

Abstract

GRIECO, LESLEY FRANCES. Cooperative Education and Retention: A Study Among Science, Math, and Engineering Students (Under the direction of Audrey Jaeger, Ph.D.)

Student retention is a serious problem in higher education and is a heavily researched topic. Cooperative education, on the other hand, is not heavily researched, but more research could assist with discovering the benefits of cooperative education. Cooperative education (co-op) is defined in this study as a situation where students participate in the cooperative education program at the university and leave school for at least one semester to work in a 'real-world' work experience. Cooperative education research studies have shown that retention is higher for students who participate in cooperative education (Avenoso & Totoro, 1994), and co-op students are more likely to graduate than non co-op students (Somers, 1986). However, cooperative education literature would benefit from additional quantitative research examining the relationship between students' participation in co-ops and their retention and graduation rates as was suggested by Van Gyn, Cutt, Loken, and Ricks (1997); Stull, Crow, and Braunstein (1997); Meade (1992); and Siedenberg (as quoted in Kerka, 1989). Furthermore, the retention and student departure literature does not mention cooperative education as a possible way to retain students.

Little research has focused on utilizing cooperative education as a means of retention of science, math, and engineering (SME) students, especially after their first year of school. SME majors, in particular, have historically participated in cooperative education, but little research has focused on using cooperative

education as a strategy for retaining this group of students. Consequently, this research study examined the relationship between retention and graduation of S.M.E. students and cooperative education at a large, public, land-grant, research-extensive university in the southern United States.

This study used secondary data from both the university and cooperative education student databases. Participation in a co-op after freshman year was significantly associated with retention and graduation. Participation in a co-op later in students' college careers was also significantly associated with graduation. Time of participation in a co-op was not significantly associated with graduation. In other words, time of co-op did not matter; participation in a co-op did. Furthermore, co-op students had higher retention and graduation rates than non co-op students.

Implications of this study are that cooperative education may be an additional tool for higher education administrators to increase retention and graduation rates and can be used by faculty members and advisors to assist students. Also, leaders of higher education institutions could investigate co-op addition and accreditation at more colleges and universities. Recommendations for future research are including more cohort years and/or more than one university, conducting research on more recent student cohorts or different types of students, connecting retention theorists' ideas and variables with cooperative education, conducting more quantitative research on student benefits of cooperative education, and utilizing a mixed methods approach.

**Cooperative Education and Retention:
A Study Among Science, Math, and Engineering Students**

By

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Dedication

This thesis is dedicated to the author's parents, Ralph and Donna Grieco, who have always been supportive and who have loved unconditionally.

Personal Biography

The author, Lesley Frances Grieco, was born in 1976 to Ralph and Donna Grieco. She has an older brother, Jeffrey Grieco, whom she considers one of her best friends. Her parents raised her in Colonial Heights, VA. After graduating from high school, Lesley attended James Madison University (JMU) and graduated Summa Cum Laude in 1998 with a Bachelor of Science degree in Psychology and a minor in Early Childhood Education. Lesley earned a Collegiate Professional Licensure and taught third grade in Fairfax, VA and later taught first grade in Colonial Heights, VA. She desired to be a teacher since she was a child but was disappointed with her teaching experiences. She reflected on her happy undergraduate memories both academically and socially as well as her participation in many extracurricular activities, especially her role as a JMU Student Ambassador. She decided to begin a new career in a university environment.

After moving to Raleigh, NC, she gained a position at North Carolina State University (NCSU) as a student recruiter in the Department of Wood and Paper Science. She greatly enjoyed her job but realized she needed to obtain another degree that pertained to her new career. Hence, she enrolled in the Higher Education degree program at NCSU. After recruiting bright students, she noticed how some students did not perform as well in college as predicted by their high school record. Since these students were science and engineering majors, they completed internships and cooperative education experiences. She became interested in studying the relationship between retention and cooperative education.

She will proudly be the first member in her family to earn a Master's degree.

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Chapter I.

Introduction

Background of the Problem

Student departure is a major problem in higher education and thus presents a challenge to higher education professionals. In fact, “28.5% of students entering four-year collegiate institutions leave at the end of their first year” (Braxton, Milem, & Shaw-Sullivan, 2000, p. 569). Prominent theorists such as Tinto (1993), Bean (1990), and Astin (1999) along with numerous researchers such as Pritchard and Wilson (2003); Braxton, Shaw-Sullivan, and Johnson (1997); Cabrera, Nora, and Castaneda (1992); Nordquist (1993); Christie and Dinham (1991); Perry, Cabrera, and Vogt (1999); Kuh (1996); and others have studied retention on many different levels considering various variables. These researchers have discovered factors related to student departure at four-year colleges and universities. “One fairly constant finding is that students leave school because they do not fit in” (Bean, 1990, p. 149), whether it is for academic reasons, economic reasons, or for other reasons. Regardless of the reason for leaving, a college education is a mutual investment for the student and the institution. When a student leaves college, resources are lost for both the student and the university - namely time and money. Furthermore, for each student who leaves, an admission place is lost for another qualified student who did not gain admission at the college or university for lack of space.

Seymour and Hewitt (1997) studied why a more specific group of students - science, math, and engineering (SME) students - were leaving their majors. Forty

percent to 60% of gifted students leave science, math, and engineering majors within two years of completing their first science or mathematics course in college (p. 391). The exodus of bright students leaving these critical majors is detrimental to the future of the US economy and its ability to be a dominant player in the global marketplace. Related to this idea, Slaughter and Leslie (1997) proposed a theory called *academic capitalism* after they observed changes in higher education during the past 30 years. They define academic capitalism as “institutional and professional market or marketlike efforts to secure external moneys” (p. 8). During the 1970s and 1980s, markets became global mainly due to competition from Pacific Rim countries (p. 6). To remain competitive, industrialized countries created new technologies (p. 6). Industries partnered with research universities to create these new technologies. Consequently, globalization forced professors to engage in marketlike behaviors. Also, during this time federal and state governments in the United States, the United Kingdom, Australia, and Canada began to decrease block grant funding in higher education. As a result, universities had to engage in marketlike behavior to secure funding from other sources in order to compensate for the decrease in governmental funding. Slaughter and Leslie (1997) contend that in the future, universities will increasingly engage in academic capitalism as a means for survival. In addition, they maintain that science and engineering schools may be the only universities in the future to receive funding since their research is close to the market. In the worst case scenario, liberal arts schools may eventually disappear. Perhaps, SME undergraduate students are the future researchers and professors who will create

new technologies to help the United States remain a dominant player in the global marketplace during the informational age.

Although educators involved with cooperative education cite its many benefits, it is not a heavily researched topic. After assessing cooperative education research studies over a 10-year period, Wilson (1997) found only three studies that related to retention and adaptation to university life. Studies have shown that retention is higher for students who participate in cooperative education experiences than students who do not (Avenoso & Totoro, 1994), and co-op students are more likely to graduate than non co-op students (Somers, 1986). However, in student persistence theories and studies, cooperative education is not mentioned as a means of retaining students.

Engineering students were the first to participate in cooperative education and, historically, SME majors have utilized co-ops as part of their academic programs. As a result, connecting cooperative education and retention of SME majors seems appropriate. Furthermore, connecting cooperative education to retention after freshman year is even more suitable since about 30% of American freshmen do not return to higher education institutions after their first year (Braxton, Milem, et al., 2000, p. 569) and 40% to 60% of SME students leave their majors within 2 years (Seymour & Hewitt, 1997, p. 391). The relationship between cooperative education and retention needs to be further researched, especially since it appears that only one other study addresses students completing a co-op after their freshman year (Avenoso & Totoro, 1994).

Statement of the Problem

Little research has focused on utilizing cooperative education as a means of retention of SME students, especially after their first year of school. Retention theories and research literature rarely mention cooperative education at all. Consequently, this research study examined the relationship between retention of SME students and cooperative education in a large, public, land-grant, research-extensive university in the southern United States.

Research Questions

In an attempt to seek some insight into the research problem, four research questions were addressed in this study:

1. Do SME students who participated in a co-op after their freshman year have significantly different retention rates relative to SME students who did not participate in a co-op?
2. Do SME students who participated in a co-op after their freshman year have significantly different graduation rates relative to SME students who did not participate in a co-op?
3. Do SME students who participated in a co-op later in their college careers have significantly different graduation rates relative to SME students who did not participate in a co-op?
4. Do SME students who participated in a co-op after their freshman year have significantly different graduation rates relative to SME students who participated in a co-op later in their college careers?

Significance of the Study

Although retention in higher education has been extensively researched and encompasses many theories, it has not been connected to cooperative education as a means of retaining students. For example, theories do not mention cooperative education as a student activity or educational strategy to improve retention. Furthermore, SME students nationally are leaving their majors in sizeable numbers (Seymour & Hewitt, 1997). SME majors, in particular, have historically participated in cooperative education, but little research has focused on using cooperative education as a strategy for retaining this group of students. Cooperative education needs to be examined in regards to its influence on retention and graduation of students (Stull, Crow, & Braunstein, 1997). The cooperative education literature would benefit from additional quantitative data and sound research demonstrating the relationship between students participating in a co-op and their retention and graduation rates as was suggested by Van Gyn, Cutt, Loken, and Ricks, 1997; Stull et al., 1997; Meade, 1992; and Siedenberg who was quoted in Kerka, 1989. This study utilized data from a university characterized as a science and engineering school, which had an active cooperative education program.

Delimitations and Limitations

This study is delimited to SME students at a large public university in the southeastern United States (Creswell, 2003, p. 148). The researcher chose this university because it had an accredited cooperative education program and was convenient to the researcher. A limitation or potential weakness of this research was that only a certain number of students participate in cooperative education, and

participating in cooperative education was not mandatory for successfully completing their major programs (p. 148). Another limitation was that the research university may not be comparable to other universities. Also, the institutional structure of this university may be different from other universities. Some majors at this university require that students apply to be accepted into a particular major but do not matriculate into that major until they complete certain classes with a C average or better. On the other hand, some students are accepted directly into their desired major at the beginning of their freshman year. Other universities may accept students into a general college and then, typically in their junior year, students choose their major. Therefore, higher education professionals may not be able to generalize the findings to their own colleges and/or universities.

Definition of Terms

To clearly understand the terms used in this research, definitions are provided.

- Science, Math, and Engineering (SME) Students – students whose majors are classified as science, math, or engineering at the university being studied. Please refer to Appendix A for a complete listing of all majors the researcher considered SME.
- Cooperative Education Experience (Co-op) – The situation where SME students participate in the cooperative education program at the university and leave school for at least one semester to work in a ‘real-world’ work experience.

- Retention – students who returned to the university after completing a co-op after their freshman year.
- Retention Rate – percentage of students who returned to the university second semester sophomore year.
- Student Classification at the Time of Co-op – the university being studied defines a student's classification by the number of credit hours completed.
 - Freshman – students who completed no more than 30 credit hours
 - Later in College Careers – students who participated in a co-op any time during or after sophomore year
- Co-op after Freshman Year – a co-op after students' freshman year may be defined as the summer after freshman year plus the next fall semester or just the next fall semester.
- Cohort – the students who entered as freshman in 1997 and 1998; of these students, three cohorts emerged:
 - SME students who first completed a co-op after freshman year
 - SME students who first completed a co-op later in their college careers
 - SME students who did not complete a co-op
- Graduation – the successful completion of all university requirements for a Bachelor's degree. University Planning and Analysis office indicates if a student graduated with a 'G' in the university student database.
- Graduation Rate – percentage of all student cohorts that successfully graduated. For example, one cohort was the students who first completed a co-op after freshman year.

Chapter II.

Review of Literature, Conceptual Framework, and Research Questions

Founding of Cooperative Education in the United States

Schneider believed that “many professional concepts and skills could not be learned effectively in the classroom, but required practical experience for their understanding and mastery” (Sovilla, 1998, pp. 18-19). His plan involved alternating “two groups of students on a weekly basis between on-campus study of engineering and off-campus employment in engineering-related jobs in local industries” (Wilson, 1971, p. 4). By implementing this plan, Schneider solved two problems that he had noticed.

First, he had noted that many elements of most professions could not be taught effectively or at all in the classroom but rather required practical experience for their adequate mastery. Second, he had found that most students either needed or wanted to work sometime during their college careers; most of these jobs, he further observed, were menial and unrelated to the students’ career goals (p. 4).

His ideas were strengthened after he interviewed engineering students. He discovered that most of them worked either during college or on their vacations and some even took time off of school to work (p. 4). Although he met resistance at the University of Cincinnati, he was allowed to begin the program, and 27 electrical and chemical engineering students enrolled in Schneider’s first cooperative education (co-op) program in the 1906-1907 school year (Sovilla, 1998, p 19). Furthermore,

thirteen employers participated during that first year (University of Cincinnati Cooperative Education Office, 2004).

Historical Definition

To explain the meaning of cooperative education, a review of the historical definitions is necessary. Cooperative education, a form of experiential education, combines classroom/lecture material and 'real-world' experience to create a more comprehensive curriculum. "The name, cooperative education, reflects the necessary cooperative relationship established between the institution and the agency providing the work situation" (Wilson, 1971, p. 3). It is an "educational strategy that involves students in productive work as an element of curriculum" (Wilson, 1978, p. 1). This definition of cooperative education has three significant components: (1) is an educational strategy; (2) provides productive work for students; and (3) is an element of curriculum (p. 1).

Two models of co-ops exist. The classical model consists of alternating between classroom study and real-world, productive work; *The Cincinnati Plan*, for example (Sovilla, 1998). Universities have added other characteristics to the model through the years to make it more formalized. For instance, these co-ops are typically "centrally administered by a director and a staff of professional coordinators who developed work assignments for the students, gave advice, and monitored work experience" (Ryder, 1989, p. 9). The schools also require students to participate in cooperative education. Again, this kind of co-op was designed initially for engineering students. In 1921, Antioch College, a liberal arts institution, created a different model of cooperative education (p. 10). This type of co-op was not as strict

as the classical model, did not require students to participate, and did not necessarily involve multiple rotations. Nonetheless, cooperative education in the liberal arts curricula proved its applicability to disciplines other than engineering and opened co-ops to females since the majority of engineering majors were typically male (p. 10).

History of Cooperative Education's Development

In 1957, Charles Kettering, research director for the General Motors Corporation and an advocate of cooperative education, convinced the Thomas Alva Edison Foundation to attract more attention to cooperative education (Sovilla, 1998, p. 19). As a result, this foundation organized a conference to discuss cooperative education's function in higher education. The conference attendees agreed on the benefits of cooperative education but realized they had to convince traditional educators to activate co-op programs. One way to convince these traditional educators was to show "documented evidence of co-op's educational value" (p. 19). Consequently, the Ford Foundation's Fund for the Advancement of Education decided to sponsor a 2-year national study to document this value (p. 19). The Foundation awarded a grant of \$95,000, formed a committee, and employed a staff (Wilson, 1971, p. 14). In 1961, Wilson and Lyons published the landmark study to document the benefits of cooperative education, *Work-Study College Programs*, and Tyler and Mills published *Report on Cooperative Education: Summary of the National Study* (as cited in Wilson, 1971). These publications documented numerous educational benefits of cooperative education for colleges and universities, the students, and the companies. Regarding students' benefits, the "students perceived

many connections between the theories studied and the practices in which they participated or which they observed while they were at work” (Tyler, 1978, p. 69). They confirmed that these work experiences gave greater significance to their college courses. As a result, the students developed “useful links between theory and practice” (p. 69). To further promote cooperative education, the Charles F. Kettering Foundation hosted a conference in June 1961 in Princeton, New Jersey, *The Princeton Conference on Work-Study in Higher Education* (Wilson, 1971, p. 14). This conference enabled representatives from institutions without cooperative education programs to learn from institutions with cooperative education programs and to devise ways to initiate programs (p. 14).

To further prove the value of cooperative education, advocates realized they “needed to formalize ways to continually relay this information to those in positions of influence” (Sovilla, 1998, p. 19). As a result, they organized the *National Commission for Cooperative Education* to widely publicize cooperative education and to raise funds to finance efforts (p. 19). Furthermore, the National Commission gave “direct assistance to institutions planning to establish programs of cooperative education” (Wilson, 1971, pp. 14-15). To publicize cooperative education, National Commission members spoke during television and radio programs, wrote papers, and provided funds for state-wide conferences (p. 15). Another group formed in the 1960s, the Cooperative Education Association (CEA), with the help of the American Society for Engineering Education’s (ASEE) Cooperative Education Division (CED). The members of ASEE and CED desired to assist the increasing number of practitioners from liberal art curricula and two-year colleges as well as the

engineering educators (Sovilla, 1998, p. 19). CEA was influential in “shaping the future directions and philosophical orientation of cooperative education” (p. 19).

Co-Op Program Accreditation

To validate cooperative education programs even further, the Accreditation Council for Cooperative Education (ACCE) originated. ACCE’s principal tasks are recognizing achievement and maintaining standards for cooperative education programs in the United States (ACCE, 2004b). Furthermore, ACCE establishes and maintains “criteria and procedures for accrediting cooperative education programs, to promote the value of such accreditation and to share information ... that will enhance the field of cooperative education” (ACCE, 2004b, para. 4). Currently, 11 universities across the United States are accredited, although an estimated 132 engineering schools employ some type of co-op program (Meade, 1992). ACCE outlines facets of faculty involvement, student involvement, and employer involvement as well as mandates five criteria for programs to become and to remain accredited:

- Criterion One: The institution has effectively included cooperative education as an integral part of the academic program and has implemented policies and practices appropriate to achievement of program evaluation goals.
- Criterion Two: The institution has a clear and publicly-stated, formalized plan for the alternation, full-time or half-time, of campus-based classroom study with multiple periods of work experiences appropriate to a program of cooperative education.

- Criterion Three: The program demonstrates faculty involvement in the cooperative education program.
- Criterion Four: The program demonstrates efforts to achieve understandings with employers as to the goals for cooperative education and to encourage agreements on policies and expectations for the cooperative relationship.
- Criterion Five: The program has been effectively defined in the institution's literature and its mission, goals and policies are appropriate to a program of cooperative education, as defined in the *ACCE Attributes of Cooperative Education Programs* (ACCE, 2004a, para. 2-10).

Definition of a Co-Op

Many people confuse co-ops and internships. To assist with the clarity of the definition of cooperative education, differences between the two are highlighted. Although co-ops and internships both serve the purpose of allowing students to relate their educational studies to 'real-world' application, they do differ in many ways. To begin with, internships typically consist of one experience that does not exceed an academic term, and in most cases, an internship is less than one term (Ryder, 1989, p. 3). Cooperative education, on the other hand, can involve multiple work experiences. Also, most internships allow students to engage in practical work, but in some instances, the student merely shadows a professional (p. 3). Students involved in co-ops, however, must engage in practical work. They also differ in their location within the curriculum. Internships typically "are part of a specific course of

study and are supervised by a faculty member” (p. 3). Co-ops are usually “offered throughout the institution ... and the principal responsibility for administering the program belongs to a professional staff” (p. 3). Furthermore, internships are “most often capstone experiences within the curriculum” (p. 3). Co-ops, on the other hand, begin earlier in the student’s academic career. Lastly, they may differ monetarily. Co-ops are paid work experiences; whereas, internships may or may not be paid. Ryder (1989) qualifies that these differences between internships and co-ops are typical although some institutions may not differentiate between the two experiences (p. 3).

Table 1.

Co-Op and Internship Comparison

Co-op	Internship
Can include multiple rotations, full academic term	One experience, may not exceed academic term
Must engage in practical work	May engage in practical work, shadow professional
Administered by professional staff	Supervised by a faculty member
Offered throughout institution	Offered as part of a course
Begins earlier in student’s academic career	Capstone experience
Paid	May or may not be paid

Note. Information compiled from Ryder (1989).

Cooperative Education Studies

Researchers documented the many benefits of cooperative education. Wilson and Lyons published the first study on cooperative education and observed that cooperative education improved students' interpersonal relations, assisted with the development of autonomy and self-confidence, increased their ability to apply theory to practice, and provided greater meaning in one's studies (as cited in Wilson, 1987, p. 276). Other researchers also studied benefits that students gained from participating in cooperative education (Baker-Loges & Duckworth, 1991; Kerka, 1989). Baker-Loges and Duckworth (1991) cite two studies that discussed student benefits of cooperative education which are Deighton (1971) and Stadt and Gooch (1977). Baker-Loges and Duckworth observed that Deighton's study discovered advantages of cooperative education, three of which are, "practical application of theory, student motivation is improved," and "higher education becomes financially possible, thus more enticing" (Baker-Loges & Duckworth, 1991, p. 255). "Stadt and Gooch noted that student retention, attendance, and counseling results are improved" (as cited in Baker-Loges & Duckworth, 1991, p. 256). Kerka (1989) discovered benefits to students, to participating institutions, and to employers. Kerka's discovery of student benefits that relate to the current study are "clarification of career goals, increased relevance of learning and motivation for study," (p. 2) "improved self-reliance, self-confidence, responsibility," and "financial assistance for educational expenses" (p. 3). Kerka (1989) cited other researchers such as Siedenberg who admitted that the "quality and quantity of research" regarding co-op's effectiveness had "methodological problems in co-op evaluation such as small

sample size, limitation to one discipline, limited response rate, and failure to control for the effects of grade point average, local unemployment rates, and prior work experiences” (p. 6).

Since cooperative education in higher education historically has been perceived as a powerful training strategy that assists with students’ career development, Van Gyn et al. (1997) attempted to validate its educational value (p. 70). These researchers hoped to discover if students’ participation in a co-op program influenced a change in their academic progress (p. 71). After comparing co-op students to non co-op students, they found significant but small differences existed between the two groups in the post-test (p. 81). Due to the results of this study, the researchers were not able to conclude with a high degree of confidence that cooperative education was more advantageous than a non-cooperative education program (p. 81). However, Van Gyn et al. (1997) maintain “there is sufficient evidence to warrant continued study of the educational efficacy of cooperative education” (p. 82).

Fletcher (1991) cites many research studies assessing co-op outcomes, which can be categorized as personal development, career development, and academic achievement (p. 46). Regarding personal development, she cites one of her earlier studies: “ ‘co-op experience contributes to increased self-confidence and enhanced self-concept... an increase in autonomy...and the development of social maturity and interpersonal skills’ ” (p. 47). She also found that cooperative education relating to career development happened through the construct of vocational maturity (p. 50). Concerning academic achievement, she maintains the effect was

likely correlated to the work experience's influence on coursework relevance and students' increased desire for degree completion since they can visualize their future careers (p. 51). Fletcher asserts that cooperative education does affect academic achievement and retention, and she surmises this change may happen indirectly through an extraneous variable such as self-esteem (p. 52).

In addition to student benefits, educational value, and outcomes of cooperative education, other topics that researchers focus on are assessing cooperative education research studies (Stull et al., 1997; Wilson, 1997). Stull et al. (1997) identified and evaluated potential research topics in cooperative education (p. 30). Fifty-nine cooperative education professionals, who were members of the 1995-1996 CEA Research Committee as well as position holders at national and regional levels, evaluated the importance of 22 research topics (p. 31). The cooperative education professionals ranked these topics as the two most important research topics:

1. Identifies and evaluates the kinds of learning outcomes attained by students who participate in cooperative education programs.
2. Provides quantitative data on the impact of cooperative education participation on recruitment, retention, academic performance, and graduation (time and rate) of students (p. 32).

Also, Wilson (1997) assessed cooperative education research studies in the *Journal of Cooperative Education* from 1986 to 1996. He found that 38% of the 60 studies attempted to answer research questions assessing cooperative education's value to students. Another 22% of studies raised questions assessing cooperative

education's value to graduates (p. 18). The remaining 40% of the studies asked other pertinent research questions, mainly focusing on program development (p. 18). The studies typically compared co-op students to non co-op students. When researchers accepted null hypotheses, indicating no differences existed between the two groups on numerous variables, researchers offered many explanations to what may have caused the results (p. 21). A growing number of studies have demonstrated positive results, which in turn has supplied an increasing body of supportive literature for cooperative education. However, Wilson asserts that explanations have not showed support (p. 21).

Of the 60 reports, only three related to retention and adaptation to university life (Somers, 1986; Carrell & Rowe, 1993; Avenoso & Totoro, 1994). Somers (1986) asserts if cooperative education practitioners can show that co-op experiences significantly improve retention and recruitment, their co-op programs will endure and may possibly garner more financial support (p. 73). After analyzing a small, Christian, liberal arts college in Massachusetts, he found that the cooperative education program drew students, and that co-op students were more likely to graduate than non co-op students (p. 73). In fact, he found 75% of the co-op participants graduated while only 65% of non-co-op students graduated (p. 77). Although Somers admits that co-op does not cause higher graduation rates, cooperative education studies - including his - suggest a strong correlation (p. 78). Carrell and Rowe (1993) examined cooperative education's effect on students' adjustment to university life and compared this adaptation of co-op students to non co-op students (p. 34). They discovered co-op students were better adjusted socially

and were more closely connected to the university than non co-op students (p. 37). Researchers argue that students who choose to co-op may have different personal characteristics than students who do not choose to co-op. As a result, this variable may be the reason co-op students have better outcomes. However, Carrell and Rowe found no differences between co-op and regular first year students on variables such as academic adjustment, social adjustment, personal-emotional adjustment, or attachment to their university (p. 39). These similarities between the two groups of students reinforce that overall differences were not due to initial academic and social differences (p. 39).

Similar to the present study is Avenoso and Totoro's (1994) study. They researched whether students who participated in co-op experiences as freshmen and sophomores had a higher rate of retention through their junior year than students who did not participate in the co-op program (p. 8). They found a statistically significant difference between retention rates of co-op and non co-op students after the first year, which suggested a relationship existed between co-op and retention at the college being studied (p. 10). Similar to Carrell and Rowe's (1993) study, students' academic profiles at the beginning of their college careers were not significantly different between co-op and non co-op students (p. 9). This finding is important because, again, researchers debate whether academically gifted students are more likely to choose to participate in cooperative education; whereas, academically weaker students are more likely to drop out of school (p. 9).

In the cooperative education research literature, very few studies have connected co-ops as a means of retaining students.

Retention Literature

Retention is an extensively researched topic in higher education. Regarding retention and student departure, Tinto, a leading researcher on this topic, initially formulated his theory in 1975 and has revised it twice in 1987 and 1993 (Braxton, Shaw-Sullivan et al., 1997, p. 110). Tinto (1993) hypothesized that students enter higher education with individual characteristics that affect student departure decisions, as well as their initial commitment to the college and to the goal of graduation (Braxton, Shaw-Sullivan et al., 1997, p. 111). Initial commitment to the institution and to the goal of college graduation then, in turn, affects academic and social integration (p. 111). Since higher education institutions contain both academic and social systems, student experiences in each system may contribute to different reasons for students departing institutions (Tinto, 1993, p. 107). Integration or membership in one system may not represent the same level of integration in the other system (p. 107). However, academic and social integration affect commitment to the institution and to the goal of graduation differently. Braxton, Shaw-Sullivan et al., (1997) summarized these relationships in Tinto's theory:

The greater the student's level of academic integration, the greater the level of subsequent commitment to the goal of college graduation.

Moreover, the greater the student's level of social integration, the greater the level of subsequent commitment to the focal college or university. ...

In turn, the greater the levels of both subsequent institutional commitment and commitment to the goal of college graduation the greater the likelihood the individual will persist in college (p. 111).

Tinto also asserted that individuals pass through rites of passage which occur in three stages: separation, transition, and incorporation (Bean, 1990, p. 154). He proposed that students leave higher education institutions when their rites of passage are incomplete (p. 154).

Many researchers studying student departure elaborated on Tinto's theory. Studies focused on student perceptions and attributes (Nordquist, 1993; Woosley, 2003; Christie & Dinham, 1991; Liu & Liu, 2000; Pritchard & Wilson, 2003; Perry et al., 1999). For example, Nordquist (1993) researched how students described their college experiences and the reasons why they left college. She discovered that these students described their "eventual departure either in terms of isolation or incongruence" (p. 27). She also found that preenrollment characteristics such as gender and family background played a more significant role in student departure than initially considered. Peer interaction had a less significant effect on retention than student-faculty interaction and faculty-student mentoring (p. 27). Unlike Tinto's theory, she found that students perceived the faculty mentoring relationship in terms of quality of interaction and not quantity (p. 16). Woosley (2003) examined whether college students' experiences during the first few weeks of college could be associated with graduating (p. 201). She included three types of initial experiences: employment, social adjustment, and academic adjustment (p. 201). Initial social adjustment was significantly related with the probability of graduating (p. 202). She

suggests higher education practitioners should support social activities and be cognizant of students' social adjustment from the first day of college (p. 201). Also using Tinto's model of college student departure, Christie and Dinham (1991) examined student perceptions of the circumstances influencing persistence decisions (p. 414). They found similar patterns of student experiences affecting social integration, both within the social environment of the institution (institutional experiences) and outside the social environment of the institution (external experiences) (p. 418). Ultimately, these researchers discovered that external experiences heavily influenced student social integration and that Tinto's model should extend to include external experiences in the same way as institutional experiences when analyzing social integration of freshmen (p. 433).

Liu and Liu (2000) also referred to Tinto's theory and investigated "the impact of social and academic integration on student satisfaction and retention" (p. 3). After assessing six variables, they concluded that academic integration, social integration, and academic performances had positive influences on student satisfaction (p. 13), whereas, academic integration, academic performance, and student satisfaction influenced student retention (p. 15). In this study Tinto's theory was partially confirmed: social integration "failed to be significant in the student's decision to stay" (p. 16). Instead of using traditional student demographic and academic variables, Pritchard and Wilson (2003) assessed whether student emotional and social health related to academic success and retention (p. 20). They found that, in fact, these factors did relate to student performance and retention. Regardless of gender, a student's emotional health was significantly associated with grade point average

(GPA) and a student's emotional health related to his or her intention to quit school (p. 25). Perry et al., (1999) researched traditional-aged freshmen's role of career maturity on college persistence (p. 41). Although career maturity did not exert direct effects on persistence, it was positively associated with numerous variables related to college persistence, such as GPA, encouragement, faculty contact, and integration (p. 41).

Other researchers correlate faculty teaching skills and methods to student retention (Braxton, Milem et al., 2000; Braxton, Bray, & Berger, 2000). Based on Tinto's hypothesis that social integration must occur in the classroom since it acts as a gateway for student participation in the academic and social communities of college, Braxton, Milem et al. (2000) assessed active learning's influence on college student departure. They researched the influence of class discussions, knowledge-level examination questions, group work, and higher-order thinking activities on social integration, subsequent institutional commitment, and student departure decisions (p. 572). The researchers found that class discussions and higher order thinking activities positively influenced social integration and that class discussions also positively influenced subsequent institutional commitment and persistence. Furthermore, social integration and subsequent institutional commitment exerted a positive influence on student decisions to persist in their chosen higher education institution (p. 580). Also based on Tinto's theory, Braxton, Bray et al. (2000) examined whether faculty teaching skills affected students' social integration, subsequent institutional commitment, and departure decisions (p. 217). Their findings demonstrated that faculty teaching skills significantly influenced student

persistence (p. 215). Faculty organization and class preparedness were found to be significant (p. 220). In other words, the more students believed their instructors possessed and executed these active teaching skills, “the more likely these same students were to become socially integrated, to feel committed to the institution, and to intend to reenroll” (p. 222).

Some researchers focused on university attributes and out-of-class experiences (Berger & Braxton, 1998; Kuh, 1996). Revising Tinto’s theory, Berger and Braxton (1998) estimated “the effects of organizational attributes on social integration in particular, and more generally on the student withdrawal process” (p. 103). Based on their findings, these researchers assert that organizational attributes may be a possible avenue for social integration (p. 116). For the institution they studied, the results indicated that students were more likely to desire to persist if they felt as if social rules and policies were conveyed clearly and enforced fairly and if they could voice their opinion and make decisions about the institution’s social rules (p. 117). Kuh (1996) investigated the impact of extracurricular experiences on college attendance outcomes that students considered valuable (p. 101). From student interviews, he found 14 categories of learning and personal development which were then reduced to five outcome domains: personal competence, cognitive complexity, knowledge and academic skills, practical competence, and altruism and estheticism (p. 101). Based on student thoughts, Kuh concluded that extracurricular experiences contributed significantly to student learning and personal development (p. 118). Acquisition of knowledge and academic skills were associated more with classroom, laboratory, and studio activities than with extracurricular activities

(p. 118). Also, student background characteristics were not associated with learning (p. 119). Personal development outcomes students considered influential and the kind of institution students attended were associated with the number of times they mentioned certain outcomes (p. 119).

Other researchers offer suggestions on how to facilitate retention of students (Braxton & Mundy, 2001-2002; Terenzini et al., 1996). Citing numerous researchers studying retention, Braxton and Mundy (2001-2002) provide 47 practical and valuable recommendations to reduce college student departure. They classified these recommendations based on Tinto's three principles:

1. Effective retention programs are committed to the students they serve.
2. Effective retention programs are first and foremost committed to the education of all, not just some, of their students.
3. Effective retention programs are committed to the development of supportive social and educational communities in which all students are integrated as competent members (pp. 96–100).

Terenzini et al. (1996) examined the people, experiences, and themes through which students progress to become or do not become members of the academic and social communities at their college (p. 54). With the themes discovered during student interviews, Terenzini et al. offered suggestions for faculty members, administrators, and institutional researchers to facilitate students' transitions, which in turn are connected to persistence:

1. Promote awareness of the varying character of the transition process for different kinds of students.

2. Early validation appears to be a central element in students' successful transition to college.
3. Involve faculty members in new student orientation programs.
4. Orient parents as well as students.
5. The transition to college involves both in- and out-of-class experiences.
6. Institutional accommodations are required.
7. Somebody has to care (pp. 62-64).

Bean (1990) proposed another theory relating to student retention. His basic assumption is that student attrition is comparable to turnover in the workplace (Bean, 1990, p. 151). In fact, he developed his theory after reviewing studies of turnover in work organizations (p. 151). His causal model of student attrition is a “complex, longitudinal process that begins with the background” variables of students (p. 154). Students interact with the institution on different levels: organizationally, academically, and socially (p. 154). Students also have environmental pulls that influence them to remain in or to leave school. Organizational variables, academic integration, and social integration shape students' attitudes about the institution. Their attitudes “affect institutional fit and loyalty – both potent predictors of continued enrollment” (p. 154). These newly developed attitudes directly influence students' intent to leave and the decisions they reach to leave or to stay in school (p. 154).

Another prominent theorist, Astin, attempts to explain student retention. Astin (1999) developed a simple developmental theory termed the *student involvement theory*. This theory encompasses “empirical knowledge about environmental influences on student development that researchers have gained over the years”

(Astin, 1999, p. 518). Furthermore, Astin espouses his theory can be utilized by researchers, college administrators, and faculty. This theory is based on five postulates:

1. Involvement refers to the investment of physical and psychological energy in various objects.
2. Involvement occurs along a continuum.
3. Involvement has both quantitative and qualitative features.
4. Amount of student learning and personal development associated with any educational program is directly proportional to the quality and quantity of student involvement in that program.
5. The effectiveness of any educational policy or practice is directly related to the capacity of that policy or practice to increase student involvement (p. 519).

He asserts that his theory connects variables in traditional pedagogical theories such as the subject-matter theory, the resource theory, and the individualized theory to learning outcomes wanted by the student as well as by the professor (p. 522). Astin focuses on behavioral mechanisms or processes that promote student development (p. 522) and has studied the outcomes of various types of student involvement: housing, honors programs, undergraduate research participation, social fraternities and sororities, academic involvement, student-faculty interaction, athletic involvement, and student government involvement (p. 524).

Milem and Berger (1997) tested a conceptual model of student persistence employing behavioral constructs from Astin's theory to better understand Tinto's

theory of student departure (p. 387). Based on their findings, they propose to use an integrated model where student behaviors and perceptions affect the development of student academic and social integration (p. 387). They discovered three principal findings: student interaction with faculty both in and out of the classroom positively influenced different cognitive and affective outcomes and early participation in the fall predicted participation during the spring (p. 396). Finally, social integration, not academic integration, served as a “significant positive predictor of institutional commitment ... and intent to reenroll” (p. 397).

Cabrera, Nora, and Castaneda (1992) propose a financial model of student retention. Since Tinto’s (1993) student integration model does not address the role finances play once students enroll and previous “research designs typically have not theoretically examined or tested the causal relationships among finance factors, student characteristics and integration and commitment factors” (p. 572), Cabrera et al. (1992) propose a causal model influenced by several theoretical frameworks. From testing their model, they assert “financial aid, and its concomitant attitude, is important ...because it equalizes opportunities between affluent and low-income students” (p. 571). Financial aid also helps students assimilate into the academic and social communities of the college and influence their decision to remain in college (p. 571).

Other theorists, Chickering and Reisser (1993), hypothesize seven key factors for encouraging student development, three of which relate to other researchers’ findings regarding student retention (Braxton, Milem et al., 2000; Braxton, Bray et

al., 2000; Astin, 1999; Milem & Berger, 1997) and can be connected to the characteristics of cooperative education:

1. When student-faculty interaction is frequent and friendly and when it occurs in diverse situations calling for varied roles and relationships, development of intellectual competence, sense of competence, autonomy and interdependence, purpose, and integrity are encouraged.
2. An educationally powerful curriculum encourages the development of intellectual and interpersonal competence, sense of competence, identity, purpose, and integrity.
3. When teaching calls for active learning, encourages student-faculty contact and cooperation among students, gives prompt feedback, emphasizes time on task and high expectations, and respects diverse talents and ways of knowing, the following qualities are fostered: intellectual and interpersonal competence, sense of competence, mature interpersonal relationships, autonomy, identity, and purpose (pp 198-199).

They also assert that three other principles influence these seven factors, one of which also reinforces the relationship between student retention and cooperative education: “integrate work and learning” (Chickering & Reisser, 1993, p. 204).

Moxley, Najor-Durack, and Dumbrigue’s (2001) book, *Keeping Students in Higher Education: Successful Practices and Strategies for Retention*, is the only book that mentions cooperative education in connection with retention. These authors provide many examples and strategies to foster retention but only include cooperative education in a small section named “Vocational, Professional, and

Career Development”. At least these authors acknowledge that combining work and academic experiences afford students the opportunity to realize life and career options, connecting their present experience to future possibilities (p. 126). They claim work experiences related to academic interest may be the motivating factor for students to persevere to graduation (p. 126). Furthermore, integrating ‘real-world’ work experiences and academic work may assist students’ evaluation if they match with the career they are considering (p. 126).

Porter (1990) utilized the “*High School and Beyond* study, a national survey of 28,000 1980 high school seniors developed by the U.S. Department of Education’s National Center for Educational Statistics” as the database in his persistence study (p. vii). Three of his findings relate to the current study:

1. The greatest enrollment loss occurred during the first year and after the eighth semester.
2. Both socioeconomic status and academic ability influence persistence.
3. The cumulative effect of socioeconomic status and ability, as illustrated by the persistence of high-ability/low-socioeconomic-status (HA/LSES) students, is greater than the influence of either factor by itself (p. viii).

Seymour and Hewitt (1997) studied why science, math, and engineering (SME) students were leaving their majors. Forty percent to 60% of gifted students leave science, math, and engineering majors within two years of completing their first science or mathematics course in college (p. 391). They claim that students leave because of “problems which arise from the structure of the educational experience and the culture of the discipline” not because of students’ inabilities or

because of attractiveness of other majors (p. 392). Two groups of students emerged: the “more pulled than pushed” and the “more pushed than pulled” (p. 392). “The first group includes very able, often multi-talented, students who have a strong interest in science and mathematics and would have stayed had the teaching been more stimulating and the curricula more imaginative” (p. 392). The second group of students was discouraged by poor teaching practices (p. 392). Although these students would prefer to stay in the sciences, they chose other majors which they regarded as a poor compromise (p. 392). The process to leave usually began with poor experiences in their math and science classes during freshman year and the realization of not being prepared adequately (p. 393). Then, academic difficulties and disappointments repeatedly occurred that triggered animosity towards particular faculty, advisors, or teaching assistants (p. 393). They also began to experience self-doubt and considered switching to non-science and math classes where they received better instruction and/or enjoyed their academic work more (p. 393).

Relating to different curricula and faculty interaction, Carrell and Rowe (1993) found a similar finding: “a significant faculty effect: arts students were better adapted to university life than were students in mathematics and science” (p. 39). Ironically, Seymour and Hewitt (1997) did not mention cooperative education in their study or as a solution to retain students, especially since cooperative education has historically been heavily utilized in the science and engineering disciplines. Furthermore, financial aid predicted drop-out rates. In fact, students, regardless of race or ethnicity, who did not secure grants had the highest drop-out rates (p. 10).

This finding can be associated with Cabrera et al.'s (1992) theory in which they assert financial aid influences students' decision to persist in college.

Cooperative Education and Retention Literature Summary

Although cooperative education has been incorporated into higher education since 1906, limited research has been conducted connecting cooperative education and retention. A substantial amount of research has been conducted on student departure and retention. In these student persistence theories and studies, cooperative education is not mentioned as a means of retaining students. Furthermore, Stull et al. (1997) found that student retention is one of the most important research topics to cooperative education professionals. Researchers have noted that almost 30% of students leave higher education institutions after their freshmen year (Braxton, Milem, et al., 2000, p. 569). Students may feel disconnected or uncommitted to the university (Tinto, 1993) or may feel isolated (Nordquist, 1993). In addition to institutional experiences, external experiences influence their social integration which relates to student retention (Christie & Dinham, 1991). Students' career maturity can be associated with student retention (Perry et al., 1999). Furthermore, active learning inside the classroom (Braxton, Milem, et al., 2000), experiences beyond the classroom (Kuh, 1996), and interaction with faculty (Milem & Berger, 1997) influence retention. Finally, financial aid affects student persistence (Cabrera et al., 1992).

Dealing with cooperative education research, students are able to connect theory and practice through their 'real-world' work experiences and provide greater meaning to their studies (Tyler, 1978). Students' motivation to study and ability to

attend college because of paid work experiences are benefits of cooperative education (Baker-Loges & Duckworth, 1991; Kerka, 1989). Cooperative education also has been found to increase students' self-confidence and self-concept and to assist with development of students' maturity and interpersonal skills (Fletcher, 1991). Co-op students seem better adjusted socially and seem more connected to the university than non co-op students (Carrell & Rowe, 1993). Avenoso and Totoro (1994) found that students who participated in a co-op during their freshman and sophomore years had a higher rate of retention than non co-op students. Co-op students are more likely to graduate than non co-op students (Somers, 1986). These student retention theories and cooperative education benefits are related but have not been thoroughly addressed in the research.

These studies, except for Avenoso and Totoro (1994), do not address students completing a co-op, especially after their freshman year. Also, these studies do not focus solely on SME students, which Seymour and Hewitt (1997) assert 40% to 60% of these students leave their majors. The present study focused on SME students who participated in cooperative education compared to SME students who did not. This study investigated the relationship of participating in a co-op after freshman year and retention. This study also examined the relationship between participating in a co-op after freshman year and graduation. This study researched the relationship of participating in a co-op later in college and graduation. Lastly, the researcher compared graduation rates of SME students who participated in a co-op after freshman year to SME students who participated in a co-op later in their college careers.

Conceptual Framework

The researcher did not use one particular framework or theory but a combination of ideas from several research studies and theories. After reviewing cooperative education and retention literature, certain ideas and variables were repeated and related to this study. Cooperative education studies typically compare co-op students to non co-op students. Studies have shown a relationship between co-op and retention rates as well as graduation rates (Van Gyn et al., 1997; Somers, 1986; Stadt & Gooch cited in Baker-Loges & Duckworth, 1991). The time of a co-op was also studied. Retention literature demonstrates that college students drop out at a rate of about 30% after their freshman year; a focus on participation in a co-op after freshman year was important to decreasing drop out rates. Avenoso and Totoro (1994) are the only researchers who studied students who participated in a co-op during freshman and sophomore years, and they found these students had a higher rate of retention. This researcher was also interested to observe if students participating in a co-op earlier in their college careers revealed any significant differences in their graduation rates.

The primary goal of the research was to analyze participation in a co-op program, thus other variables were excluded such as high school GPA, SAT verbal score, SAT math score, gender, and ethnicity so their influence would not confound the findings. For example, critics of cooperative education assert that brighter students choose to participate in a co-op. However, studies have shown that initial academic profiles and adjustment are not significantly different between co-op participants and non co-op participants (Avenoso & Totoro, 1994; Carrell & Rowe,

1993). The researcher also intended to exclude the influence of gender and ethnicity so the relationship between participation in a co-op and retention or graduation rates could be determined. As a result, the researcher controlled for gender, ethnicity, SAT verbal scores, SAT math scores, and high school GPA.

Figure 1. *Model for Research Questions 1 and 2*

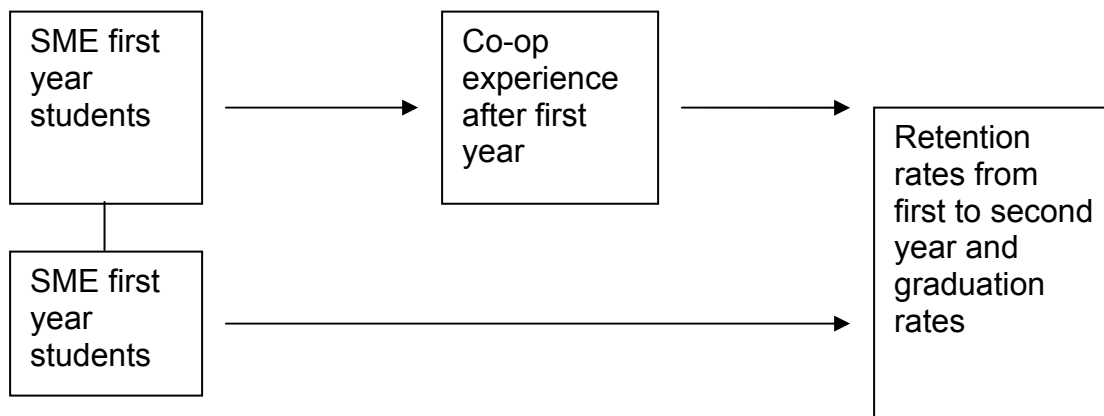
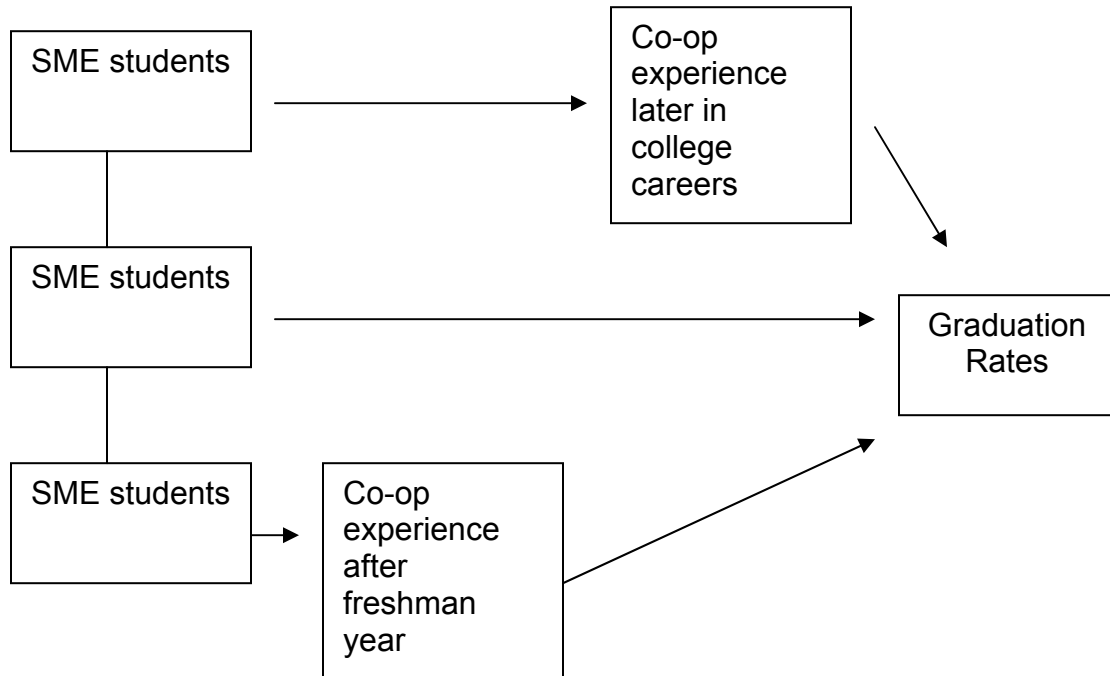


Figure 2. *Model for Research Questions 3 and 4*



Research Questions

As an outgrowth of the literature review and conceptual framework, this study will address four research questions:

1. Do SME students who participated in a co-op after their freshman year have significantly different retention rates relative to SME students who did not participate in a co-op?
2. Do SME students who participated in a co-op after their freshman year have significantly different graduation rates relative to SME students who did not participate in a co-op?
3. Do SME students who participated in a co-op later in their college careers have significantly different graduation rates relative to SME students who did not participate in a co-op?
4. Do SME students who participated in a co-op after their freshman year have significantly different graduation rates relative to SME students who participated in a co-op later in their college careers?

Chapter III.

Method

Research Study Site

The site of this study was a large public, land-grant research university in the southern United States. The undergraduate enrollment was roughly 20,000 students. In the public university system of this state, the university being studied was historically considered the leading engineering and agricultural university, thus a primary draw for science, math, and engineering (SME) students. Another engineering and agricultural university also existed in this state with an undergraduate enrollment of about 9,000 students. The researcher contacted the Institutional Review Board (IRB) to determine if the university's name should be disclosed. The IRB left the decision of anonymity to the researcher.

At the institution being studied, a university office called Cooperative Education Program existed. This office monitored students' cooperative education experiences. The Accreditation Council for Cooperative Education accredited the university's co-op program.

Co-op students in the university being studied must fulfill program entry requirements: "full-time enrollment during the semester prior to first work term, completion of at least two semesters..., minimum grade point average (GPA) of 2.25..., and attendance at a cooperative education orientation meeting" (NC State University Cooperative Education Office, 2004, para. 1). The university considered

the student enrolled when s/he was completing his/her co-op. After students finished their co-op, they returned to the university and continued to take classes.

The tables that follow illustrate selected retention and graduation rates of students for the university being studied. The university did not collect data on students that the researcher considered SME as one group, nor was there a convenient way of sorting students in colleges that had both SME and non-SME majors. Therefore, the researcher included in Table 2 and Table 3 the College of Engineering and the College of Physical and Mathematical Sciences as groups representative of SME majors. The years selected were those that consisted of the most recent, complete data available. Interestingly, the retention rates were higher than reported in Seymour and Hewitt's (1997) national study.

Table 2. *Retention Rates*

	Year	Percentage after first year	Percentage after second year
All University Freshmen	2000	88.5	81.9
College of Engineering	2000	90.8	85.6
College of Physical and Mathematical Sciences	2000	87.8	84.6

Note. Retention rate defined by the University Planning and Analysis office is the percentage of students in each cohort who return to the university each year.

Source: University Planning and Analysis Office.

Table 3. *Graduation Rates*

	Year	Percentage after four years	Percentage after five years	Percentage after six years
All University Freshmen	1996	27.5	57.4	63.8
College of Engineering	1996	23.7	59.8	68.4
College of Physical and Mathematical Sciences	1996	38.4	64.6	68.7

Note. Graduation Rate defined by the University Planning and Analysis office is the percentage of students in each cohort who graduate each year.

Source: University Planning and Analysis Office.

Population

This study used secondary data from the university's student database. The researcher selected participants using longitudinal data from the university's 1997 and 1998 freshmen cohorts. The researcher chose the 1997 and 1998 freshmen cohorts to ensure a large enough number of students who participated in cooperative education after their freshmen year to satisfy the chi-square test assumption. Also, students who entered the university as freshmen in 1997 and 1998 had six and seven years to graduate, which the researcher thought seemed an appropriate amount of time for determining graduation rates. The University Planning and Analysis office maintained a historical database of all university students. The Cooperative Education office managed a more detailed database of all current and past cooperative education students.

The researcher, with assistance from University Planning and Analysis, chose majors considered to be science, math, or engineering (SME) and only included these students in the research database. (Refer to Appendix A for a complete listing

of SME majors.) The cooperative education information, such as co-op participation and time of co-op, was matched to the university database by student identification numbers. All information about SME students was consolidated into one database in an Excel spreadsheet. The population of SME students who entered the university in 1997 and 1998 was 4,311 students. Of those students, 461 students completed a co-op and 3,850 students did not.

The following information was extracted from the university student database on SME students:

- cohort year
- gender
- ethnicity
- high school GPA
- SAT verbal
- SAT math
- co-op participation
- semester the student first participated in a co-op
- year the student first participated in a co-op
- hours passed when student first participated in a co-op
- enrollment status after sophomore year
- GPA after sophomore year
- final cumulative GPA
- final cumulative hours
- final enrollment status

- semester of final status
- year of final status.

The final dataset received from University Planning and Analysis was void of student identification numbers. Since the dataset did not have a column categorizing students as retained, the researcher created a retained variable to satisfy the first research question. The definition of retention in this research study was students who returned to the university after completing a co-op after their freshman year. Therefore, students who were retained would still be enrolled after their sophomore year. The researcher reviewed students' enrollment status after sophomore year. The university classified students as enrolled (E.), suspended (S.), withdrawn (W.), or graduated (G.). If students were enrolled after sophomore year (E.), then the researcher placed a yes in the added column labeled retained. If the students were not enrolled after sophomore year (S. or W.), then the researcher placed a no.

The researcher constructed a second variable, co-op after freshman year. The researcher reviewed when the students entered the university (cohort year) and when they first participated in a co-op. She defined students who entered the university in 1997 and who participated in a co-op summer or fall 1998 as participating in a co-op after freshman year. She also defined students who entered the university in 1998 and participated in a co-op in summer or fall 1999 as participating in a co-op after freshman year. The researcher placed a yes in this column for these students. The total number of students who participated in a co-op after freshman year was 29.

The researcher then separated the data so the statistical program, SAS® System for Windows, could analyze the four research questions. For research questions one and two, the researcher created a dataset to include students who had participated in a co-op during freshman year and those who had never participated in a co-op. For research question three, she created another dataset to include students who participated in a co-op later in their college careers and those who did not participate in a co-op. Finally, she created a third dataset for research question four and only included students who participated in a co-op after their freshman year and those who participated in a co-op later in their college careers.

Variables and Their Definitions

After reviewing retention and cooperative education research literature, variables in this study were similar to those in other studies.

Research Variables – These variables were addressed in the four research questions.

- Co-op – time of co-op; semester and year
- Retention Rate – percentage of students who returned to the university after their co-op experience after freshman year
- Graduation Rate – percentage of all cohorts that successfully graduated
- Student Classification at Time of Co-op – freshman or later in college careers

Control Variables – These variables were used as controls so their influence on the research variables would not obscure the findings. Also, research studies highlighted in the review of literature excluded these variables so this research was in accordance with others on retention and cooperative education.

- Gender – female or male
- Ethnicity – White, African American, Native American, Asian, Hispanic, International
- GPA – high school cumulative
- SAT Score – verbal, math

Originally, the researcher classified students by freshman, sophomore, junior, or senior based on the number of credit hours defined by the university. However, the researcher had to modify this classification system because the university database did not include credit hours that students acquired at community colleges or other universities. The credit hours were not accurate, thus the researcher could not decipher students' classification based on credit hours. The researcher, however, could decipher students who participated in a co-op after their freshman year by reviewing their cohort year, co-op participation, and the semester and the year they first participated in a co-op. To compare older students for research questions three and four, the researcher defined *later in college careers* to include students who participated in a co-op anytime during or after their second semester of sophomore year.

Statistical Analysis and Procedure

The researcher created summary statistics to examine outliers or other problems with the data as well as to provide more detailed information about the data. The researcher then analyzed all four research questions using a chi-square test for independence or a Fisher's exact test to determine if a relationship existed between two variables in a two-dimensional contingency table.

The assumptions of a chi-square test are each observation belongs to only one cell of the contingency table and expected values are five or more for each cell (Agresti & Finlay, 1997, p. 258). The researcher expected that due to the large number of students involved, this assumption was valid. However, in the event that a particular contingency table resulted in expected values of less than five per cell, the researcher used Fisher's exact test (p. 265). In this test of hypothesis, the assumptions are the same as the chi-square test for independence, but it does not have the condition that the expected cell counts exceed five.

Chi-square tests (or Fisher's exact test) were used to examine the relationship between the response and explanatory variables. To further determine this relationship, the researcher used logistic regression to examine the possible influence of extraneous variables on the relationship between explanatory and response variables. The explanatory variable was co-op participation, and the response variables were retention and graduation. Extraneous variables included gender, ethnicity, high school GPA, SAT verbal score, and SAT math score. The logistic regression procedure considered the relationship of the explanatory and response variables conditional on the extraneous variables, thus controlling for their

influence. As a result, the researcher could determine what variables were significantly associated with cooperative education.

Tests of hypothesis and summary statistics were calculated using the SAS® System for Windows. The researcher designated a p-value of less than .05 as significant.

Chapter IV.

Findings

Summary Statistics

The researcher corrected outliers before conducting statistical tests.

Summary statistics are included in text and tables.

Co-Op Participation

Of the 4,311 students defined as SME majors in the 1997 and 1998 freshmen cohorts, 461 students participated in cooperative education and 3850 students did not. In other words, 11% of SME students completed a co-op and 89% of SME students did not.

Regarding gender, more males enrolled in SME majors and more males participated in a cooperative education experience than females. Six percent of females and 13% of males participated in a cooperative education experience.

Table 4. *Gender*

Gender	Co-op	Non Co-op	Total	Percentage of Each Gender Who Participated in a Co-op
Females	96	1,454	1,550	6
Males	365	2,396	2,761	13

Five of the six ethnic groups participated in cooperative education from the 1997 and 1998 freshmen cohorts: White, African American, Native American, Asian, and Hispanic students. When comparing students in each ethnic group, Asian students had the highest participation rate in cooperative education.

Table 5. *Ethnicity*

Ethnicity	Co-op	Non Co-op	Total	Percentage of Each Ethnic Group Who Participated in a Co-op
1. White	375	3,173	3,548	11
2. African American	30	409	439	7
3. Native American	2	30	32	6
4. Asian	49	175	224	22
5. Hispanic	5	63	68	7

Co-Op Participation with Quantitative Extraneous Variables

The researcher compared high school GPAs of students who participated in a co-op to those who did not. The mean high school GPA for co-op students was 4.02, whereas, it was 3.86 for non co-op students. Students who completed a co-op after freshman year had a mean high school GPA of 4.05, and students who participated in a co-op later in their college careers had a mean GPA of 4.01.

When reviewing the students' final cumulative GPA at graduation from college, co-op students had a mean GPA of 3.17 and non co-op students had a mean GPA of 2.74. Students who completed a co-op after freshman year had a mean final GPA of 3.20. Students who participated in a co-op later in their college careers had a mean final GPA of 3.17.

When comparing students' SAT verbal score, co-op students had a mean score of 582 and non co-op students had a mean score of 577. Students who

completed a co-op after freshman year had a mean score of 612, and students who participated in a co-op later in their college careers had a mean score of 580.

When reviewing students' SAT math score, co-op students had a mean score of 638 and non co-op students had a mean score of 606. Students who completed a co-op after freshman year had a mean score of 661. Students who participated in a co-op later in their college careers had a mean score of 637.

Retention

Retention was defined in this study as students returning to the university after completing a co-op after freshman year. Of the SME students who completed a co-op, 100% returned to the university. Of the students who did not complete a co-op, 81% of students returned to the university second semester sophomore year.

Table 6. *Retention Rate*

	Yes	No	Total	Retention Rate of Each Group after Sophomore Year
Co-op	29	0	29	100%
Non Co-op	3,115	735	3,850	81%

Graduation

Students who completed a co-op had a higher graduation rate than students who did not complete a co-op. Ninety-three percent of students who participated in a co-op graduated; whereas, only 67% of students who did not participate in a co-op graduated.

Table 7. *Graduation Rate*

	Yes	No	Total	Graduation Rate
Co-op	430	31	461	93%
Non Co-op	2,568	1,282	3,850	67%

Students who completed a co-op after freshman year had a 90% graduation rate, and non co-op students had a 67% graduation rate.

Table 8. *Graduation and Co-Op Participation After Freshman Year*

Graduation	Yes	No	Total	Graduation Rate
Co-op after Freshman Year	26	3	29	90%
Non Co-op	2,568	1,282	3,850	67%

Students who participated in a co-op later in their college careers also had higher graduation rates than students who did not participate in a co-op. Of the students who participated in a co-op later in their college careers, 94% of students graduated; whereas, only 67% of non co-op students graduated.

Table 9. *Graduation and Co-Op Participation Later*

Graduation	Yes	No	Total	Graduation Rate
Co-op Later in College Careers	404	28	432	94%
Non Co-op	2,568	1,282	3,850	67%

Statistical Analysis of Research Questions

After creating summary statistics, the researcher then conducted a chi-square test for independence for each research question. Research question four had expected values of less than five in a cell so the researcher conducted a Fisher's exact test. Next, the researcher conducted logistic regression to determine if the extraneous variables influenced the relationship between the explanatory and response variables. The explanatory variable was participation in a co-op, whether after freshman year or later in college careers, and the response variable was retention or graduation. Extraneous variables were high school GPA, SAT verbal and math scores, gender, and ethnicity. The researcher designated a p-value less than .05 as significant.

Research Question 1. Do SME students who participated in a co-op after their freshman year have significantly different retention rates relative to SME students who did not participate in a co-op?

The researcher conducted a chi-square test for independence. Participating in a co-op after freshman year was significantly associated with retention, $\chi^2(1, N = 3879) = 12.236, p = .0005$. The researcher also conducted logistic regression, which examined the impact of participating in a co-op after freshman year on retention conditional on the extraneous variables. Participation in a co-op after freshman year still significantly impacted retention rates, $\chi^2(1, N = 3879) = 10.82, p = .001$. High school GPA was significantly associated with co-op after freshman year and retention, $\chi^2(1, N = 3879) = 103.8579, p < .0001$. Lastly, SAT

verbal score was also significantly associated with co-op after freshman year and retention, $\chi^2(1, N = 3879) = 7.0242, p = .0080$.

Research Question 2. Do SME students who participated in a co-op after their freshman year have significantly different graduation rates relative to SME students who did not participate in a co-op?

The researcher conducted a chi-square test for independence. Participating in a co-op after freshman year was significantly associated with graduation, $\chi^2(1, N = 3879) = 8.313, p = .0039$. The researcher also conducted logistic regression. Participation in a co-op after freshman year significantly impacted graduation rates, $\chi^2(1, N = 3879) = 4.4382, p = .0351$. High school GPA was also significantly associated with co-op after freshman year and graduation, $\chi^2(1, N = 3879) = 173.4439, p < .0001$. When reviewing the odds ratio, students who participated in a co-op after freshman year are 3.7 times more likely to graduate than students who did not participate in a co-op.

Research Question 3. Do SME students who participated in a co-op later in their college careers have significantly different graduation rates relative to SME students who did not participate in a co-op?

The researcher conducted a chi-square test for independence. Participating in a co-op later in students' college careers was significantly associated with graduation, $\chi^2(1, N = 4282) = 167.088, p < .0001$. After conducting logistic regression, co-op participation later in college careers and graduation were still

significant, $\chi^2(1, N = 4282) = 85.6127, p < .0001$. High school GPA was again significantly associated, $\chi^2(1, N = 4282) = 175.2005, p < .0001$. When reviewing the odds ratio, students who participated in a co-op later in their college careers are 6.4 times more likely to graduate than students who did not participate in a co-op.

Research Question 4. Do SME students who participated in a co-op after their freshman year have significantly different graduation rates relative to SME students who participated in a co-op later in their college careers?

The researcher conducted a Fisher's exact test since the values in a cell were less than five. The results of a two-tail Fisher's exact test demonstrated that time of co-op was not significantly associated with graduation, ($N = 461$) $p = .4324$. After conducting logistic regression, time of co-op and graduation still were not significantly associated given the other variables, $\chi^2(1, N = 461) = .4560, p = .4995$. Gender was significantly associated with time of co-op and graduation, $\chi^2(1, N = 461) = 5.8933, p = .0152$.

Co-Op vs. Non Co-Op

Although a specific research question did not exist comparing co-op students vs. non co-op students, the researcher was interested in investigating this relationship further. To determine the relationship between participation in a co-op and graduation, the researcher also conducted a chi square test for independence with these two variables. Co-op participation was significantly associated with graduation, $\chi^2(1, N = 4311) = 137.2661, p < .0001$. The researcher also conducted logistic

regression to determine if the extraneous variables affected this relationship. Even with logistic regression, co-op participation was significantly associated with graduation, $\chi^2(1, N = 4311) = 89.7673, p < .0001$. High school GPA was also significantly associated with co-op participation and graduation, $\chi^2(1, N = 4311) = 142.1266, p < .0001$. When reviewing the odds ratio, students who participated in a co-op are 6.1 times more likely to graduate than students who did not participate in a co-op.

Chapter V.

Conclusions, Implications, and Recommendations

Student retention is a serious problem in higher education and is a heavily researched topic. Cooperative education, on the other hand, is not heavily researched, but more research could assist with discovering the benefits of cooperative education. However, cooperative education literature would benefit from additional quantitative research examining the relationship between students' participation in co-ops and their retention and graduation rates. Little research has focused on utilizing cooperative education as a means of retention of science, math, and engineering (S.M.E) students, especially after their first year of school. Therefore, this study compared SME students who participated in a co-op to those who did not. This study used secondary data from both the university and cooperative education office student databases. After analyzing four research questions using chi square test for independence, Fisher's exact test, and logistic regression, the researcher found that participation in a co-op was significantly related to retention and graduation. Also, co-op students had higher retention and graduation rates than non co-op students.

Conclusions

Cooperative education in America began in the beginning of the 20th century because one man had a revolutionary idea. Schneider's innovative idea began at the University of Cincinnati, which came to be known as *The Cincinnati Plan*. Cooperative education then spread to numerous institutions across the United

States. Although cooperative education has been used in American universities since the beginning of the 20th century, relatively little research has been conducted regarding the benefits of cooperative education. The decade of the 1960s was significant for cooperative education. After a 2-year study on the benefits of cooperative education, four researchers published findings in 1961. *The National Commission for Cooperative Education* formed and lobbied for financial support from the federal government.

Cooperative education, which combines classroom theories with paid practical experiences, began in engineering disciplines but extended to curricula of many kinds. As a result, cooperative education is in every kind of institution:

public and private, sectarian and nonsectarian, urban and nonurban, large multipurpose universities and small single-purpose colleges, coeducational colleges and all-men or all-women colleges, colleges serving affluent students and colleges serving low-income students, senior colleges and junior colleges. It is among the two-year junior and community colleges ...

(Wilson, 1971, p. 16).

In fact, “there are approximately 600 co-op programs” currently in the United States (University of Cincinnati Cooperative Education Office, 2004, para. 1).

Student retention is a growing concern for higher education; an estimated 30% of students leave after their first year. Student departure is a very researched topic and “is a financial issue that is clearly a high priority for all institutions” (Avenoso & Totoro, 1994, p. 12). Seymour and Hewitt (1997) estimated 40% to 60% of SME students leave their majors within two years. Research addressing the

relationship between retention and cooperative education is necessary to offer new solutions to student retention. “By enhancing one factor – relevance of coursework to career goals – student persistence can be influenced” (Avenoso & Totoro, 1994, p. 12).

For this group of SME students, cooperative education seemed valuable in both retention and graduation. When reviewing the summary statistics, SME students who participated in a co-op after freshman year had higher retention rates: 100% compared to 81% for non co-op students. This finding is similar with Avenoso and Totoro’s research (1994) and Stadt and Gooch (as cited in Baker-Loges & Duckworth, 1991). Co-op students also had a higher graduation rate: 93% compared to 67% for non co-op students. Furthermore, statistical tests demonstrated that participation in a co-op after freshman year was significantly related with retention. Also, participation in a co-op, whether after freshman year or later in college careers, was significantly related with graduation. This finding is in congruence with Somers (1986). Students who participated in a co-op later in their college careers had the highest graduation rate. This finding seems logical because juniors and seniors are more likely to graduate than freshmen.

Regarding the extraneous variables, high school GPA and SAT verbal score were significantly associated with participation in a co-op after freshman year and retention. High school GPA was again significantly associated with participation in a co-op after freshman year and graduation, participation in a co-op later in their college careers and graduation, and participation in a co-op and graduation. Gender was significantly associated with time of co-op, after freshman year or later in

college careers, and graduation. Ethnicity and SAT math score were not significantly associated with the research questions.

Students who participated in a co-op after freshman year had higher high school GPAs and higher SAT verbal and math scores than compared with the other SME students who participated in a co-op later in their college careers and non co-op students. Students who participated in a co-op later in their college careers had higher high school GPAs and higher SAT verbal and math scores than SME students who did not participate in a co-op. These pre-college academic variables were different between co-op and non co-op students. This finding is in conflict with Avenoso and Totoro (1994) and Carrell and Rowe's (1993) results which found that co-op students had similar initial academic profiles than non co-op students. The researcher is skeptical of Avenoso and Totoro (1994) and Carrell and Rowe's (1993) findings regarding the initial academic profiles. The population of students in this study may have had different initial academic profiles than the students in their studies because of their major choices; science, math, and engineering. Nevertheless, the researcher can confidently state due to multiple statistical analyses conducted that although co-op students had higher high school GPAs and SAT scores, participation in a co-op was significantly associated with retention and graduation.

Although student departure or retention research studies do not mention cooperative education as a means of retaining students, many of those ideas and findings may help to explain why participation in cooperative education is significantly related with retention and graduation in this study. Nordquist (1993) and

Milem and Berger (1997) both found that student-faculty interaction and faculty-student mentoring, both in and out of the classroom, positively influenced student retention as well as cognitive and affective outcomes. Also, Chickering and Reisser (1993) hypothesized factors that encouraged student development and also related to retention: one factor being student-faculty interaction which was frequent and friendly and occurs in diverse situations. Students who participate in cooperative education interact with the co-op program director, associate director, and assistant directors. In fact, these directors actually visit students during their cooperative education experiences. Co-op students have another faculty/staff member with whom they form a relationship as well as interact with on campus and off campus during their co-op.

Liu and Liu (2000) found that academic integration, academic performance, and student satisfaction influenced student retention. Cooperative education allows students to connect theory to practice in a 'real world' work setting. Co-op students may become integrated academically because they understand and see the application of their subject matter. In turn, their academic performance may improve in general because their knowledge learned in the classroom is expanded upon in a co-op environment. In this study, co-op students had higher final cumulative college GPAs than non co-op students.

Other researchers and theorists such as Braxton, Milem, et al. (2000) and Chickering and Reisser (1993) focused on active learning: activities such as class discussions, knowledge level examination questions, group work, and higher order thinking activities. Braxton, Milem, et al. (2000) found that active learning positively

influenced institutional commitment and persistence. Chickering and Reisser (1993) hypothesized that an educationally powerful curriculum and active learning encouraged student development. Cooperative education allows students to actively learn their subject matter hands-on in a workplace setting. As a result, their coursework seems to become more relevant.

Cabrera et al. (1992) proposed a financial model of student retention. They theorized that financial aid allows students to remain in college as well as to assimilate into the academic and social communities of the college environment. While researching why SME students were leaving their majors, Seymour and Hewitt (1997) found that a lack of financial aid predicted drop-out rates. Cooperative education seems to be a viable means for students to help fund their college education. A co-op is paid and over a longer period of time than a summer internship, so students are able to earn a substantial amount of money that can be used for college expenses.

Kuh (1996) researched the impact of extracurricular activities on retention and found that extracurricular activities contributed significantly to student learning and personal development. Cooperative education is similar to an extracurricular activity: it is not in an academic classroom or laboratory, it allows students to improve interpersonal relations, it assists with development of autonomy and self-confidence (Wilson, 1987; Fletcher 1991), and it improves self-reliance and responsibility (Kerka, 1989). SME students are responsible for projects and working with others to accomplish goals when working in a co-op. Many extracurricular activities foster

students' personal abilities and provide leadership opportunities much like a cooperative education experience can.

Perry et al. (1999) researched traditional-aged freshmen's role of career maturity on college persistence. They found career maturity was positively associated with many variables related to college persistence such as GPA, faculty contact, and integration. This finding can be connected to the success of SME students who participated in cooperative education after freshman year. These students had higher high school GPAs, SAT scores, and final cumulative GPAs from college. These students may have had more career maturity than students who did not choose to participate in cooperative education.

Implications

Cooperative education was significantly associated with retention and graduation in this study. Although others cannot generalize these findings to their colleges and universities, cooperative education does seem to be a possible means to aid students in remaining in college until graduation. Cooperative education can be used as an additional tool that higher education administrators can employ to not only enrich students' academic experiences in college but also to raise graduation rates.

Co-op opportunities need to be more publicized to all university students, especially to freshman in introductory science, math, and engineering courses. Freshmen students are becoming acclimated to college life and probably are unaware of their possibilities such as cooperative education. Furthermore, cooperative education can help finance students' college education. Since students

earn an income during a cooperative experience, it “has an important value in making higher education possible and attractive to many young people who would not otherwise go to college” (Tyler, 1978, p. 70).

Faculty members teaching introductory courses and advisors need to be aware of the cooperative education program on campus and encourage students to take advantage of this opportunity. Faculty members and advisors should also know whom the contact person is for the cooperative education program and where it is located on campus. Faculty and advisors typically assist students by informing them about on-campus services such as tutoring. They could also use cooperative education as another way to help students succeed, especially students who are struggling academically or financially, students who are unsure of their career choice, and/or students who need academic enrichment.

Many colleges and universities seem to have some type of cooperative education program, but only 11 are accredited by the *Accreditation Council for Cooperative Education*. Leaders of more higher education institutions should investigate adding an official cooperative education program to their campus environment which will provide an organized, approved program for their students. Although cooperative education traditionally has been for engineering students, more liberal arts students are benefiting from the co-op experience.

Recommendations for Research

Further research should include more cohort years and/or more than one university to obtain a higher number of co-op students, both co-ops after freshman year and co-op students in general.

Concerning retention studies, students possibly may participate in a co-op after freshman year more today than they did in 1997 and 1998. More companies such as International Paper, Georgia Pacific, and MeadWestvaco promote co-ops as opposed to summer internships. Additional research could explore more recent student cohorts utilizing similar statistical analyses.

Additional research should address different populations of students such as minorities or females to determine if co-ops are significantly associated with retention and graduation rates. Also, co-ops have traditionally been utilized by engineering students. A study focusing on liberal arts students would be useful to determine if co-ops are significantly associated with retention and graduation for these students as well.

Many retention theorists' ideas and variables have not been connected with cooperative education. A research study comparing the relationship of retention and graduation with other variables such as career maturity as used in Perry et al.'s study (1999), academic integration as used in Liu and Liu (2000), or the amount of financial aid (Cabrera et al., 1992) earned in co-ops would be useful to determine if these variables affect the cooperative education and retention/graduation relationship.

Some researchers such as Van Gyn et al., 1997; Stull et al., 1997; Meade, 1992; and Siedenberg (as quoted in Kerka, 1989) have criticized that cooperative education research literature needs additional, sound quantitative studies. More quantitative research needs to be conducted on the benefits of cooperative education for students.

A mixed methods approach using both quantitative and qualitative methods could also be useful. After analyzing quantitative research including co-op and non co-op students, a researcher could then interview a random sample of students to listen to their thoughts and ideas about the benefits of cooperative education. By conducting a mixed methods approach, a researcher could satisfy the criticisms of others about needing more quantitative research but also expose themes that statistical tests do not reveal.

Ultimately, educators at all levels in higher education need to be aware of the many benefits of cooperative education and the role it plays regarding retention and graduation. Educators can offer students another option to become connected to the university, to their majors, and to subsequent careers.

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Appendix A. Complete Listing of all Majors Considered to be Science, Math, or Engineering at the University Being Studied

Curriculum Title and Degree Type

Aerospace Engineering (Bachelor of Science - BS)
Aerospace Engineering Unmatriculated (BS)
Agricultural & Environmental Technology (BS)
Agronomy – Agronomic Sciences (BS)
Agronomy – Crop Production (BS)
Agronomy – Soil Science (BS)
Agronomy – Turfgrass Management (BS)
Animal Science (Industry) (BS)
Animal Science (Science) (BS)
Applied Mathematics (BS)
Biochemistry (BS)
Biological Engineering (BS)
Biological Engineering – Agricultural Engineering Concentration (BS)
Biological Engineering – Bioprocessing Engineering Concentration (BS)
Biological Engineering – Environmental Engineering Concentration (BS)
Biological Engineering Unmatriculated (BS)
Biological Sciences (BS)
Biological Sciences – Nutrition Concentration (BS)
Biomedical Engineering (BS)
Biomedical Engineering Unmatriculated (BS)
Botany (BS)
Chemical Engineering (BS)
Chemical Engineering – Biomolecular Concentration (BS)
Chemical Engineering – Green Chemistry and Engineering Concentration (BS)
Chemical Engineering – Honors Program (BS)
Chemical Engineering – Nanoscience Concentration (BS)
Chemical Engineering/Textile Engineering Double Major (BS)
Chemical Engineering Unmatriculated (BS)
Chemistry (Bachelor of Art – BA)
Chemistry (BS)
Chemistry – Marine Sciences Concentration (BS)
Civil Engineering (BS)
Civil Engineering Unmatriculated (BS)
Computer Engineering (BS)
Computer Engineering Unmatriculated (BS)
Computer Science (BS)
Computer Science Unmatriculated (BS)
Construction Engineering and Management Unmatriculated (BS)
Construction Engineering and Management General Construction (BS)
Construction Engineering and Management Mechanical Construction (BS)

Electrical Engineering (BS)
Electrical Engineering Unmatriculated (BS)
Engineering Unmatriculated (BS)
Environmental Engineering (BS)
Environmental Engineering Unmatriculated (BS)
Environmental Science – Air Quality (BS)
Environmental Science – Ecology Concentration (BS)
Environmental Science – Economic Policy (BS)
Environmental Science – Environmental Soil Science (BS)
Environmental Science – Geology Concentration (BS)
Environmental Science – Statistics (BS)
Environmental Science – Watershed Hydrology (BS)
Environmental Technology (BS)
Fisheries & Wildlife – Fisheries (BS)
Fisheries & Wildlife – Wildlife (BS)
Fisheries & Wildlife Sciences – Fisheries (BS)
Fisheries & Wildlife Sciences – Wildlife (BS)
Food Science – Science Concentration (BS)
Food Science – Technology (BS)
Forest Management (BS)
Forest Management – Biology (BS)
Forest Management – Business (BS)
Forest Management – Forestry (BS)
Forest Management – International (BS)
Forest Management – Related Fields (BS)
Geology (BA)
Geology (BS)
Geology – Earth Systems History (BA)
Geology – Earth Systems History (BS)
Horticultural Science – Science (BS)
Horticultural Science – Technology, General (BS)
Horticultural Science – Technology, Landscape (BS)
Industrial Engineering (BS)
Industrial Engineering – Furniture Option (BS)
Industrial Engineering Unmatriculated (BS)
Marine Sciences – Chemistry Concentration (BS)
Marine Sciences – Geology Concentration (BS)
Marine Sciences – Meteorology Concentration (BS)
Marine Sciences – Physics Concentration (BS)
Materials Engineering (BS)
Materials Engineering Undesignated (BS)
Materials Science & Engineering (BS)
Materials Science Unmatriculated (BS)
Mathematics (BS)
Mechanical Engineering (BS)
Mechanical Engineering Unmatriculated (BS)

Meteorology (BS)
Meteorology – Marine Science Concentration (BS)
Microbiology (BS)
Natural Resources – Ecosystem (BS)
Natural Resources – Marine & Coastal (BS)
Natural Resources – Soil & Water Systems (BS)
Natural Resources – Soil Resources (BS)
Nuclear Engineering (BS)
Nuclear Engineering Unmatriculated (BS)
Paper Science & Engineering (BS)
Paper Science & Engineering Undesignated (BS)
Physical & Mathematical Sciences Undesignated (BS)
Physics (BA)
Physics (BS)
Poultry Science – Science Concentration (BS)
Poultry Science – Technology Concentration (BS)
Pre-Medical/Pre-Dental Advising Option
Pre-Veterinary Requirements
Statistics (BS)
Textile Chemistry – ACS Certified (BS)
Textile Chemistry – Science & Operations Concentration (BS)
Textile Engineering – Chemical Processing (BS)
Textile Engineering – Information Systems (BS)
Textile Engineering – Machine Design (BS)
Textile Engineering – Product Engineering (BS)
Textile Engineering Undesignated (BS)
Textile Technology (BS)
Undeclared Textiles (BS)
Undeclared Natural Resources (BS)
Wood Products (BS)
Wood Products – Business Management Concentration (BS)
Wood Products – Manufacturing Concentration (BS)
Zoology (BS)