the literature review was the lack of reliable statistical data and comparative research on academic performance of ethnic and language minority students in educational institutions providing practical, career-oriented academic programs, such as DeVry's engineering technology programs, where "hands-on," experiential learning was an important integral component to help students to be successful. Most current research and literature on Asian and Hispanic students have been predominantly concerned with their general academic performance in traditional, mainstream academic settings, and with the results of educational programs sponsored by federal and state governments (McDonnell & Hill, 1993). One of the purposes of this

study was to investigate how graduating students with minority ethnic and language backgrounds, specifically those with Asian and Hispanic ethnic origins, will perform academically in such institutions where the mission was to provide practical, career-oriented technology and business programs.

The general conclusion from the study was that both native English-speaking graduating seniors and nonnative English-speaking graduating seniors performed equally well in DeVry University's EET programs, assessed by the DeVry University assessment instrument, and measured by their overall composite GPAs. The graduating students of different language and ethnic backgrounds from DeVry University's career oriented, practical EET programs were generally not rated differently by the DeVry University assessment instrument. They were also doing equally well in academics in terms of their overall composite GPAs. The research results strongly disagreed with the Cultural Deficit Theory declaring that ethnic and language minority students were intelligently inferior.

It is worth pointing out that based on DeVry University's mission statement; the University's Academic Catalog (2003-2004) indicates that the program goals of the Electronics Engineering Technology curriculum are to:

> Prepare graduates to join the work force as technical professionals in a variety of industries. EET graduates play an essential role in the engineering team, typically designing and implementing hardware and software solutions to technical problems. Graduates should also possess appropriate knowledge, experience and skills to function effectively in multidisciplinary teams, adapt to changes in technical

environments throughout their careers, and progress in their professional responsibilities. (p. 34)

For many years at DeVry University, the EET program objectives have provided a focus on the diverse student body of various ethnic and language backgrounds with the following strategies: (a) providing a sound foundation in mathematics, physics, and technical science, as well as develop competencies in a broad spectrum of technical specialty areas; (b) incorporating a strong laboratory component associated with each technical course to emphasize "learning through experiences"; (c) integrating oral and written competencies in technical courses; (d) encouraging teamwork in all projects and laboratory courses; and (e) encouraging multi-cultural understanding and communication through the essential integration of general education competencies in the EET courses (Academic Catalog, 2003-2004). DeVry University assessment process has focused on the senior project as a culminating and integrative exercise appropriate to evaluate the accomplishment of the program goals and objectives.

Based on January 1998 data, the EET programs at DeVry produced 24.4% of all TAC/ABET (Technology Accreditation Commission of the Accreditation Board for Engineering and Technology) accredited electrical, electronics, electromechanical, and computer engineering technology bachelor's degrees. DeVry's commitment to diversity was reflected in the 41.6% of EET graduates who were ethnic or gender minorities; and 34% of graduates were advanced into management positions after 10 years of employment.

With the successful completion of the EET curriculum requirements, the graduates of the EET programs from DeVry University have been observed to join the

workforce as successful technical and management professionals in a variety of industries. Over the years of 1999 to 2003, the six-month-after-graduation placement rate of DeVry University EET graduates into subject-related professions were ranging from 82% to 98%. Considering the economic difficulties during the recent years, the placement data showed that the DeVry EET graduates were widely accepted by industrial employers. DeVry graduates have played essential roles in the engineering team, typically designing and implementing hardware and software solutions to technical problems. Most of them have been complimented for possessing adequate skills to communicate with multicultural clients, and they are expected to be equipped with the appropriate knowledge, experience, and skills to adapt to the changing world.

The Public Opinion Laboratory (1999) at the Northern Illinois University surveyed eighty-nine companies that hired DeVry University EET graduates in regard to their post-graduation performance. Employers were generally very satisfied with the education their employees received at DeVry University. The survey results showed that 80% or more of the employers rated "good" to "excellent" for the areas including (a) electronics fundamentals, (b) electronics devices and instrumentation, (c) well prepared for entry level position, (d) potential advancement in specialization, (e) ability to learn new skills, (f) project team skills, and (g) ethics. When asked "Would you consider hiring from DeVry again," 95.8% employers said "Yes," only 4.2% said "No." This is one of the evidences that DeVry University's career oriented, practical curriculum provides an equal opportunity for students with different language and ethnic backgrounds to be successful.

In fall of 1998, DeVry headquarters surveyed the alumni who graduated in 1989, 1991, 1993, 1995, and 1997. Nearly 1,900 graduates responded; 436 identified themselves as EET graduates. More than 75% of the graduates surveyed rated "good" or "excellent" for the areas of (not limited to) (a) overall satisfaction with DeVry, (b) curriculum quality, (c) quality of teaching, (d) preparation for employment immediately after graduation, (e) preparation-installation and testing, and (f) problem solving and critical thinking. This research study also showed, in DeVry University's practical, career-oriented technology programs, that graduating students with Hispanic ethnic background performed equally well as compared to the graduating students of other ethnic origins.

All of the above data showed that the goals and practices implemented in DeVry University's engineering technology curricula provided positive academic experiences for students including those with minority ethnic and language backgrounds, as evidenced by their average academic performance measures, by the graduate placement rates, by the results of employer surveys, and by students' self-perceptions.

Difference in Communications Skills

One of the major findings in this study was that there was a significant difference between the native speakers of English and nonnative speakers of English in regard to the competency ratings in oral/written communication skills. Native English-speaking graduating seniors had higher average ratings in communication skills than nonnative English-speaking graduating seniors. The similar result was also found that there was a statistically significant difference between nonnative English-speaking and native English-speaking graduating seniors in regard to their academic performance in general

education measured by their cumulative GPAs in the English/humanities course sequence. Native English speakers were found to perform better academically in their English and humanities courses. Significant difference was found between graduating seniors with Hispanic ethnic background and graduating seniors with Asian background in regard to their oral/written communications skills. Graduating seniors with Hispanic ethnic background were rated significantly higher than graduating seniors with Asian background in regard to oral/written communications skills. It was also found, within nonnative English-speaking group, that there was a significant difference between students' GPAs in the general education course sequence and their GPAs in the technical course sequence. Nonnative English speakers' GPAs in the English/humanities course sequence was significantly lower than their GPAs in the technical course sequence.

Spellman (1997) stated that the present reality was that although many immigrant students with limited English competency had graduated from high schools in America, they might still have developmental English needs even if they were placed into mainstream classes. Helping these students to achieve high level of English communication proficiencies is the key to their ultimate success in academics (Spellman, 1997).

Immigrant students with minority ethnic and language backgrounds experience various difficulties in adjusting to the language and cultural norms of this country during different learning stages; the most difficult obstacle that nonnative English-speaking students encountered was inadequate English language skills (Gray et al., 1996; McDonnell & Hill, 1993). As Gray et al. indicated, the weak English skills of some

students with nonnative English background might be the most serious impediment to their pursuit in higher education.

The finding that graduating seniors with Hispanic ethnic background were rated significantly higher than graduating seniors with Asian background in regard to their oral/written communications skills might be due to the possible factors that there were very different orthography and literary traditions between Western languages and Asian languages, so it might be more difficult for students with Asian ethnic and language background to grasp English communications skills (Siu, 1996), and that Asian students tended to choose courses requiring minimal English language skills, thus their opportunities to improve their English skills were limited (Gray et al., 1996).

In order to strengthen communication skills for the diverse student body with different ethnic and language backgrounds, a "common writing final" for all DeVry students in beginning English has been implemented since 1998. This five-paragraph essay exam requires the demonstration of the minimum writing skills needed to progress in the EET program and other programs (DeVry University Chicago Campus Student Handbook, 2002-2004). The professors of the General Education Department indicated that students were better prepared for their later term English and humanities courses after they successfully passed the "common writing final."

It has also been emphasized that the technology courses must incorporate an emphasis on oral/written communication skills, for both native and nonnative English-speaking students. It was stressed that the syllabus for the senior project course must include the point value of the oral presentation component, and that the grading sheets for the senior project classes must document the grading for oral presentations. Professors

from the General Education Department were invited to provide input regarding oral presentations to EET students, and to participate in the assessment of oral communication competencies. The communications components were included in other appropriate technical courses, which were taken into account in the review and evaluation of student technical work.

At DeVry University Chicago, a pamphlet was developed which includes guidelines to instruct technical faculty on how to evaluate the English component for student technical work. Although grading for language and grammar has been required of EET faculty members for a number of years, continuous effort is essential to improving students' oral/written communications competencies.

DeVry University Chicago's English as a Second Language (ESL) Department has actively worked with engineering technology programs to better respond to the unique needs of our multicultural population. In recent years the ESL Department has actively evaluated and assessed its functions, and has taken the following actions: (a) expanded the use of technology in classwork; (b) assigned Internet research and technical vocabulary development; and (c) established Email communication between instructor and students. ESL faculty played an important role in assessing and evaluating student learning outcomes. At the end of each term, instructors meet to evaluate the class in regard to syllabi, curricula, and course goals.

Difference in Technical Courses

The general conclusion was that both native English-speaking graduating seniors and nonnative English-speaking graduating seniors performed equally well in DeVry University's EET programs measured by most of their competency ratings and overall

composite GPAs. For graduating students sampled in this research, nonnative English-speakers had higher cumulative GPAs in the engineering technology course sequence than native English speakers, and nonnative English speakers of other ethnic backgrounds had higher assessment ratings in experimentation skills than native English speakers. This was opposite to the finding that native English-speakers were performing better academically in their English and humanities course sequence, as concluded in the previous section.

The possible contributing factors to these findings include:

(1) nonnative English-speaking students were more likely to follow a technical academic track to balance their disadvantages in English language; and they tended to choose a marrow set of majors, especially students with Asian background (Gray et al., 1996; Vernez & Abrahamse, 1996);

(2) immigrant students came to the U.S with strong educational backgrounds since they immigrated from the countries where the basic education in fundamental subjects were more emphasized and rigorous (Gray et al., 1996; Pong, 2003); on the other hand, the local primary and secondary schools in the urban districts in the United States "lack the human and fiscal resources to educate students well" (McDonnell & Hill, 1993); and

(3) based on the researcher's observations, nonnative English-speaking students spent more time on technical subjects including experimentations than on English/humanities subjects, assuming that their weaker GPAs in the English/humanities course sequence due to the English language disadvantages could be compensated for by better GPAs in technical subjects.

Other reasons might also include the factors that most immigrants are a highly selected group of people who have exceptional capabilities to successfully come the long way from their countries to the United States (Pong, 2003). They were an outstanding group of people from their countries to overcome immigration difficulties in order to finally enter America. Some of these factors are topics for future studies.

Meanwhile, the educational policy makers and educational administrators should seriously consider the implications if native-born students enter higher education with relatively weaker educational backgrounds (Gray et al., 1996), especially if their basic education in fundamental mathematics/science subjects were less rigorous. There might be need for improving policies, curricula, and instructional methods, so that the children who grew up in the American education system would not fall behind in technical subjects.

To enhance basic technical skills for the diverse student body with both native English-speaking and nonnative English-speaking language backgrounds, the EET faculty implemented the following actions: (a) assigned "common lab finals" for the fundamental DC/AC circuit analysis courses; (b) implemented "Active Learning Strategies" including library usage, written and oral communication practice, computer usage, and calculus across the curriculum; (c) incorporated computer-aided circuit analysis software to help students comprehend complicated circuit problems in EET courses; (d) strengthened lab experiments to include the use of computer-based instrumentation in electronics and physics labs; and (e) provided internet-based curriculum support for students. The result from these actions will be evaluated over time.

Personal Reflections

As an academic instructor I have taught various electronics engineering technology courses at several universities and colleges, including traditional, public universities and the private, for-profit university such as DeVry for many years. I also have been an academic administrator for technology programs at DeVry University since the beginning of 1997. My personal observation is that the "hands-on" learning strategies implemented in DeVry University's technology programs were essential for students with practical learning styles to be successful. These students chose DeVry based on their belief that they may learn better through experimentations incorporated in all technical courses.

I have observed that DeVry has a history of academic quality and accreditation. DeVry's EET curriculum was initially accredited in 1955 at the associate degree level by the Engineer's Council for Processional Development (ECPD). This group was later reorganized as the Accreditation Board for Engineering and Technology (ABET), a specialized accreditation organization accrediting high quality engineering and technology programs in higher educational institutions. After the Chicago campus started a bachelor's degree program in EET in 1969, it was accredited by the Technology Accreditation Commission of the Accreditation Board for Engineering the Technology (TAC of ABET). DeVry attained candidacy status with the Commission on Institutions of Higher Education for the North Central Association of Colleges and Schools in 1980, and was initially accredited in 1981.

I also observed that DeVry University has been a leading institution in providing practical and flexible delivery modes, including its year-round trimester system so

students can complete a four-year degree within three years, the accelerated course offerings, evening/weekend course offerings, and online courses. I believe that these practical instructional methodologies, the flexible delivery modes, and teaching schedules are contributive to the survival of students with various ethnic and language backgrounds, since many of them have to maintain heavy work schedules in order to financially support their families.

I observed that the supporting services to link academic studies with real world career opportunities helped to meet the needs of students with minority ethnic and languages backgrounds. DeVry University's practical educational approach, career oriented curricula, and its career service system have provided students with motivations to be persistent and successful in their academic pursuit. I observed that students from different language and ethnic backgrounds are encouraged to stay and do well in DeVry's programs, since they are generally aware that they will be highly employable immediately after graduation.

For certain language and ethnic minority students, DeVry made it possible for them to get a college education. Without DeVry, these students may not survive in traditional university settings. DeVry not only helped these students to find a suitable academic track, but also provided them with a *career* that they can live on for their lives. As one of the DeVry educators commented, "DeVry changed many people's lives." In DeVry's history, DeVry educated and provided careers for different groups of immigrant youths during different political eras.

I believe that DeVry University has developed its strengths based on its *for-profit* characteristics. Unlike public, state supported higher educational institutions, or private

universities supported by private contributions or foundations in addition to high tuition, DeVry depends almost entirely on its tuition revenues to finance its expenditures and operations. As a result, its survival and expansion are directly dependent upon the quality of its academic programs, the efficiency of its operations, and most importantly, its responsiveness to the diversity of students, their needs, and their concerns.

I would recommend that we at DeVry to even more to promote DeVry University's practical programs, its hands-on aspects, its flexible delivery modes and schedules, and its career services systems, to both native English-speaking and nonnative English-speaking, immigrant students in our recruitment efforts. I would like to emphasize that DeVry will not only provide students with a quality education, but may provide them with a solid career. I would also like to recommend that we advocate the strength of our English as a second language facilities, and be more sensitive to the academic needs of nonnative English-speaking and ethnic minority students.

Recommendations for Future Research

Since the sample for the current research included only students who were in graduating classes from EET programs on DeVry University Chicago area campuses, further research is needed to include statistical analyses on nonnative English-speaking students' enrollment and retention in such career-oriented higher education institutions as DeVry University. Specifically, comparative research using quantitative methodology is needed on retention and graduation rates of nonnative English-speaking (ESL) students versus native English-speaking students in the technology and business programs at DeVry University. Such research should be designed to explore whether there are

statistically significant differences between nonnative English-speaking students and native English-speaking students, and among students with difference ethnic backgrounds, in the technology and business programs at DeVry University, in regard to their enrollment patterns, retention figures throughout different academic terms and courses, and graduation rates over years. Such future research should also identify whether there exist significant interactions between students' ethnic backgrounds and language backgrounds, in regard to their enrollment patterns, retention figures, and graduation rates.

Comparative studies using quantitative methodology are needed to explore whether this is a statistically significant difference between nonnative English-speaking (ESL) students at traditional state-run universities, such as University of Illinois, or Colorado State University, versus nonnative English-speaking students at practical, career-oriented private for-profit universities, such as DeVry University, in regard to their academic performance measured by standardized instruments or tests. Such further research should also include a statistical quantitative analysis to investigate whether there are statistically significant differences among students with different ethnic backgrounds, between traditional state-run universities and career-oriented private for-profit universities, in regard to their academic achievements measured by some sort of standardized instruments. Such research would help to better understand if practical, career-oriented universities provide nonnative English-speaking students of various minority ethnic backgrounds with equal learning opportunities.

Future research is also needed to conduct more comprehensive and in-depth comparative studies using quantitative methodology to investigate the post graduation

performance of nonnative English-speaking (ESL) students versus native English-speaking students from the technology and business programs at DeVry University. Such research should be designed to explore whether there are statistically significant differences between nonnative English-speaking students and native English-speaking students, and among students with difference ethnic backgrounds, in the technology and business programs at DeVry University, in regard to their post graduation performance in terms of promotion patterns in three, five and ten years, salary figures throughout a length of time, and post graduate degree accomplishments. Such future research should again investigate whether there exist significant interactions between students' ethnic backgrounds and language backgrounds, in regard to their post graduation performance.

The increase in nonnative English-speaking students entering into U.S. higher education places greater demands for university administrators and admissions because of time-consuming and labor-intensive evaluation of foreign transcripts and academic documents (Gray et al., 1996). Future research may be needed using quantitative methodology to systematically quantify the correlations and differences between nonnative English-speaking countries and the United States in terms of secondary and postsecondary transcripts and academic credit systems, so that a fair and consistent practice will be developed to facilitate the admission and transfer processes. The researcher believes that all higher education institutions will benefit from these practical research studies.

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APPENDIX A

Code Book and Data Format of Research Variables for the Study

Research Question 1

Independent Variables

Independent Variable 1.

LANGBGRD Students Language Background
1

Measurement Level: Nominal
Column Width: 8 Alignment: Right
Print Format: F8
Write Format: F8

Value	Label
1	Native English Speakers
2	Nonnative English Speakers (ESL)

Independent Variable 2.

ETHNBGRD Students Ethnic Background
2

Measurement Level: Nominal
Column Width: 8 Alignment: Right
Print Format: F8
Write Format: F8

Value	Label
1	Asian Students
2	Hispanic Students
3	Other Ethnic Groups

Dependent Variables

Dependent Variable 1.

EXPERIMT Assessment Rating - Exprimt
3

Measurement Level: Scale
Column Width: 8 Alignment: Right
Print Format: F8.2
Write Format: F8.2

Dependent Variable 2.

PROGRAM Assessment Rating - Programming
4

Measurement Level: Scale
Column Width: 8 Alignment: Right
Print Format: F8.2
Write Format: F8.2

Dependent Variable 3.

DESIGN Assessment Rating - Design
5

Measurement Level: Scale
Column Width: 8 Alignment: Right
Print Format: F8.2
Write Format: F8.2

Dependent Variable 4.

COMM Assessment Rating - Communications
6

Measurement Level: Scale
Column Width: 8 Alignment: Right
Print Format: F8.2
Write Format: F8.2

Dependent Variable 5.

TEAM Assessment Rating - Team Skills
7

Measurement Level: Scale
Column Width: 8 Alignment: Right
Print Format: F8.2
Write Format: F8.2

Dependent Variable 6.

LIFELG Assessment Rating - Lifelong Learning
8

Measurement Level: Scale
Column Width: 8 Alignment: Right
Print Format: F8.2
Write Format: F8.2

Research Question 2

Independent Variables

Independent Variable 1.

LANGBGRD Students Language Background
1

Measurement Level: Nominal
Column Width: 8 Alignment: Right
Print Format: F8
Write Format: F8

Value	Label
1	Native English Speakers
2	Nonnative English Speakers (ESL)

Independent Variable 2.

ETHNBGRD Students Ethnic Background
2

Measurement Level: Nominal
Column Width: 8 Alignment: Right
Print Format: F8
Write Format: F8

Value	Label
1	Asian Students
2	Hispanic Students
3	Other Ethnic Groups

Dependent Variable

GPA General Composite GPA
9

Measurement Level: Scale
Column Width: 8 Alignment: Right
Print Format: F8.2
Write Format: F8.2

Research Question 3

Independent Variables

Independent Variable 1.

LANGBGRD Students Language Background
1

Measurement Level: Nominal
Column Width: 8 Alignment: Right
Print Format: F8
Write Format: F8

Value	Label
1	Native English Speakers
2	Nonnative English Speakers (ESL)

Independent Variable 2.

ETHNBGRD Students Ethnic Background
2

Measurement Level: Nominal
Column Width: 8 Alignment: Right
Print Format: F8
Write Format: F8

Value	Label
1	Asian Students
2	Hispanic Students
3	Other Ethnic Groups

Dependent Variable

GPAGENED GPA in GenEd - Communications
11

Measurement Level: Scale
Column Width: 8 Alignment: Right
Print Format: F8.2
Write Format: F8.2

Research Question 4

Independent Variables

Independent Variable 1.

LANGBGRD Students Language Background
1

Measurement Level: Nominal
Column Width: 8 Alignment: Right
Print Format: F8
Write Format: F8

Value	Label
1	Native English Speakers
2	Nonnative English Speakers (ESL)

Independent Variable 2.

ETHNBGRD Students Ethnic Background
2

Measurement Level: Nominal
Column Width: 8 Alignment: Right
Print Format: F8
Write Format: F8

Value	Label
1	Asian Students
2	Hispanic Students
3	Other Ethnic Groups

Dependent Variable

GPAMTHSC GPA in Mth/Science
10

Measurement Level: Scale
Column Width: 8 Alignment: Right
Print Format: F8.2
Write Format: F8.2

Research Question 5

Independent Variables

Independent Variable 1.

LANGBGRD Students Language Background
1

Measurement Level: Nominal
Column Width: 8 Alignment: Right
Print Format: F8
Write Format: F8

Value	Label
1	Native English Speakers
2	Nonnative English Speakers (ESL)

Independent Variable 2.

ETHNBGRD Students Ethnic Background
2

Measurement Level: Nominal
Column Width: 8 Alignment: Right
Print Format: F8
Write Format: F8

Value	Label
1	Asian Students
2	Hispanic Students
3	Other Ethnic Groups

Dependent Variable

GPATECH GPA in Technical Courses
12
Measurement Level: Scale
Column Width: 8 Alignment: Right
Print Format: F8.2
Write Format: F8.2

Research Question 6

Paired Variables

Paired Variables 1.

GPAGENED
1
Measurement Level: Scale
Column Width: 8 Alignment: Right
Print Format: F8.2
Write Format: F8.2

GPATECH
2
Measurement Level: Scale
Column Width: 8 Alignment: Right
Print Format: F8.2
Write Format: F8.2

Paired Variables 2.

GPAMTH/Science
1
Measurement Level: Scale
Column Width: 8 Alignment: Right
Print Format: F8.2
Write Format: F8.2

GPATECH
2
Measurement Level: Scale
Column Width: 8 Alignment: Right
Print Format: F8.2
Write Format: F8.2

Research Question 7

Independent Variables

Independent Variable 1.

GPAMTH/Science
1
Measurement Level: Scale
Column Width: 8 Alignment: Right
Print Format: F8.2
Write Format: F8.2

Independent Variable 2.

GPAGENED
2
Measurement Level: Scale
Column Width: 8 Alignment: Right
Print Format: F8.2
Write Format: F8.2

Dependent Variable

GPATECH
3
Measurement Level: Scale
Column Width: 8 Alignment: Right
Print Format: F8.2
Write Format: F8.2

APPENDIX B

EET COMPETENCY EVALUATION SHEET

EET COMPETENCY EVALUATION SHEET

Objective #1: *Conduct experiments involving electronic systems using modern test equipment, interpret test results and use them to improve products or methodologies.*

Outcomes	Ratings (0 - 4)	Criteria	Weaknesses/ Suggestions for Improvement
1. Perform Needs Analysis–define the problem		■ Identify the problem to be solved ■ Identify tests needed to isolate the cause of the problem or to provide additional information toward solving the problem	
2. State goals and objectives of the experiment		■ State objectives of the investigation ■ State how the investigation will help toward problem solution	
3. Identify resources to conduct experiment (parts, equipment, data sheets, etc.)		■ Identify instruments, parts, software, etc. needed to set up the test ■ Draw any schematic diagrams, flow charts, etc. of the system to be constructed ■ Collect any technical data sheets, equipment manuals, etc. as needed	
4. Develop data-collection procedures using modern test equipment		■ Plan stages of operation ■ Plan the sequence of tests to be performed ■ Conduct tests and gathers data	

Outcomes	Ratings (0 - 4)	Criteria	Weaknesses/ Suggestions for Improvement
5. Analyze test results and draw conclusions		■ Analyze test results and their usefulness toward solving the problem ■ Use the results toward solving the problem ■ Isolate and identify errors and malfunctions ■ If further tests are necessary, propose and carry out the same	

Objective #2: *Create and implement high-level, and Assembly language programs in support of technical activities.*

Outcomes	Ratings (0 - 4)	Criteria	Weaknesses/ Suggestions for Improvement
1. Analyze the problem logically		■ Perform feasibility studies ■ Determine the output desired ■ Determine the input needed ■ Identify the processing required ■ Draw a flow diagram ■ Define the objective of each module	
2. Design the solution		■ Diagram a structure chart ■ Select appropriate data structures ■ Develop the logic for each module in an algorithm	
3. Implement the solution		■ Choose language appropriate for the problem ■ Code the algorithm into an extendable reusable software ■ Create good documentation	

Outcomes	Ratings (0 - 4)	Criteria	Weaknesses/ Suggestions for Improvement
4. Test and debug the software		■ Select test data ■ Test and debugs each module ■ Test and debugs the program as a whole ■ Refine the program	

Objective #3: *Use the principles of science, mathematics, engineering, and technology to design, implement, and evaluate hardware and software solutions to complex technical problems.*

Outcomes	Ratings (0 - 4)	Criteria	Weaknesses/Suggestions for Improvement
1. Select and define a meaningful problem specifications taking safety, ethical, social, economic, technical constraints, and user requirements into consideration		■ Propose a problem for investigation ■ Consider safety, ethical, social, economic, technical constraints, and user requirements into problem definition ■ Apply criteria in defining and specifying the problem ■ Identify scope of the problem including a problem statement and solution criteria	
2. Devise process to solve problem		■ Identify subtasks and appropriate actions to solve problem ■ Gather and organizes resources ■ Plan a realistic schedule for process (e.g., design, construction, report, etc.) ■ Organize tasks around available technology, personnel and financial resources effectively and efficiently	

Outcomes	Ratings (0 - 4)	Criteria	Weaknesses/Suggestions for Improvement
3. Apply appropriate knowledge of scientific, mathematical, and engineering design tools toward the design and analysis of problem solutions.		■ Integrate knowledge of fundamentals in selecting system components using appropriate technology (including manufacturers' catalogs and network databases) ■ Use modern engineering design tools, such as HDL, Pspice, Matlab, etc. ■ Display the ability to acquire a working knowledge of new design tools	
4. Identify key issues in designing and building a prototype		■ Identify materials necessary to build the prototype including power source ■ Prioritize procurement of design components ■ Define steps to building a prototype	
5. Build, test, and troubleshoot prototype		■ Use good craftsmanship in building prototype ■ Create software and documentation ■ Test operation of the prototype (does it meet original design specs?) ■ Identify and define fault ■ Identify and implement remedy	
6. Optimize prototype with a commitment to quality, timeliness and continuous improvement		■ Test solution to determine if design specs are met and if needed, refine it ■ Complete project on time	

Objective #4: *Communicates effectively both orally and in writing*

Outcomes	Ratings (0 - 4)	Criteria	Weaknesses/ Suggestions for Improvement
1. Communicate effectively in writing		■ Define goals of the report ■ Synthesize material into appropriate presentation types (e.g., text, pictures, schematics, graphics, etc.) ■ Select and focus on data to support the thesis of the report ■ Present ideas and arguments clearly and logically using appropriate balance of text and visual graphic materials (flow charts, pie and bar charts, block diagrams, etc.) ■ Use English syntax and technical terms appropriately	
2. Communicate effectively orally		■ Choose structure and order of presentation ■ State problem clearly ■ Use data, information in audio visual formats to support problem solution ■ Display a professional demeanor, and uses appropriate body language and word choice ■ Effectively respond to questions and comments	

Objective #5: *Works effectively in a team environment*

Outcomes	Ratings (0 - 4)	Criteria	Weaknesses/ Suggestions for Improvement
1. Exhibit good dialoguing skills		■ Speak in turn with clarity using articulation of ideas ■ Listen actively ■ Ask appropriate questions ■ Start, join, maintain, and terminate conversation well	
2. As part of a small-group project, perform assigned roles effectively		■ Support other team members in effective performance of their assigned roles ■ Work for constructive conflict resolution ■ Strive for a meaningful group consensus ■ Initiate and participates in group maintenance activities	

Objective #6: *Use applied research and problem-solving skills to support learning at DeVry as well as for life-long personal and professional development*

Outcomes	Ratings (0 - 4)	Criteria	Weaknesses/ Suggestions for Improvement
1. Recognize the need to know information beyond one's own expertise and demonstrate the ability to gather and synthesize the necessary information into the solution of a problem		■ Recognize the need for information (beyond one's own expertise) to support learning and problem solving ■ Gain appropriate knowledge through independent or group study ■ Use appropriate sources (e.g., library resources and databases) or experts (team members, teachers, industry engineers, etc.) to help address information and problem-solving needs ■ Synthesize acquired knowledge into the solution	
2. Use engineering problem-solving methodology in solving problems		■ Gather data from various sources including customers to verify the existence of a problem ■ Define problem (symptom recognition and elaboration) ■ Generate alternative solutions (symptom analysis and design of solutions) ■ Select the most appropriate solution based on criteria and applies the solution (adjustment/replacement/ repair) ■ Collect feedback and applies it toward continuous improvement (evaluation)	

Rating Scale:

4 = Outstanding: outcome achieved and demonstrated with no errors (evidence of high-qulaity completed work)

3 = Good: outcome achieved and demonstrated with no significant errors (evidence of good quality completed work)

2 = Fair: outcome achieved and demonstrated with occasional errors (evidence of mediocre quality completed work)

1 = Poor: outcome poorly achieved and with significant number of errors (evidence of poor quality completed work)

0 = Fail (evidence of poor quality incomplete work)

APPENDIX C

CRONBACH'S ALPHAS OF THE TEST RESULTS ON EET COMPETENCY EVALUATION SHEET

Cronbach's Alpha - Experimentation Construct

		Mean	Std Dev	Cases
1.	EXP1	3.0000	.7276	35.0
2.	EXP2	2.9143	.9509	35.0
3.	EXP3	2.9143	.8531	35.0
4.	EXP4	2.7429	.9185	35.0
5.	EXP5	2.4000	.9762	35.0

Correlation Matrix

	EXP1	EXP2	EXP3	EXP4	EXP5
EXP1	1.0000				
EXP2	.6377	1.0000			
EXP3	.6160	.4620	1.0000		
EXP4	.6601	.6475	.5716	1.0000	
EXP5	.6211	.6400	.5015	.7413	1.0000

N of Cases = 35.0

Statistics for Scale	Mean	Variance	Std Dev	N of Variables
	13.9714	13.4992	3.6741	5

Item Means	Mean	Minimum	Maximum	Range	Max/Min	Variance
	2.7943	2.4000	3.0000	.6000	1.2500	.0573

Inter-item Correlations	Mean	Minimum	Maximum	Range	Max/Min	Variance
	.6099	.4620	.7413	.2793	1.6045	.0061

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
EXP1	10.9714	9.5580	.7583	.5841	.8550
EXP2	11.0571	8.6437	.7067	.5269	.8623
EXP3	11.0571	9.5261	.6163	.4289	.8812
EXP4	11.2286	8.4168	.7953	.6483	.8400
EXP5	11.5714	8.3109	.7525	.6056	.8512

R E L I A B I L I T Y A N A L Y S I S - S C A L E (A L P H A)

Reliability Coefficients 5 items

Alpha = .8835 Standardized item alpha = .8866

Cronbach's Alpha - Design Construct

		Mean	Std Dev	Cases
1.	DESN1	2.7429	.7800	35.0
2.	DESN2	2.7143	.9258	35.0
3.	DESN3	2.6571	.9684	35.0
4.	DESN4	2.7429	.9500	35.0
5.	DESN5	2.6000	.8812	35.0
6.	DESN6	2.2571	1.0667	35.0

Correlation Matrix

	DESN1	DESN2	DESN3	DESN4	DESN5	DESN6
DESN1	1.0000					
DESN2	.6284	1.0000				
DESN3	.6197	.6092	1.0000			
DESN4	.7020	.6497	.6047	1.0000		
DESN5	.5306	.5047	.5239	.5411	1.0000	
DESN6	.5767	.6127	.7712	.6476	.6446	1.0000

N of Cases = 35.0

Statistics for	Mean	Variance	Std Dev	N of Variables
Scale	15.7143	21.0924	4.5927	6

Item Means	Mean	Minimum	Maximum	Range	Max/Min	Variance
	2.6190	2.2571	2.7429	.4857	1.2152	.0345

Inter-item Correlations	Mean	Minimum	Maximum	Range	Max/Min	Variance
	.6111	.5047	.7712	.2665	1.5279	.0048

R E L I A B I L I T Y A N A L Y S I S - S C A L E (A L P H A)

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
DESN1	12.9714	15.9109	.7349	.5856	.8877
DESN2	13.0000	15.0588	.7204	.5337	.8878
DESN3	13.0571	14.5261	.7625	.6496	.8815
DESN4	12.9714	14.6756	.7576	.6105	.8822
DESN5	13.1143	15.7513	.6526	.4616	.8974
DESN6	13.4571	13.6672	.7972	.6996	.8766

Reliability Coefficients 6 items

Alpha = .9030 Standardized item alpha = .9041

Cronbach's Alpha - Programming Construct

		Mean	Std Dev	Cases
1.	PROG1	2.9143	.8531	35.0
2.	PROG2	2.6286	.7702	35.0
3.	PROG3	2.5429	.8859	35.0
4.	PROG4	2.2857	1.1000	35.0

Correlation Matrix

	PROG1	PROG2	PROG3	PROG4
PROG1	1.0000			
PROG2	.6215	1.0000		
PROG3	.6860	.5628	1.0000	
PROG4	.6850	.5455	.7114	1.0000

N of Cases = 35.0

Statistics for Scale	Mean	Variance	Std Dev	N of Variables
	10.3714	9.5345	3.0878	4

Item Means	Mean	Minimum	Maximum	Range	Max/Min	Variance
	2.5929	2.2857	2.9143	.6286	1.2750	.0671

Inter-item Correlations	Mean	Minimum	Maximum	Range	Max/Min	Variance
	.6354	.5455	.7114	.1659	1.3041	.0044

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
PROG1	7.4571	5.6672	.7730	.5985	.8149
PROG2	7.7429	6.4319	.6423	.4293	.8650
PROG3	7.8286	5.5580	.7640	.5919	.8169
PROG4	8.0857	4.7277	.7519	.5851	.8319

R E L I A B I L I T Y A N A L Y S I S - S C A L E (A L P H A)

Reliability Coefficients 4 items

Alpha = .8696 Standardized item alpha = .8745

Cronbach's Alpha - Communications Construct

		Mean	Std Dev	Cases
1.	COM1	2.9143	.9194	35.0
2.	COM2	2.6000	.8471	35.0

Correlation Matrix

	COM1	COM2
COM1	1.0000	
COM2	.7477	1.0000

N of Cases = 35.0

Statistics for Scale	Mean	Variance	Std Dev	N of Variables
	5.5143	2.7277	1.6516	2

Item Means	Mean	Minimum	Maximum	Range	Max/Min	Variance
	2.7571	2.6000	2.9143	.3143	1.1209	.0494

Inter-item Correlations	Mean	Minimum	Maximum	Range	Max/Min	Variance
	.7477	.7477	.7477	.0000	1.0000	.0000

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
COM1	2.6000	.7176	.7477	.5590	.
COM2	2.9143	.8454	.7477	.5590	.

Reliability Coefficients 2 items

Alpha = .8540 Standardized item alpha = .8556

Cronbach's Alpha - Team Construct

		Mean	Std Dev	Cases
1.	TEAM1	2.8571	.8452	35.0
2.	TEAM2	3.2000	.7593	35.0

Correlation Matrix

	TEAM1	TEAM2
TEAM1	1.0000	
TEAM2	.6417	1.0000

N of Cases = 35.0

Statistics for Scale	Mean	Variance	Std Dev	N of Variables
	6.0571	2.1143	1.4541	2

Item Means	Mean	Minimum	Maximum	Range	Max/Min	Variance
	3.0286	2.8571	3.2000	.3429	1.1200	.0588

Inter-item Correlations	Mean	Minimum	Maximum	Range	Max/Min	Variance
	.6417	.6417	.6417	.0000	1.0000	.0000

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
TEAM1	3.2000	.5765	.6417	.4118	.
TEAM2	2.8571	.7143	.6417	.4118	.

Reliability Coefficients 2 items

Alpha = .7790 Standardized item alpha = .7817

Cronbach's Alpha - Lifelong Learning Construct

		Mean	Std Dev	Cases
1.	LFLG1	3.0000	.7670	35.0
2.	LFLG2	2.6857	.8668	35.0

Correlation Matrix

	LFLG1	LFLG2
LFLG1	1.0000	
LFLG2	.7521	1.0000

N of Cases = 35.0

Statistics for Scale	Mean	Variance	Std Dev	N of Variables
	5.6857	2.3395	1.5295	2

Item Means	Mean	Minimum	Maximum	Range	Max/Min	Variance
	2.8429	2.6857	3.0000	.3143	1.1170	.0494

Inter-item Correlations	Mean	Minimum	Maximum	Range	Max/Min	Variance
	.7521	.7521	.7521	.0000	1.0000	.0000

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
LFLG1	2.6857	.7513	.7521	.5657	.
LFLG2	3.0000	.5882	.7521	.5657	.

Reliability Coefficients 2 items

Alpha = .8549 Standardized item alpha = .8585