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Relationships among learning community participation, student self-efficacy, confidence, outcome expectations, and commitment

Karen Ann Zunkel
Iowa State University

Relationships among learning community participation, student self-efficacy, confidence, outcome expectations, and commitment

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Karen Ann Zunkel

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Program of Study Committee:
Larry Ebbers, Major Professor
Virginia Arthur
Doug Jacobson
Howard Shapiro
Mack Shelley

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Karen Ann Zunkel

has met the dissertation requirements of Iowa State University.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER I: INTRODUCTION

> Universities are communities of learners, whether those learners are astrophysicists examining matter in the far reaches of space or freshmen new to an expanded universe of learning. The shared goals of investigation and discovery should bind together the disparate elements to create a sense of wholeness... Large universities must find ways to create a sense of place and to help students develop small communities within the larger whole (Boyer Commission, 1998, pp. 17 and 34).

When identifying key actions needed to be taken by research institutions to reinvent and improve the undergraduate educational experience, The Boyer Commission on Educating Undergraduates in the Research University cited the need to develop a sense of community and shared learning within institutions. To increase student success and learning, the report cites the need to develop learning communities for students. The report also stresses that all members of the institution are participants in the learning process. Faculty, staff, researchers, and students must work together to enhance the learning process. Therefore as active participants in the learning process, faculty and staff must continually research programs associated with the learning process with the goal of improving those programs. It is this focus on continual improvement that served as the impetus for the research contained in this dissertation.

In the past several decades the learning community movement has captured the interest of many within the higher education community (Lenning & Ebbers, 1999). This need to create a sense of community that was highlighted by the Boyer Commission is derived from the retention research by Astin (1977) and Tinto (1993). In their research, a key factor in determining whether a student would be retained in college was the level of involvement or engagement the student had with their education. Astin captured this idea in the development of the theory of student involvement, which states that the more involved students are in their education, the more likely they are to succeed and be retained in college (Astin, 1984). Although the idea of students learning together is not new, the systematic structuring of the curriculum and educational experience to support a learning community has gained increased popularity as a successful method of increasing student retention and learning. Learning communities provide a structured curricular, co-curricular, and/or residential program that facilitates increased student involvement. Research has shown that students participating in learning communities persist at a higher rate than students not participating in learning communities. Doering (1999) documented that participation in learning communities at Iowa State University is related to higher retention rates and academic performance.

Parallel to the increase in learning community development, there has been increased investigation on the role that student self-efficacy and confidence play in student retention and success. From a student psychological development perspective, several different facets of self-efficacy and confidence have been researched to determine the effect they have on retention and student success (Betz & Hackett, 1983). Areas researched include confidence in ability to succeed in specific courses, confidence in ability to complete courses for specific degree programs, and confidence in academic skills and abilities. Along with self-efficacy and confidence, there has also been research into the role that perceived outcome expectancies have on retention and success. If students anticipate positive outcomes as the result of an action or involvement with an activity, then it has been shown that their retention is also increased. For students to be successful and persist in a major, students must believe they can be successful and that by attaining the degree they will experience positive outcomes. Schaeffer (1993) found in a study of engineering students at Iowa State University that students who persisted in engineering and science had higher self-efficacies and outcome expectations than students who did not persist.

From the educational research perspective, participation in learning communities increases retention rates and success. From the psychological research perspective, high levels of self-efficacy, confidence, and outcome expectations are correlated with increased retention rates and success. This study will investigate the relationships between these two perspectives. By bringing together these two research perspectives, this study will yield new insights and understanding into learning communities and their affect on student development.

Need for the Study

As learning communities continue to expand, it becomes increasingly important to understand the relationships between learning community participation and individual student development. To develop effective learning communities, it is important to understand how participation in a learning community affects a student's psychological, emotional, and cognitive development. This study will begin that investigation by determining the potential relationships among learning community participation, self-efficacy, confidence, outcome expectations, and commitment. By gaining a better understanding of these relationships, an institution will be able to develop educational learning communities that have positive outcomes for student development and student academic achievement.

The Undeclared Engineering Learning Community at Iowa State University will serve as the basis for this investigation bringing together the research on self-efficacy and learning communities. Each year 30% of the first-year students entering engineering at Iowa State University enter as undeclared engineering students. These students are not connected with a specific department or curriculum. They are advised centrally by the college using professional staff advisors. Although they lack the support structure of a department, historically the undeclared engineering student retention rate is comparable to that of students who have declared a specific engineering curriculum when they enter Iowa State, with about 72% of the students being retained in engineering after the first year. Historically, only 50% of the students who start in engineering at Iowa State University graduate with degrees in engineering (Moller-Wong, 1995). This low graduation rate coupled with increased demands from industry for engineers is causing a shortage of engineers across the nation. The hope is that through retention programs aimed at the critical first year of college, the college will be able to graduate an increased number of engineers. Currently Iowa State University graduates around 700 B.S. engineering students each year; however, based on employer demands the college has established a goal of graduating 900 students each year by the year 2003 (College of Engineering, 2000).

Since fall semester 1999, undeclared engineering students at Iowa State University have been given the opportunity to join one of nine linked-course learning communities. The purpose of these learning communities was two-fold: to increase the retention of undeclared engineering students in engineering and to increase the academic success of students in the learning community, as measured by grade point averages. The learning communities for undeclared engineering students consisted of a mathematics course, an orientation seminar, and a weekly cooperative learning session facilitated by a peer mentor. Within this structure, there were different learning communities based on the level of mathematics the student is prepared to take, ranging from trigonometry, to calculus I, to calculus II. The orientation seminars were courses of about 50 students taught by the undeclared engineering advisors. There were nine different sections of the orientation seminar offered during both fall semester 1999 and 2000 for undeclared engineering students. Each section was tied to one learning community. Learning community students accounted from between 35 and 50% of the students in each orientation seminar. The weekly cooperative learning session led by a peer mentor focused on developing interactive social skills through cooperative learning strategies, while focusing the academic content for the mathematics course associated with the learning community.

Fall semester 1999 132 students chose to participate in the Undeclared Engineering Learning Communities. Students who did not chose to participate in a learning community were still enrolled in the orientation seminar and in the mathematics courses, and met three times during the fall semester with a peer mentor. However, they were not clustered in their orientation and mathematics courses and did not attend the weekly cooperative learning sessions. For fall semester 2000, 192 students participated in the Engineering Undeclared Learning Communities.

A pilot study of fall semester 1999 students revealed that there was a statistically significant increase in retention for students participating in the learning community as compared to non-learning community students, with 83.3% of the learning community students being retained in engineering and 70.5% of non-learning community students being retained. The incoming student demographics for the two groups of students were similar, with a few notable exceptions. The students choosing to participate in the learning community had significantly lower ACT composite scores, with a mean of 25.8 compared to a mean of 26.6 for students not participating. When comparing academic performance based on semester grade point averages, there was no difference between the two groups of students [t=0.825, p=0.41] (Zunkel, 2000b).

The pilot study confirmed early research results that have indicated participation in a learning community is correlated with higher retention rates. However, although students participated in weekly mathematics sessions, the overall grade point average and grade point average in mathematics courses were not significantly higher for students participating in the learning community. By using grade point averages, it appears that participation in the Undeclared Engineering Learning Community did not have the desired correlation with higher academic achievement. Although the grades for the first year weren't significantly higher, it remained to be determined whether the learning community had any impact on the students' mathematical ability, confidence, and potential future success. Was there any difference in the changes of student self-efficacy and confidence in math between learning community students and non-learning community students? Also, questions were raised due to the fact that the students self-selected into the learning community. Was the difference in retention rates due more to the fact that the students who self-selected into the learning community were more committed to engineering and more confident of their ability to succeed in engineering than the fact that they participated in the learning community?

Significant amounts of staff time and financial resources have been used to support the Undeclared Engineering Learning Communities at Iowa State. In the spirit of fiscal responsibility and continual learning it is important to further investigate the potential relationships between learning community and student self-efficacy/confidence research with the goal of applying that research to improving the educational process for the undeclared engineering students.

Scope of the Study

This study will seek to confirm the results of the fall 1999 pilot study, while expanding the study to determine the relationship among retention, academic performance/success, self-efficacy, confidence, outcome expectations, and commitment for students participating in the Undeclared Engineering Learning Communities. This investigation attempts to answer the following questions:

- Is there a difference in student math self-efficacy or confidence between entering students selecting to participate in the learning communities and students not participating?
- Is there a difference in student outcome expectations between entering students selecting to participate in the learning communities and students not participating?
- Is there a difference in student commitment to engineering between entering students selecting to participate in the learning communities and students not participating?
- Is there a difference in student retention in engineering between students participating in the learning community and those not participating?
- Is there a difference in student achievement (grade point averages) between students participating in the learning community and those not participating?
- At the end of the first year, is there a difference in the change in student self-efficacy or confidence between students participating in the learning community and those not participating?
- At the end of the first year, is there a difference in the change in student outcome expectations between students participating in the learning community and those not participating?
- At the end of the first year, is there a difference in the change in student commitment to engineering between students participating in the learning community and those not participating?

By answering these questions, the staff in the College of Engineering will be able to apply this knowledge in the refinement of their Undeclared Engineering Learning Community, thereby increasing the retention rate and academic success of the students in the college. Similarly, the understanding gained through this study can also serve as a resource to others using learning communities to enhance the educational experience for their students.

Limitations of the Study

This study has the following limitations that may affect the ability to draw conclusions or infer results beyond the scope of the study.

- The study is limited to undeclared engineering students at Iowa State University.
- The learning communities were available only to students enrolled in select math courses; students who needed advanced or remedial mathematics did not have the same opportunities to participate and were excluded from the analysis.
- The study relied on quantitative measures of self-efficacy and confidence. It did not use qualitative methods such as focus groups or interviews to determine student self-efficacy, confidence, or commitment to engineering.
- The study did not differentiate for students that might have been enrolled in a learning community other than the undeclared learning community (for example, women enrolled in the WISE residential learning community, Honors Program, etc).

- Of the total of 385 students enrolled in the orientation course, 356 (92%) completed the initial survey.
- 130 students completed both the initial and follow-up survey, that is, 36.5% of the students who completed the initial survey also completed the follow-up survey.

CHAPTER II: LITERATURE REVIEW

This chapter provides a literature review related to learning communities and self-efficacy concepts, to provide a foundation for the research in this study. This chapter will provide an overview of research literature in six main areas: student success; learning communities; engineering education related to learning communities; self-efficacy, outcome expectations, and confidence; self-efficacy specifically, related to engineering and science areas; and the merging of self-efficacy and learning communities.

Student Success

The initiatives related to learning communities and self-efficacy have as underpinnings the desire to improve student success, in particular success as demonstrated through enhanced learning and retention. Fundamental research in the area of student success serves as a basis for developing and evaluating learning communities.

The theory of student involvement, developed by Astin (1975, 1977, 1984, 1985), is critical in the understanding the learning community movement. Through his study of over 100,000 students, Astin was able to identify key elements that were critical in a students' decision to stay in college or to drop out (1975). Academic support programs, orientation, on-campus work, on-campus residence, and involvement with the institution were all factors that contributed to a student being more likely to stay in college. As Astin noted, "A student's tendency to drop out of college is inversely related to the degree of direct involvement in the academic and social life of the institution" (1975). The student involvement theory has five basic 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 qualitative and quantitative features, 4) The 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, and 5) The effectiveness of any educational policy or practice is directly related to the capacity of that policy or practice to increase student involvement (Astin, 1984).

It is often difficult for students at a large institution to become engaged and actively involved in the learning process. Students in the first year of college often face large lecture classes of 300 or more students. They often feel no connection to the institution or their major. The lack of engagement was highlighted as one of the key areas that higher education needed to address by the Boyer Commission's 1998 report (Boyer, 1998). In an engineering curriculum, where students often do not have classes in their major department until the sophomore or junior year, this lack of connection and isolation can be even more pronounced. This isolation can impact both student learning and success (or retention).

Tinto (1993) identified four factors that lead to attrition among college students: adjustment, difficulty, incongruence, and isolation. To increase student retention in college, he asserts the need to integrate the social and intellectual facets of the student experience, creating a community of learners. Tinto also suggests that additional research is needed investigating how curriculum and pedagogy can shape the learning experience and persistence on college campuses (1997).

Another keystone research effort on student learning was the National Study of Student Learning (NSSL), conducted in the 1990's. In preparation for the NSSL, Terenzini, Springer, Pascarella, and Nora (1995) conducted a large pilot study at an urban mid-west university. The survey of 327 students was conducted in Fall 1991, with 210 students completing the follow-up survey in Spring 1992. The surveys utilized form 88B and 88A of the Collegiate Assessment of Academic Proficiency (CAAP) developed by the American College Testing Program, the College Student Experiences Questionnaire, and a specially designed survey. These instruments would be used starting Fall 1992 in the National Study of Student Learning. The findings from this study indicate that "What happens to students after they matriculate has a substantially greater influence on what and how much they learn than does the pre-college personal and academic baggage students bring with them to college." The study used a model that defined two factors for the construct of intellectual orientation: 1) interest in academic learning and 2) intrinsic value of learning. The data support the conclusion that both students' class-related experiences and their out-of-class experiences made statistically significant and unique contributions towards explaining the variance in these intellectual orientations over the two semesters. The National Study of Student Learning, conducted at the University of Illinois-Chicago began in Fall 1992 with an initial survey of 3,840 randomly selected first-year students from 23 institutions (18 four-year and five two-year institutions) located in 16 states. Students also were administered follow-up surveys in Spring 1993, Spring 1994, and Spring 1995. The last follow-up study, in Spring 1995, generated 994 useable surveys. Some of the results from this large scale study are highlighted in the following paragraphs.

Pascarella, Edison, Whitt, Hagedorn, Nora, and Terenzini (1996) summarized some of the major findings from the first year of the NSSL. When controlling for variables such as precollege ability and academic motivation, gender, socioeconomic status, age, credits taken, residence, etc., the following are some of the early findings:

- Both in-class and out-of-class experiences had small but positive effects on changes in critical thinking. The effect of out-of-class experiences was somewhat more important than the effect of in-class experiences.
- High levels of teacher organization skills (as judged by students in the classes) show a positive association with student cognitive development.
- There is no statistically significant difference in cognitive development between black students attending predominately white campuses and students attending historically black colleges or universities (HBCUs).
- There is no statistically significant difference in cognitive development between students attending four-year or two-year institutions.
- There was a small, but significant, difference between first-generation students and other students, indicating that first-generation students might benefit from additional transition programs.

- Certain student athletes showed significantly lower cognitive development in comparison to non-athletes. This was true for men participating in football and basketball and for all women athletes.
- Students who participated in fraternities or sororities had lower cognitive development compared to other students.

Whitt, Nora, Edison, Terenzini, and Pascarella (1999) examined the relationships between peer interactions and cognitive development outcomes using the NSSL data set. The research considered both course-related and non-course-related interactions, occurring both in and out of class. The analysis controlled for a variety of potentially confounding variables, such as pre-college CAAP scores, race/ethnicity, gender, socioeconomic status, credit hours completed, hours per week spent studying, residence, and the number and types of courses taken. When these other factors were taken into account, the more that students were involved with their peers in both course-related and non-course-related interactions, the greater their cognitive growth during college.

Cabrera, Nora, Bernal, Terenzini, and Pascarella (1998) examined how preferences towards cooperative learning and cooperative learning practices influenced students' gains in cognitive development, affective level, and openness to diversity. Four scales developed by Pace in 1979 (personal development, appreciation for the arts, analytical skills, and understanding science and technology) were used in conjunction with a seven-item "Openess to diversity scale" to assess student development. Cooperative learning was found to have the highest effect, when controlling for pre-college CAAP, race/ethnicity, gender, socioeconomic status, average hours per week spent studying, and high school grade point average.

Doyle, Edison, and Pascarella (2000) examined the extent to which instructional processes affected the general cognitive development of students. The study sought to prove that instructional processes that promote higher-order thinking would positively impact students' self-reported gains in cognitive development. Controlling for similar variables as other studies in the NSSL, this study found significant differences in student cognitive development over the three years of the study relative to the Cognitive Level of Instruction Scale.

The NSSL outcomes reaffirm the importance of student involvement and engagement in learning that had been previously highlighted in the work of Alexander Astin (1993). The NSSL study relied on a large national sample of incoming freshman tracked over four years, looking at 82 different student outcome measures, both cognitive and affective. The results of this study reinforced that the three most important forms of involvement are academic involvement, involvement with faculty, and involvement with student peer groups. Of these the "Strongest single influence on cognitive and affective development is the student's peer group. Generally speaking, the greater the interaction with peers, the more favorable the outcome" (Astin, 1996).

Two decades after his original research on the importance of student involvement in learning, Astin revisited the research as it relates to higher education in the 1990's (Astin, 1996). Some key concepts from his original work that Astin highlights are the following:

1) To appreciate the concept of student involvement in learning, faculty members need to understand the various types of learning that takes place for a college student. Curricula are established to develop student knowledge and cognitive abilities. However, it is important to remember that college also develops students' affective outcomes, such as leadership, self-understanding, and citizenship. Therefore, the educational community needs to redefine "learning" to include both affective and cognitive outcomes.
2) That greater student "involvement," referring to the amount of time and physical and psychological energy that a student invests into learning, clearly increases a student's learning and personal development.
3) Of the 27 specific recommendations made in 1984, several have been adopted by colleges across the United States, such as learning communities, orientation seminars, more support for co-curriculum, etc.

Involvement in student learning encourages students to extend their learning experiences beyond the typical classroom setting. Terenzini, Pascarella, and Bliming (1996) provide a literature review of the impact that out-of-class experiences can have on student learning and cognitive development. Their research summarized prior work in the areas of residence, fraternities and sororities, intercollegiate athletics, employment, other extracurricular activities, faculty interactions, and peer interactions. Through the review, five conclusions were drawn: "1) Students' out-of-class experiences appear to be far more influential in students' academic and intellectual development than many faculty members and student affairs administrators think; 2) not all out-of-class activities exert a positive influence on student learning; 3) student affairs programs may not be capitalizing on the potential of students' out-of-class experiences to enhance learning; 4) in virtually all cases that students' out-of-class experiences were found to enhance academic or cognitive development, those experiences included active student involvement; and 5) the most powerful source of influence on student learning appears to be students' interpersonal interactions, whether with peers or faculty" (Terenzini, Pascarella, & Bliming, 1996).

Learning Communities

The concept of learning communities has exploded within the literature of higher education in the past decade. As chronicled by Lenning and Ebbers (1999), the learning community movement is an outcome of a variety of efforts including the development of learning communities throughout the state of Washington by the Washington Center for Improving the Quality of Undergraduate Education, the publication of the Jossey-Bass New Directions source book on learning communities (Gabelnick, McGregor, Matthews, & Smith, 1990), the development of a national clearinghouse on the topic, research by Vincent Tinto and his colleagues at the National Center on Postsecondary Teaching, Learning, and Assessment, and funding for the development of learning communities provided by the Fund for the Improvement of Postsecondary Education (FIPSE).

Lenning and Ebbers (1999) and Gablenick at al. (1990) provide an overview of the history, types, and successes of learning communities. Levine (1999) provides a resource for individuals interested in developing a learning community, covering everything from a basic definition of learning community models, to garnering funding for learning communities, to assessment of learning communities.

"Learning communities are intentionally developed communities that will promote and maximize learning" (Lenning & Ebbers, 1999). Learning communities provide the structure and opportunity for students to connect their learning to their academic and social development. Learning communities are not a new concept, having roots back to Alexander Meiklejohn's Experimental College at the University of Wisconsin in the 1920's and Joseph Tussman's efforts at the University of California at Berkeley in the 1960's (Gablenick et al., 1990). There is not one definition or model of a learning community, but rather a range of models having differing levels of interaction and integration. Lenning and Ebbers (1999) categorize learning communities into four broad types: curricular learning communities, classroom learning communities, residential learning communities, and student-type learning communities.

Curricular learning communities include models such as clustered courses, federated learning communities, freshman interest groups, thematic studies, coordinated studies, integrated studies, and linked courses. The focus of curricular learning communities is to restructure the curriculum to create a community of students and learning. The level of change to the existing curriculum can be small (clustering of students into existing courses with little or no change from the faculty or curriculum itself) or great (a completely integrated, team-taught curriculum or coordinated studies program).

The second type of learning communities, classroom learning communities, works to develop a sense of community and shared learning within a classroom. One of the most common ways to develop this community within a classroom is through the use of cooperative learning strategies.

Students spend more time out of class than they do in class. To respond to this fact, many campuses have developed residential communities, to extend the learning outside the classroom. Clustering students with similar backgrounds, interests, majors, and/or classes into the same residence hall creates a natural support structure for students. Many times, residential learning communities also provide other programming, such as seminars or peer mentors, to enhance the residential learning experience (Fleming, 2001).

The fourth type of learning community described by Lenning and Ebbers is focused more on the type of student served rather than the structure of the community itself. Student-type learning communities involve the development of learning communities for a particular type of student. Examples that have been developed include learning communities of honors students, at-risk students, under-represented minority students, women students, and students within a particular major.

A single learning community may incorporate more than one of the learning community types; it is even possible to incorporate all four types of learning communities within one particular learning community. For example, a living-learning community that has at-risk students (student-type) living in the same residence hall (residential), taking linked courses (curricular), in which the faculty members are actively using cooperative learning strategies within the classrooms (classroom) incorporates all four types of learning communities within a single learning community.

Schroeder and Hurst (1996) discuss how different models of learning communities can provide the needed framework to support common learning models that incorporate involvement, challenge, support, structure, feedback, application, and integration. They provide descriptions of a Wakonse residence-based learning community and freshman interest groups that help support this framework.

Learning communities have been shown through quantitative and qualitative evaluation to increase retention of students, student academic performance, and student intellectual development (Doering, 1999; Gablenick et al., 1990; Windschitl, 1998). In comparing 1555 students at a Midwestern university who participated in learning communities between 1995 and 1997, Doering (1999) found that students who participated in freshman learning communities earned higher cumulative grade point averages and persisted at the institution at a higher level.

Ting, Grant, and Plenert (2000) found that students participating in the ExCEL learning community earned higher grade point averages compared to other freshman students. They also found significant differences on selected study skill development, such as ability to select main ideas, information processing, and testing skills as measured by Weinstein and Palmer's Learning and Study Strategies Inventory (LASSI) instrument. Students participating in residential learning communities have significantly higher levels of involvement, interaction, and gains in learning compared to non-learning community students (Pike, 1999).

Walker (2001) found that participation in clustered course learning communities was positively associated with nine of 18 student outcomes, in areas of cognitive development (critical thinking, analytical thinking, reading skills, and writing skills), perceptions of faculty provide intellectual stimulation and challenge, collaborations (working in groups, interdisciplinary courses, and seminar participation), and increased discussions with peers on course content.

In addition to increasing retention and academic performance, learning communities can also be used to assist in cultural changes on campus. At Michigan State University, the Multiracial Unity Living Experience has been successful in addressing issues of racial tensions and issues on a campus (Gazel, 2001).

Qualitative research also provides some insight into the benefits of learning communities. Gablenick at al. (1990), as part of the evaluation of learning communities, utilized focus groups to assess changes in student development resulting from learning community involvement. Students participating in learning communities "felt a surge of self-confidence about themselves as learners." Qualitative research has also suggested that students participating in learning communities find the learning environment more supportive, are more positive about their overall learning experience, and are able to draw connections among their classes (Tinto, Goodsell-Love, & Russo, 1993; Tinto & Goodsell, 1994). Interviews with developmental commuter students have shown that participation in a learning community experience assisted these students in adjusting to college life and developing skills necessary for further college studies (Horn, 2000).

Coulter-Kern used class observations, videotaping, student interviews, surveys, and academic histories to compare students in learning community classes with freestanding classes (2000). She observed that students in learning communities: "1) were more likely to attend class, 2) were less likely to fail or withdraw, 3) studied more with each other, 4) socialized more with each other, and 5) were more lively in the classroom."

In some cases, there have been some mixed results for some research related to learning communities. Chonko (1999) found that there were significant differences between students participating in learning communities as compared to those not participating. In spite of these differences, there was no significant difference in achievement, retention, or student involvement, suggesting that the learning community involvement did have a positive effect on students. Halloran (2000) found that there were no significant differences in perceptions of adjustment between learning community students and non-learning community students surveyed at week 3 and week 13 of their first semester.

In addition to benefits for students, there has been some research on the impact that learning communities have on faculty participants. Golde and Pribbenow (2000) interviewed faculty to determine the benefits of their involvement in a residential based learning community. The faculty felt that teaching learning community courses with the residential community provided them with the following benefits: 1) enhanced relationships between faculty and students, 2) increased collegiality from working with faculty across the campus, 3) enjoyment in the experimental nature of the learning communities, and 4) improvement of teaching through a better understanding of student issues and frames of reference.

The majority of the research seems to support the concept of learning communities as a positive educational experience. As previously noted, involvement in learning is critical to student retention. Learning communities provide a structure that encourages student involvement. Tinto expanded upon this idea, suggesting that institutional organizational reform to support the development of learning communities in three areas would facilitate increased student retention. First, colleges should restructure, to create learning communities of students and faculty. Second, since the first year is critical for student success, colleges should revisit the concept of a university college, an academic unit that is focused on the first-year educational experience. Finally, colleges should restructure to allow faculty to work more easily across disciplines to connect faculty as learners (Tinto, 1993).

Learning Communities in Engineering

A review of engineering education publications and conference proceedings confirms that the concepts behind learning communities have been embraced by many in the engineering education field (Zunkel, 2000a). The number of publications that directly reference "learning communities" is still fairly small (Brent et al. 1999; Fisher, Della-Piano, & Crowley, 1998; Landis, 1990; Steadman & Whitman, 1999; Zunkel, 2000b). Although the term "learning community" is not very prevalent in the engineering literature, the concepts underlying the learning community efforts are very visible in the engineering literature. Learning community-related research and publications in engineering can be classified into six broad categories: integrated curriculum, multidisciplinary courses, course or student clustering, cooperative learning, peer mentoring, and residential communities.

Integrated Curriculum

One of the most prevalent types of learning community models in engineering education literature is the integrated curriculum. An integrated curriculum involves a team-taught curriculum that includes content from more than one traditional curriculum. The integration level in some learning communities in fairly low, involving just two courses, such as calculus and physics (Hundhaussen & Yeatts, 1995), economics and engineering economy (Moody & Burtner, 1998), or economics and management (Boardman, Hasan, & Tedesco, 1997). At the opposite end of the spectrum, some institutions have created one- or two-year-long integrated experiences with the equivalent of 12 credits each semester integrated. The Integrated First-Year Curriculum in Science, Engineering, and Mathematics (IFYCSEM) at Rose-Hulman Institute of Technology is an example of higher-level of integration. IFYCSEM is equivalent to two 12-credit block courses that combine calculus, physics, computer science, engineering, and chemistry. The course is treated as one block of time with dynamic sharing of time among the topics, integrated exams, and students receiving one grade for the entire integrated experience (Froyd, 1995; Froyd & Rogers, 1997; Rogers & Winkel, 1993).

Drexel University's E-4 (Enhanced Educational Experiences for Engineers) program was one of the leaders in creating major curricular reform in engineering through integration of curriculum. In 1989 Drexel initiated a two-year integrated E-4 curriculum with a cohort of 100 students (Quinn, 1993, 1995). Analysis of performance and retention data for the initial cohort in 1989 and subsequent cohorts of 100 students in 1990 and 1991, showed that the new integrated curriculum increased grade point averages, progress toward degree, and retention in engineering. In the fall of 1994, Drexel adopted the new integrated curriculum for all entering engineering students.

The success of Drexel's two-year integrated curriculum has been modified and adopted by many institutions in the form of an integrated first-year curriculum. The integrated first-year curriculum, such as the IFYCSEM at Rose-Hulman, is the most common type of integrated curriculum in the engineering literature. Many of the first-year integrated curriculums were developed through innovations and collaborations of National Science Foundation-supported engineering education coalitions (Al-Holou et al., 1998, 1999). Institutions that have developed integrated first-year experiences through coalition efforts include Arizona State University (Duerden et al., 1997; Evans, 1995), North Carolina State (Felder et al., 1995, 1996, 1997, 1998), Texas A&M (Corleto et al., 1996, 1997), and the University of Alabama (Friar, 1995; Parker et al., 1995). Some of the integrated curriculum efforts remain at the trial stage, working with smaller cohorts within the engineering population. However, institutions such as Louisiana Tech (Nelson & Napper, 1999) and Rose-

Hulman (Froyd & Rogers, 1997) also have adopted the integrated curriculum as the standard engineering curriculum for all students.

Although the first-year integrated curriculum is the most prevalent model, others have taken Drexel's model and expanded the integration into a two-year program (Hoit & Ohland, 1996; Halpin et al., 1999) or specifically created an integrated curriculum for sophomores (Heenan & McLuauchlan, 1997). Others have created integrated curriculum for only the first semester of courses, as part of a two-year technical degree (Goldberg, 2001; Goldberg et al., 2001). The integrated curriculum model also has been used to serve displaced workers in a special engineering continuing education program (Sehitoglu & Saint, 1998).

In general the research on student performance and retention is positive for integrated curriculum (Al-Holou et al., 1999). However, integrated curriculum does not always translate into an increase in student retention, even for those programs with high levels of integration. At Auburn University the retention rate of students participating in the two-year integrated curriculum was not statistically different from that of students not participating in the integrated curriculum (Halpin et al., 1999).

A specialized version of integrated curriculum is the concept of integrating writing and communication within the engineering curriculum, rather than having separate English courses. The engineering literature provides many examples of institutional efforts to integrate writing and communication content into the core engineering curriculum (Crowley, 1998; Hendricks & Pappas, 1996; Larson et al., 1998; Olds, 1998; Schulz & Ludlow, 1996; Sharp et al., 1999; Waitz & Barrett, 1997; Wheeler & McDonald, 1998). The integration of communication with traditional engineering courses can occur within a single engineering design course, throughout the entire engineering curriculum, or within specific levels such as freshman or seniors (Alford & Rocheleau, 1998; Fentiman & Demel, 1995; Harms et al., 2001a; Tharp, 1998). These efforts to integrate writing or communication typically are focused on incorporating technical writing or communication skills into the engineering curriculum. However, there are examples that integrate other types of writing into the curriculum, such as Millan's integration of poetry into engineering education (1996).

Multidisciplinary courses

An integrated curriculum is created from the merging of two or more traditional courses or knowledge areas into one unified curriculum. A variation of this within engineering is the multidisciplinary course which is a single course that involves students from a variety of disciplines and curricular knowledge from a variety of courses (King et al., 1999; Lamancusa et al., 1997). The most common version of a multidisciplinary course is one that is project-based and involves students from a variety of majors solving practical engineering problems (Amon et al., 1996; Jahanian, 1999). Sometimes the disciplines included in the integration are from within the engineering or science areas (Schuab et al., 1999), while other times the disciplines, such as marketing, span to other colleges (Seymour et al., 1999). Although a multidisciplinary course may not be viewed by some to be a learning community since it is a single course, the level of interaction between disciplines and cooperative learning philosophies used in these courses makes them relevant to learning community research.

Course or Student Clustering

Clustering differs from an integrated curriculum in the level of interaction among faculty teaching the courses. With course clustering, students are group scheduled into the same sections of courses. This enhances the opportunities for students to collaborate in study groups and form a supportive peer network. However, unlike an integrated curriculum, there is no (or very little) collaboration or coordination of content between the faculty teaching the different courses. In addition to the group scheduling, some clustered courses also provide a unifying seminar course to develop the students into a more cohesive group and to provide some linkage between the courses (Fisher et al., 1998). Another common approach is to cluster students from underrepresented groups such as ethnic minority students or women, into the same sections of courses (Landis, 1990; Lenning & Ebbers, 1999; McDowell & Yost, 1998). In addition to clustering the students in the same classes, additional support services are provided to assist in creating the sense of community. As a pilot study for this dissertation research, Zunkel (2000b) completed a review of the impact on the course clustered learning community on undeclared engineering students. The study of 132 students enrolled in the Undeclared Engineering Learning Communities fall semester 1999 showed that there was a statistically significant difference in the retention in engineering for students participating in the learning community as compared to students not participating in the learning community. This difference held true when controlling for academic preparation (ACT scores and high school rank), gender, and ethnicity. The study did not support earlier studies that indicated a significant difference in academic achievement, as demonstrated by grade point average. There was no significant difference in either the first semester or first year grade point average for students participating in the learning community when compared to students not participating in the learning community.

Cooperative Learning

Integrated curricula, multidisciplinary courses, and clustering are attempts to create community and shared knowledge through the structure and content of the courses. Cooperative learning is a method of creating a learning community within a course by changing how the course is taught. The works of David and Roger Johnson and Karl Smith serve as the basis for many of the cooperative learning initiatives within engineering (Johnson, Johnson, & Smith, 1991; Smith, 1995, 1998). The philosophy behind cooperative learning is to shift from a teach-center teaching environment to a student-centered learning environment (Catalano & Catalano, 1999, Mourtos, 1997). The acceptance of cooperative learning philosophies within the engineering education community has also expanded internationally (Claussen, 1997).

Many cooperative learning publications document the experiences of faculty and students using cooperative learning strategies within specific engineering disciplines and courses, such as microprocessor design (Avila & Hinojosa, 1999), materials engineering (Demetry & Groccia, 1997), microelectronics (Flores & Della-Piana, 1998), aviation (Karp, 1998), industrial engineering (Shuman et al., 1996), engineering orientation (Della-Piana, Vila, & Pinon, 1996), and electrical engineering (Wooten, 1998). Others have addressed the issue of how to incorporate cooperative learning techniques into large lecture courses (Jones & Brickner, 1996; Mehta, 1998; Meier, 1999). Martinazzi and Samples (1997) discuss the use of cooperative learning within the context of an integrated curriculum. Clark (1997) discusses the incorporation of technology into the cooperative learning environment. Haller, Gallagher, Weldon, and Feller analyzed the interactional dynamics and student roles within cooperative learning situations (1999).

Teams and group work has been a part of the engineering curriculum for decades. As a result, there are numerous publications on the use of groups within engineering education literature. Dyrud's work summarizes and categorizes recent publications in the engineering literature related to groups (1999).

The implementation of cooperative learning into the classroom requires the development of engineering faculty. Many faculty members are resistant to use cooperative learning due to myths about the impact on student learning and the quality of education (Jacobson, Davis, & Licklider, 1998b). There have been several initiatives documented on successful faculty development processes for cooperative learning. Most of these initiatives create a community of faculty who learn together cooperatively (Brent et al., 1999; Fulton & Licklider, 1998; Jacobson, Davis, & Licklider, 1998a; Matsumoto et al., 1998).

For effective cooperative learning to take place, it is important to understand that not all students learn in the same way. Rosati (1999) and Tonso (1996) analyze the various learning styles and preferences of engineering students, including analysis according to gender. Hein and Budny (1999a, 1999b) take the information about different learning styles and provide suggestions on how to provide alternative strategies to accommodate for differences in style. Hunkeler and Sharp (1997) discuss the impact that learning style should have on the assignment of students to groups, to create highly functional teams. Sharp, Harb, and Terry (1997) used an understanding of the Kolb learning styles as they incorporated writing into the traditional engineering curriculum. They classified each of the writing assignments according to their appeal to the four Kolb learning types and created a variety of assignments to insure all four types were used throughout the course.

Peer Mentoring

Learning communities have as a basic component the development of relationships centered on learning. Since research has shown that the peer interactions are one of the most influential interactions to increase student learning, many learning communities use the student-to-student relationship to help foster a sense of community. The use of peer mentors, upper-class students, is one method employed by engineering educators to assist in creating a community of peers. Many of the mentoring initiatives within engineering were started to support underrepresented groups (minorities and women) in engineering (Becerra-Fernandez et al, 1997; Gregg, Hirschfeld, & Watford, 1996; Landis, 1990; Tooley, 1997; Watford, 1996). However, as the engineering education community strives to increase the success of all students, the use of mentors has expanded into the mainstream of engineering education.

At the University of Pittsburgh mentors were utilized to lead weekly freshman small group seminars, to replace the traditional large lecture engineering orientation course. The peer mentors helped establish a sense of community among the 20 students in the group and provided essential advice and skills concerning success in engineering (Bishop & Besterfield-Sacre, 1996). The initial indications are that the program has created a stronger connection between students and the college and reduced the number of students in good standing academically who leave engineering (Shuman et al., 1999).

Most peer mentors are paid paraprofessional positions. Oregon State University has taken a different approach for their peer mentors. At Oregon State, the upper-class students are actually enrolled in a Leadership and Mentoring course, for which they receive academic credit. This course also helps develop the skills necessary to be an effective peer mentor. Oregon State also extends their peer mentoring program through sophomore level courses (Rochefort, 1998).

Residential communities

Recognizing that not all learning takes place in the classroom, many institutions have expanded their academic learning community efforts into residential communities. Each residential community described in the engineering literature has unique characteristics and level of involvement with faculty and linkage of courses. At Northern Illinois University the learning community is open to all students (not just women), and also incorporates peer mentors, facilitated study groups, seminars, and more frequent faculty interactions (Pauschke et al., 1996). The University of Wyoming residential community has its own orientation course and freshman interest groups to assist in creating an academically focused residential experience (Steadman & Whitman, 1999).

At Iowa State University, the Agricultural and Biosystems Engineering (ABE) Department and the Electrical and Computer Engineering (ECE) Department have seen large increases in student retention and satisfaction with their residential learning community. The ABE community combines residence, linked courses with English and peer mentors (Harms et al., 2001a, 2001b; Mickelson et al., 2001). The ECE community includes a residential community with a revised computer engineering freshman level course, peer mentors, and a variety of hands-on activities to develop confidence in computer engineering and social skills development (Jacobson & Licklider, 1999). West Virginia University and Michigan State University add yet another level of interaction, by clustering the students into the same sections of courses (Craven, Wayne, & Stiller, 1999; Gunn, 1996). Many residential learning communities are also focused on special student populations such as women, minorities, honors, or at-risk students. Examples include the University of Detroit Mercy and Iowa State University residential living option for women in engineering and/or science (Gandhi, 1997, 1999; McDowell & Yost, 1998).

Self-Efficacy and Confidence

The theory of self-efficacy was first developed by Bandura (1977) as a unifying theory of behavioral change. Self-efficacy is a measure of an individual's beliefs about one's ability to successfully perform a given behavior (Bandura, 1986). These beliefs are presumed to influence a wide range of behavior outcomes, including one's preference for a task and one's effort expenditure and persistence related to these tasks in the face of obstacles (Bandura, 1986). The theory asserts that there are four major sources of information that can affect self-efficacy beliefs: 1) past accomplishments, 2) vicarious learning, 3) verbal persuasion and support from others, and 4) emotional or physiological arousal in the context of task performance.

Lopez and Lent (1992) studied the relative importance of these four sources among 50 high schools students enrolled in a junior-level algebra class. As hypothesized, the most influential source of self-efficacy was past performances or accomplishments (mastery experiences). In contrast to results from studies done with college students (Lent et al., 1984, 1986, 1993), this study of high school students found that emotional arousal added significantly to the prediction of self-efficacy.

These behavioral outcomes associated with self-efficacy beliefs related to task preference can be linked to selection of a career or college major; Betz and Hackett (1981) were some of the first researchers to apply the self-efficacy theory into the realm of vocational/career selection. Several researchers have provided a review of the application of self-efficacy theory on career development (Hackett & Lent, 1992; Lent & Hackett, 1987; Multon, Brown, & Lent, 1991).

Female students with high self-efficacy are more likely to pursue non-traditional careers (Betz & Hackett, 1981, 1983, 1989; Blaisdell, 2000; Lent et al., 1993).

Self-Efficacy Related to Math and Engineering

Within the self-efficacy research domain, one branch of literature has focused on the application of this theory to the specific area of mathematics self-efficacy. Research has indicated that math self-efficacy is related to college major selection (Betz & Hackett, 1983; Blaisdell, 2000) and career options (Lent, Lopez, & Bieschke, 1991). In addition to selection of college major, the model has also been used to assess the success and retention of students in math related fields, such as the sciences and engineering (Hackett et al., 1992; Lent, Brown, & Larkin, 1986; Lent et al., 1984, 1986, 1987, 1993; Schaeffer, 1993). Several studies have looked at these concepts specifically in relation of the enrollment and retention of women students in non-traditional math-related majors (Betz & Hackett, 1983; Blaisdell, 2000; Lent et al., 1991; Schaeffer, 1993) and of both women and minority students (Hackett et al., 1992). In these studies, the selection of engineering or math-related majors and retention in those majors was correlated to higher levels of math self-efficacy. The integration of self-efficacy with other factors such as outcome expectations and past achievements (Lent, Lopez, & Bieschke, 1993) and outcome expectations, stress, strain, social support, and traditional academic predictors (Hackett et al., 1992) also have been investigated. These studies support the significant relationship between self-efficacy and academic performance (as measured by cumulative GPA).

Lent, Brown, and Larkin (1984, 1986, 1993) have been researching the relationship between self-efficacy, vocational/career choice, and persistence related to science and engineering for over a decade. In their 1984 study, Lent, Brown, and Larkin found that students' beliefs about their ability to complete educational requirements of an engineering degree were predictive of subsequent performance. Students with high self-efficacy earned higher grades and one-year persistence rates in engineering than students with low self-efficacy. Their 1986 study extended the 1984 study by incorporating in measures of ability, achievement, and interest along with self-efficacy to determine if these develop a predictive model for success and persistence in engineering and science fields. The 1986 study involved 105 students enrolled in a career planning course. Hierarchical regression analysis indicated that self-efficacy did contribute significantly to prediction of grade point average and persistence in engineering, even when controlling for math ability (as measured by PSAT), high school achievement (as measured by high school rank) and vocational interest (using inventory developed by Betz & Hackett, 1981).

Understanding the importance that math self-efficacy and gender in selection of a science-related college major was the objective of Betz and Hackett's (1984) study of 262 undergraduate students. Their results supported their hypothesis that male students had higher math self-efficacy than women students. When looking at 52 individual measures of self-efficacy, men scored significantly higher on 24 of the 52 items and scored higher on 50 of the 52 items. The study also confirmed that selection of a science-related college major is correlated with higher math self-efficacy scores. In the stepwise multiple regression model, math self-efficacy, years of high school math, lower math anxiety, and gender significantly contributed to the prediction of a science-related major in college.

Blaisdell (2000) conducted a study of 245 high school students to assess gender and self-efficacy differences related to students' decisions to enter college in engineering. Demographic information, educational background, academic confidence (math self-efficacy, academic milestones self-efficacy, and copy self-efficacy), occupational interests, outcome expectations, and career plans were compared using logistic regression. All the students in the study had attended an engineering recruiting event, so they had some career interest related to engineering while in high school. Although self-efficacy did not emerge as a significant predictor of choice of engineering major, there were still significant differences in self-efficacy between male and female students. Female students took higher levels of math and science and earned higher grade point averages than male students; however, female students had significantly lower self-efficacy than male students. This result supports the research of Betz and Hackett (1981). A finding from this study was that female students who had high outcome expectations were more likely to enroll in engineering than male students who had high outcome expectations. The fact that male students with higher outcome expectations related to engineering did not choose to enroll in engineering was identified as an area that should be investigated further. As Blaisdell noted, this difference may be attributable to the fact that the female students in this survey had significantly higher grade point averages compared to the male students in the survey. Although grade point averages did not emerge as significant predictors in the selection model, she felt that there may be some interactions among grade point averages, outcome expectations, and gender worth investigating.

Lent, Lopez, and Bieschke (1993) studied the relationships among math self-efficacy, mathematics course interests, outcome expectations, and mathematics course intentions, choices, and performances. The study also explored gender differences associated with these variables and the predictive model. The study showed that male students demonstrated higher math self-efficacy, outcome beliefs, ACT scores, and math course interests and intentions than female students. The regression models also showed that most variables (with the exception of outcome expectations and gender related to grades) contributed to the prediction models for determining math interests, course intentions, and grades.

Schaeffer (1993) conducted a study of 278 undergraduate students who had entered a large mid-western university in engineering. The study compared students who persisted in engineering, physical sciences, or mathematics compared to students who did not persist, comparing the results for men and women. Personal performance accomplishments (or mastery experiences) were the best predictors of mathematics self-efficacy, followed by ability as measured by ACT scores and grade point averages. This study found gender was uncorrelated with persistence and that there was no difference in measures of mathematics self-efficacy between male and female participants. Students who persisted in engineering, mathematics, or physical sciences had higher levels of mathematics self-efficacy, higher mathematical ability, and higher outcome expectations than non-persisters. This study supported Bandura's (1986) hypothesis that the most important predictor of mathematics self-efficacy was personal performance accomplishments (or mastery experiences).

Although Lent, Brown, and Larkin (1984) found that students with high self-efficacy measures persisted longer in engineering, Elias and Loomis (2000) did not find that this applied to students from a broader range of majors. In a study of 99 students from diverse majors enrolled in an introductory psychology course, Elias and Loomis investigated the relationship between persistence in a major and student levels of academic self-efficacy. Contrary to the hypothesis, academic self-efficacy scores were not significantly related to persistence within a university major. However, data from this study did show a negative relationship between the number of times a student changes majors and the student's milestone self-efficacy. Students with lower milestone self-efficacy changed their majors more times than students with higher self-efficacy.

Hackett, Betz, Casas, and Rocha-Singh (1992) expanded upon Betz and Hackett's prior research to incorporate outcome expectations and an examination of stress and support related to self-efficacy, vocational choice, and academic achievement. The study focused on 197 students enrolled in a west-coast engineering college. The results of this broad study indicated the following: Men had higher outcome expectations than women, African-American men perceived the strongest levels of faculty encouragement compared to all other groups, self-efficacy had a strong positive relationship with academic performance (college grade point average), and positive outcome expectations were moderately related to self-efficacy. However, as with similar studies, the most powerful result of the study was the importance of relationship between self-efficacy and success in engineering.

Recognizing that self-efficacy is an important factor in retention of students, the question becomes what can faculty do that will increase a student's self-efficacy? Ponton, Edmister, Ukeiley, and Seiner (2001) discuss the role of self-efficacy and principles that engineering faculty can use as guidelines in developing instructional strategies which will increase motivation of students to continue in engineering. Engineering faculty must decide what skills are important for practicing engineers, then share with students explicitly what those skills are and provide mastery experiences that will allow students to develop and assess their skill levels. Their recommendation is that engineering professors "Should incorporate strategies that enhance efficacy through performance attainments that develop desired skills (mastery experiences), by increasing peer interaction (vicarious experiences), accurately telling students that they have requisite capabilities (verbal persuasion), and recognizing student stress and imparting coping strategies (e.g., teaching students that reductions in stress will occur with increases in ability)."

Learning Community and Self-Efficacy Combined Research

There is limited research that combines the theories of self-efficacy with the practice of learning communities. One study that has been documented relates to a residential living option type of learning community for women science and engineering students (Gandhi, 1997, 1999). In this program women students self-selected to participate in a residence option that grouped them with other women studying engineering or science. The participants had the opportunity to participate in a variety of seminars and programs in addition to living together in the same residence floors. This was strictly a residential program, the students were not clustered together in similar courses and there was no linking academic orientation or seminar course. The results of these surveys showed there was no difference in self-efficacy measures for students participating in the learning community versus a control group. Similarly, when a follow-up survey was completed after eight months, there was no change in academic self-confidence or self-efficacy. Although there were individual question/variables which showed significance, there was no overall group significance. This study used the math self-efficacy for math-related courses, confidence in academic achievement, and confidence in academic skills as the three primary measures of self-efficacy.

Another related study by Wilke compared the self-efficacy of students in classrooms taught with active learning practices compared with students in traditional lecture classrooms. This research indicated that students participating in the active learning classrooms had higher self-efficacies than students not participating in an active learning classroom (Wilke, 2000).

Summary

A review of the literature has illustrated that learning communities have a positive impact on student success and retention in engineering. The review also highlighted that the incorporation of a wide variety of learning community models and elements have been adopted by engineering colleges across the nation. The literature also provides examples of how learning community initiatives are related to the fundamental student development theory of student involvement.

Similar to the research on learning communities, the literature demonstrates that success and retention in engineering are positively impacted by students' confidences in themselves as measured by self-efficacy, confidence, and outcome expectations models.

Research that attempts to link learning community success with self-efficacy, confidence, and outcome expectations is very limited. Similarly, there are very few research studies that have attempted to determine how students are affected developmentally by participation in learning communities; most research on learning communities has focused on documenting the student success, satisfaction, and retention through involvement with various learning community models and structures.

CHAPTER III: METHODS

This chapter will describe the methods and statistical analyses used in this study. Details will be provided about the sample selection, survey instrument development and administration, database design and creation, and the quantitative analysis procedures used. This chapter also will describe the selection/registration process and key components of the Undeclared Engineering Learning Community that was used for this study. Approval for conducting this research was received from Iowa State University Human Subjects Review Committee (Appendix I).

Sample Selection

The initial population for this study was all freshman students enrolled Fall semester 2000 in undeclared engineering sections of Engineering 101, an Orientation Seminar required of all engineering students. There were 385 freshman students enrolled in the nine undeclared engineering sections of Engineering 101. For these students, demographic information (ACT scores, high school rank, major after two semesters, etc.) and academic performance data (learning community participation, cumulative grade point average, grades earned in mathematics course, etc.) were obtained from the Office of the Registrar.

Of the 385 students enrolled in the orientation course, 356 completed the initial survey that was administered in September 2000 during class. Only one of the 356 students completing the survey did not complete the release and Social Security Number section of the survey. The initial survey results for this student could not be matched to demographic information. The student also did not receive the follow-up survey. Data for the 356 students that completed the survey can be used to compare whether there is a difference between learning community and non-learning community students relative to self-efficacy, outcome expectations, and commitment to engineering for students when they entered engineering.

All students who completed the initial survey and provided release and Social Security Number information were sent a follow-up survey in April 2001. Students were sent electronic mail reminders to complete and return the follow-up surveys. Of the 356 students that completed the initial survey, 130 students (36.5%) completed the follow-up survey. Data from these 130 students can be used to determine whether there is any difference in the change of self-efficacy, outcome expectations, and commitment to engineering over time between learning community students and non-learning community students.

Survey Instrument

To supplement the academic and demographic information available from the Office of the Registrar and to assess student self-efficacy, outcome expectations, and commitment to engineering, students completed the initial survey during September 2000 and the follow-up survey in April 2001. The majority of the items on the survey were adapted from previously validated instruments. Detailed description of the survey items are listed in the following sections. Copies of the surveys are provided in Appendices II and III. The initial survey was distributed and collected by the academic advisors teaching the engineering orientation courses

(ENGR 101). The follow-up survey was done via mail, with follow-up reminder electronic mail messages to students. The surveys were a combination of established and new survey questions to gather additional demographic data and assess a variety of self-efficacy and confidence variables.

Math and Science Self-Efficacy

The basis for these survey questions was the math self-efficacy occupations scale from Betz and Hackett (1983). The scale was modified to reference degree programs offered in Iowa State's College of Engineering, resulting in a revised 21-item scale. For this scale students were asked to rate their confidence in their ability to complete a degree in specific math, science, or engineering related majors. The students used the same 10-point scale as for the course self-efficacy measures. Internal reliability using Cronbach's alpha for these three scales had been reported to between 0.89 and 0.95 (Betz & Hackett, 1983; Gandhi, 1999; Schaeffer, 1993). The survey used the math self-efficacy courses (MSE-C, 16 items) and related science self-efficacy (SSE-C, 7 items) modified by Gandhi (1999) based on the research of Betz and Hackett (1983). These scales asked students to rate their confidence in their ability to complete specific math or science related courses with a grade of "B" or better. Students responded using a 10-point Likert-type scale (1 = no confidence at all, 10 = complete confidence). In addition to course self-efficacy, students were assessed for self-efficacy for mathematics related occupations (MSE-O) using a similar 10-point Likert-type scale. Appendix IV identifies which survey items were associated with each of the three self-efficacy scales.

General Academic Confidence

Two scales, "Confidence of academic achievement" (ACCONF) and "Self-Confidence in academic skills" (SKILLS), were used to assess general academic confidence. The confidence of academic achievement scale asked students to rate their confidence in their ability to achieve six different academic outcomes (e.g., "Complete your degree on time (4 or 5 years)" or "Achieve a cummulative GPA of 3.0 by graduation"), using a 10-point Likert-type scale (1 = no confidence at all, 10 = complete confidence). The self-confidence in academic skills asked students to rate their ability/skill level for a range of skills related to academic success as compared to their classmates. Students were asked to rank their abilities for 11 skills as compared to other students in engineering on a scale from "lowest 10%," "below average," "average," "above average," to "top 10%." These two scales had previously demonstrated reliability having Cronbach's alpha of 0.93 and 0.91 (Gandhi, 1999). Appendix V provides a listing of survey items associated with these two scales.

Math and Science Outcome Expectations

In addition to asking students about their confidence, the survey included questions to assess students' expectations of outcomes associated with mathematics. The 19-item outcome expectation (OE) scale from Schaeffer (1993) had a previously reported internal consistency as demonstrated by a Cronbach's alpha value of 0.86. This scale asked students to indicate their agreement with statements of outcomes related to mathematics on a 10-point Likert-type scale (1 = strongly disagree, 10 = strongly agree). Appendix VI provides a listing of survey items associated with the outcome expectations scale.

Commitment to Engineering

Four new items were added to the survey to assess the student's commitment towards engineering (COMMIT). Students responded to the items using a 10-point Likert-type scale (1 = strongly disagree, 10 = strongly agree). The four items were "I have known for a long time that engineering is for me," "I often wonder if engineering is for me," "I feel confident that I will graduate with an engineering degree," and "There are many other majors besides engineering that interest me."

Database Development

The survey data and information from the Office of the Registrar were merged from Excel files into an SPSS 10.0 data file for analysis. Recoding of the data was necessary in some cases to be able to complete the data file. A listing of recoding and translations done on the raw data is provided below:

- Convert student mathematics grades (A, B, etc.) into numeric equivalents based on a 4.0 scale.
- Convert SAT verbal and mathematics scores into an equivalent ACT math and composite score using concordance tables from the Iowa State University Office

of Institutional Research (2001). These translated scores were used for students without ACT scores.

- Match student records from the Office of the Registrar, the initial survey and the final survey using Social Security Number as the key. Social Security Number then was removed from the final data file to maintain confidentiality and anonymity.
- Five items of the outcome expectation scale, two items of the commitment to engineering scale, and one item of the skills scale were reverse coded to maintain consistent polarity.
- Assignment of numeric ordinal values to non-numeric data, such as gender, minority status, and parents' educational attainment.
- Development of "scale" variables, which were the means of the individual survey items.
- Due to the large number of 0.0 values (and a bimodal distribution) for math, term grade point average, and cumulative grade point average, to ordinal values of 0.0, 1.0, 2.0, 3.0, and 4.0 for use in the analyses.

A complete listing of the final database variables and scales is provided in Appendix VII.

Description of Undeclared Engineering Learning Community Program

Students at Iowa State University have a wide variety of learning community options available to them as incoming first-year students. Students in this study were informed of learning community options available to them through a brochure mailed to from the Office of Admissions. This brochure was mailed to students during the spring of their senior year in high school. The Undeclared Engineering Learning Communities were described in that university brochure. The brochure also contained contact information, so that students could obtain additional information from the coordinator of the learning community.

The actual decision to enroll in the learning community was finalized during a meeting involving the student and the student's academic advisor. All undeclared engineering students meet with an academic advisor as part of the orientation process. The purpose of this meeting is to develop a list of potential courses for the first semester. At this meeting, students were given additional information about the Undeclared Engineering Learning Communities including specific course sections and meeting times. Advisors also discussed with students the potential benefits of participating (meeting other students, having an upper-class student serve as a peer mentor, and potentially earning higher grades through group study and extra time spent on mathematics). The students were also informed that the one-credit collaborative workshop course would be an additional course commitment by the student, which would not count towards credits required for their degrees. If students expressed an interest in the learning community, they also were given information on how to register for the learning community through the regular class registration process. Students then could choose whether or not they were interested in participating in the learning community. It was the student's option and responsibility to register for the classes, including the learning community. The College of Engineering worked with the Office of the Registrar to insure that there were sufficient spaces in the learning community courses to allow all interested students the chance to participate.

The Undeclared Engineering Learning Communities involved clustering a group of up to 20 students in the same Introduction to Engineering (ENGR 101) course and a mathematics course (calculus, trigonometry, or both). Due to the number of undeclared students, there were eight different sections of Undeclared Engineering Learning Communities.

The students in these learning communities participated in a weekly cooperative learning workshop which was facilitated by an upper-class peer mentor. The workshop content focused on the mathematics course, providing students the opportunity to extend their learning beyond the classroom. This workshop was offered as a pass-fail one-credit course, with attendance and participation being the criteria for determining whether a student passed. In addition to the weekly group meetings, students participating in the learning communities also met one-on-one with their peer mentor at least three times during the fall semester.

Hypotheses

Based on the research questions posed in the purpose of study, the following hypotheses are posed for this study:

- Students that select to participate in the Undeclared Engineering Learning Community will have a higher incoming self-efficacy, confidence, outcome expectations, and commitment to engineering than students not choosing to participate in the learning community.

- Students participating in the Undeclared Engineering Learning Community will be retained in engineering at a higher rate than students not participating in the learning community.
- Students participating in the Undeclared Engineering Learning Community will earn higher cumulative, term, and math grade point averages than students not participating in the learning community.
- At the end of the first year, students participating in the Undeclared Engineering Learning Community will have a positive change in self-efficacy, confidence, outcome expectations, and commitment to engineering compared to students not choosing to participate in the learning community.
- At the end of the first year, students retained in engineering will have a positive change in self-efficacy, confidence, outcome expectations, and commitment to engineering compared to students not retained in engineering.

Quantitative analysis

The analysis of data was divided into four stages. The first stage of analysis was to investigate whether the previously established scales used on the survey instrument were the most appropriate grouping of items for use in this study. Many of these previously validated scales had large numbers of items, which can lead to inflated reliability values. To determine appropriate groupings of items into scales, a factor analysis was completed on the existing scale items. The second stage of analysis was to compare the incoming student population, through the initial survey and demographics, to determine whether there were any significant differences between students selecting to participate in the learning community and those not selecting to participate. Discriminant analysis was used to evaluate differences between the two populations of students. The third stage of analysis was to determine the relationships among the variables, learning community participation, and outcomes of retention and academic performance. Standard independent t-tests, logistic regression, and discriminant analysis were used for these various comparisons. The final stage of analysis included the use of repeated measures to determine if there were any significant differences in the changes between the initial survey and the follow-up survey for students participating in the learning community or students retained in engineering.

Chapter IV: Results

The analysis of data was divided into four different stages: 1) factor analysis to determine appropriate scales/groupings of survey instrument items, 2) analysis of differences between students selecting to participate in learning communities and those students who didn't select to participate, 3) analysis of differences in initial variables and their relationship to retention and academic performance, through t-tests, logistic regression, and discriminant analysis, and 4) an analysis to compare the impact of learning community participation and retention in engineering on the changes from the initial survey to the follow-up survey.

Determination of Appropriate Scale Groupings

With the exception of the commitment to engineering items, the self-efficacy and confidence measures used in this study had been used and validated by other researchers (Betz & Hackett, 1983; Gandhi, 1997, 1999; Schaefers, 1993). However, several of the scales included a fairly large number of items. For example, the Math Courses Self Efficacy scale consisted of 16 items and the Outcomes Expectations Scale consisted of 16 items. Due to the nature of reliability calculations, as the number of items included in a scale increases, the scale can tend to give inflated reliability results. So, although the numbers may appear on the surface to indicate that the grouping is a highly reliable and reasonable grouping, some of this is actually due to the large number of variables included in the scale. Rather than proceeding with the established scales, a factor analysis was run on the initial scale items for Academic Confidence, Math and Science Course Self-Efficacy, Confidence in Academic Ability, Academic Confidence, Outcome Expectations and Commitment to Engineering, and Math Career Self-Efficacy. The purpose of the factor analysis was either to confirm the previous scales were the appropriate scales use or to determine a more appropriate grouping of items into new scales.

For the factor analysis, an eigenvalue of 1.0 was used as the cut-off point, to determine the appropriate number of scales (factors) into which the items were grouped. If more than one factor was identified, varimax rotation was used to determine onto which scale an individual survey item would load. Through factor analysis, the initial six-item, Academic Confidence (ACCONF) scale remained a single factor. Table 1 shows the eigenvalues used to determine the number of scales and Table 2 shows the weighting of the individual items onto the scale. Items listed in bold text in Table 1 have an eigenvalue of at least 1.0.

Table 1. Eigenvalues and factor analysis for Academic Confidence scale

	Eigenvalue	**% Variance**	**Cum. %**
1	**3.343**	55.709	55.709
2	0.767	12.778	68.487
3	0.660	11.000	79.488
4	0.597	9.948	89.436
5	0.361	6.022	95.458
6	.0273	4.542	100.00

Table 2. Weighting of individual items from Academic Confidence scale

	Scale Name: ACCONF (Academic Confidence)
	Factor weighting
Understand material	0.821
Earn a 3.0 GPA	0.795
Complete engineering degree	0.761
Conduct research	0.649
Obtain a good job	0.647

The math and science courses self-efficacy scales (MSE-C and SSE-C) were combined into one analysis related to self-efficacy for courses. Based on this analysis, the 23 course items loaded onto four scales. The four new self-efficacy courses scales were grouped by the following areas: courses in the life sciences (LIFESCI), courses in basic mathematics (BASMATH), courses that use higher level mathematics (HGHMATH), and courses that apply basic mathematics (BASAPPL). Tables 3 and 4 contain information on the eigenvalues and the rotated factor weightings for the four new scales.

The 21 math self-efficacy occupations (MSE-OCC) were placed onto three different factors using factor analysis. One factor, tangible applied mathematics (TANGAPP), included careers involving physical structures or environments such as architecture, landscape architecture, civil engineering, and agricultural engineering. Items listed in bold text in Table 3 have an eigenvalue of at least 1.0.

Table 3. Eigenvalues and factor analysis for Math and Science Courses Self-Efficacy scale

Component	Eigenvalue	% Variance	Cum % Variance	Rotated Total	Rotated % Variance	Rotated Cum %
1	**10.598**	**46.077**	**46.077**	**5.591**	**24.310**	**24.310**
2	**3.146**	**13.680**	**59.757**	**4.033**	**17.536**	**41.846**
3	**1.823**	**7.925**	**67.682**	**4.012**	**17.445**	**59.291**
4	**1.022**	**4.444**	**72.126**	**2.952**	**12.835**	**72.126**
5	0.834	3.624	75.750			
6	0.611	2.657	78.407			
7	0.564	2.452	80.859			
8	0.471	2.046	82.905			
9	0.414	1.799	84.704			
10	0.401	1.743	86.447			
11	0.366	1.589	88.036			
12	0.349	1.518	89.554			
13	0.342	13488	91.042			
14	0.334	1.453	92.495			
15	0.290	1.259	93.754			
16	0.256	1.111	94.865			
17	0.237	1.029	95.894			
18	0.229	0.997	96.891			
19	0.211	0.917	97.808			
20	0.180	0.783	98.591			
21	0.120	0.521	99.112			
22	0.109	0.473	99.585			
23	0.095	0.415	100.000			

Table 4. Weighting of individual items from Math and Science Courses Self-Efficacy

	Factor 1 LifeScience	**Factor 2 HigherMath**	**Factor 3 BasicMath**	**Factor 4 BasicApplied**
Course	Weighting	Weighting	Weighting	Weighting
Botany	0.906			
Anatomy	0.888			
Environmental	0.858			
Genetics	0.742			
Zoology	0.734			
Biochemistry	0.697			
Physiology	0.626			
Advanced Calculus		0.780		
Physics		0.750		
Engineering		0.735		
Calculus		0.729		
Computer Science		0.641		
Chemistry		0.620		
Algebra 2			0.917	
Algebra 1			0.886	
College Algebra			0.771	
Geometry			0.743	
Trigonometry			0.627	
Business				0.705
Accounting				0.691
Economics				0.654
Statistics				0.544
Philosophy				0.509

The second career self-efficacy factor, applied mathematics (MATHAPP), included careers that were mathematically focused but had less of a physical environment focus. Careers on this scale included areas such as electrical engineering, physics, mathematics, and industrial engineering. The final career factor (SCIENCE) was focused in the chemistry and science area. It included careers in chemistry, astronomy, chemical engineering, and geology. Tables 5 and 6 provide information on the eigenvalues used to determine the number of factors and the weighting of individual survey items onto the appropriate factor. Items listed in bold text in Table 5 have an eignenvalue of at least 1.0.

Table 5. Eigenvalues for factor analysis of Math and Science Occupations Self-Efficacy scales

Component	Eigenvalue	% Variance	Cum %	Rotated total	Rotated % Variance	Rotated Cum %
1	**11.528**	**54.895**	**54.895**	**5.328**	**25.372**	**25.372**
2	**1.804**	**8.591**	**63.486**	**5.318**	**25.326**	**50.697**
3	**1.290**	**6.144**	**69.630**	**3.976**	**18.932**	**69.63**
4	0.907	4.317	73.947			
5	0.778	3.704	77.650			
6	0.718	3.418	81.068			
7	0.598	2.849	83.917			
8	0.440	2.094	86.011			
9	0.421	2.004	88.015			
10	0.368	1.753	89.768			
11	0.357	1.702	91.469			
12	0.298	1.421	92.891			
13	0.261	1.245	94.135			
14	0.246	1.170	95.305			
15	0.210	1.000	96.305			
16	0.194	0.926	97.232			
17	0.175	0.835	98.067			
18	0.124	0.589	98.655			
19	0.114	0.543	99.198			
20	0.104	0.496	99.694			
21	0.064	0.306	100.000			

Table 6. Weighting of individual items from Math and Science Occupations Self-Efficacy

Course	Factor 1 TangApp Weighting	Factor 2 MathApp Weighting	Factor 3 Science Weighting
LANDS	0.840		
ARCH	0.798		
CE	0.754		
CONE	0.752		
AGE	0.617		
MATE	0.577		
STAT	0.507		
EE		0.812	
CPRE		0.725	
ME		0.699	
ESCI		0.698	
COMPSCI		0.633	
IE		0.631	
PHYS		0.611	
EOP		0.601	
MATHEMAT		0.583	
AERO		0.489	
CHEM			0.832
CHE			0.826
ASTRO			0.697
GEOL			0.568

Survey items on outcome expectations and commitment to engineering were included in the same factor analysis. These 23 individual items separated into five distinct factors, with the four commitment to engineering items remaining a unique factor. This factor was labeled commitment (COMMIT). In addition to commitment, one factor (SOCIAL) was related to the impact pursuing mathematics courses or careers would have on the individual's social life or leisure activities. This factor included survey items such as "In math-related majors, there is no time to have fun" and "I will have to sacrifice leisure activities to remain in a math-related major." Another factor (VALUES) was a grouping of items that involved things the student valued. This factor included items such as "Doing well in math enhances my career opportunities," "Doing well in math will increase my self-worth," and "Choosing a math-related major would lead to the kind of career I want." Valued relationships and the importance of those relationships was yet another factor grouping, Valued Relationships (RELVAL). This factor included items such as "My friends respect me for enrolling in math classes," "Good math performance is valued by my family," and "Pursuing a math-related major enables me to meet the kind of people I value most." The final factor grouping (ENJOYS) included individual survey items related to enjoyment or satisfaction. This grouping included items such as "Math classes are enjoyable to me," "Taking a math related class would increase my overall GPA," and "I get excited about college math classes." Tables 7 and 8 provide the analysis of eigenvalues and factor weightings for the outcome expectations and commitment to engineering items. Items listed in bold text in Table 7 have an eigenvalue of at least 1.0.

The final area of the survey that was investigated using factor analysis included items involving the student's perceived academic ability or skill in specific areas. Unlike the previous areas, the grouping of items from the original SKILL scale into factors was not as clear-cut. Using an eigenvalue of 1.0, the eleven individual items were grouped into three factors. One factor (MANAGE) grouped around the student's skills and abilities to manage or work on a team, including the items on "leadership ability," "ability to work cooperatively," and "ability to balance involvement in multiple tasks." A second factor, Higher Order Thinking (HOTHINK), grouped items that dealt with the student's individual ability to solve problems individually. This factor included the items on "overall academic ability," "analytical and problem-solving skills," "ability to think critically," "mathematical ability," "ability to work independently," and "scientific reasoning." All but two of them items fell onto the MANAGE or HOTHINK scales. The remaining two items were "computer skills" and "English writing skills." These two items were classified as a factor named Language, LANG. Tables 9 and 10 contain information on the eigenvalues and factor weighting for these three scales. Items listed in bold text in Table 9 have an eigenvalue of at least 1.0.

These three scales appear to be logical groupings and have reasonable factor weightings; however, when all the new scales were evaluated for internal reliability, the Cronbach's alpha value for the LANG scale was extremely low. Table 11 provides information on each of the new scales and their internal reliability as measured by Cronbach's alpha.

Based on the low alpha, a second factor analysis was completed on the SKILLS items, forcing the items onto two factors instead of the initial recommended three factors. When forced to two factors, the MANAGE factor remained the same and all other variables placed onto the other variable. When the Cronbach's alpha value was calculated on the new merged scale, the internal reliability was 0.80 compared to 0.85 without the computer and English variables. For both items, the scale indicated that the reliability of the scale would be greater if the items were removed.

Table 7. Eigenvalues and factor analysis for Outcome Expectations and Commitment scales

Component	Eigenvalue	% Variance	Cum %	Rotated total	Rotated % Variance	Rotated Cum %
1	**6.269**	**27.256**	**27.256**	**3.583**	**15.578**	**15.578**
2	**3.300**	**14.350**	**41.605**	**3.315**	**14.413**	**29.991**
3	**1.971**	**8.571**	**50.177**	**2.525**	**10.980**	**40.971**
4	**1.403**	**6.101**	**56.277**	**2.517**	**10.945**	**51.917**
5	**1.021**	**4.438**	**60.715**	**2.024**	**8.799**	**60.715**
6	0.938	4.077	64.792			
7	0.816	3.549	68.341			
8	0.805	3.499	71.840			
9	0.716	3.114	74.954			
10	0.657	2.857	77.811			
11	0.598	2.602	80.413			
12	0.579	2.515	82.929			
13	0.543	2.362	85.291			
14	0.454	1.975	87.266			
15	0.445	1.936	89.202			
16	0.403	1.751	90.953			
17	0.365	1.588	92.541			
18	0.342	1.488	94.029			
19	0.319	1.388	95.416			
20	0.301	1.307	96.724			
21	0.262	1.137	97.861			
22	0.248	1.080	98.941			
23	0.244	1.059	100.000			

Table 8. Weighting of individual items from Math for Outcome Expectations and Commitment

	Factor 1 Social (Soc)	**Factor 2 Values**	**Factor 3 Enjoy**	**Factor 4 Commit**	**Factor 5 Valued relationships (Relval)**
Item	Weighting	Weighting	Weighting	Weighting	Weighting
RSocial	0.868				
RNotime	0.814				
RRelat	0.798				
RLeisure	0.788				
RFun	0.650				
Options		0.769			
Career		0.768			
Positive		0.668			
People		0.627			
Desirejob		0.571			
Selfworth		0.447			
Excited			0.826		
Enjoy			0.762		
Best			0.636		
GPA			0.483		
RWonder				0.855	
Longtime				0.771	
Confid				0.665	
RMajors				0.563	
Friends					0.734
Meet					0.583
Rewards					0.540
Family					0.500

Table 9. Eigenvalues and factor analysis for Academic Skills scale

Component	Eigenvalue	% Variance	Cum %	Rotated total	Rotated % Variance	Rotated Cum %
1	**4.224**	**38.403**	**38.403**	**3.662**	**33.294**	**33.294**
2	**1.567**	**14.242**	**52.645**	**2.117**	**19.247**	**52.541**
3	**1.035**	**9.407**	**62.052**	**1.046**	**9.511**	**62.052**
4	0.862	7.841	69.893			
5	0.697	6.335	76.228			
6	0.679	6.177	82.405			
7	0.533	4.847	87.253			
8	0.489	4.442	91.694			
9	0.382	3.475	95.170			
10	0.281	2.558	97.727			
11	0.250	2.273	100.000			

Table 10. Weighting of individual items from Academic Skills

	Factor 1 Higher order thinking (Hothink)	**Factor 2 Management skills (Manage)**	**Factor 3 Language skills (Lang)**
Course	Weighting	Weighting	Weighting
Problem solving	0.830		
Critical thinking	0.807		
Overall ability	0.796		
Math skills	0.770		
Science skills	0.718		
Independent	0.487		
Leadership		0.824	
Cooperative		0.807	
Multiple tasks		0.688	
English			0.699
Computer (reversed)			0.634

Table 11. Internal reliability for new scales.

New Scales	Measures	Number of Variables	Variable Names	Alpha Reliability
ACCONF	General academic confidence - abilty to complete an engineering degree	6	Compdeg, Comp45, Comp30, Undmaterial, Research, Goodjob	0.84
BASMATH	Confidence in ability to achieve a "B" in basic math courses	5	geom, algebra1, algebra2, collegealge, trig	0.91
BASAPPL	Confidence in ability to achieve a "B" in basic applied math courses	5	stat, philos, econ, acct, bus	0.88
HGHMATH	Confidence in ability to achieve a "B" in higher math related courses	6	physics, chem, engr,advcalc, calc, comsci	0.88
LIFESCI	Confidence in ability to achieve a "B" in life science related courses	7	biochem, zool, physiol, anat, botany,environ,gene tics	0.94
HOTHINK	Confidence in ability/skills compared to other students	6	overall, probsolv, math, indep, science, critical	0.85
MANAGE	Confidence in ability/skills compared to other students	3	coop, leader, multiple	0.72
LANG	Confidence in ability/skills compared to other students	2	computer, English	0.06
SOC	Outcomes associated with social interactions	5	fun, leisure, social, relation, notime	0.87
VALUE	Outcomes associated with personal values	6	people, positive, desirejob, options, selfworth, career	0.80
ENJOY	Outcomes associated with enjoyment	4	excited, enjoy, best, gpa	0.79
RELVAL	Outcomes associated with valued relationships	4	rewards, family, friends, meet	0.67
COMMIT	Commitment to engineering	4	longtime, confid, wonder, majors	0.75
TANGAPP	Ability to complete a degree in a tangible math related field	7	age, arch, lands, ce, stat, cone, mate	0.91

Table 11. (Continued) Internal reliability for new scales.

MATHAPP	Ability to complete a degree in an applied math related field	10	aero, compsci, math, physics, cpre, ee, esci, ie, me, eop	0.93
SCIENCE	Ability to complete a degree in a science related field	4	astro, che, chem, geol	0.88

A plot of English ability versus computer ability, as shown in Figure 1, shows that there is a wide dispersion and lack of correlation between how students view their English skills in relation to their computer skills.

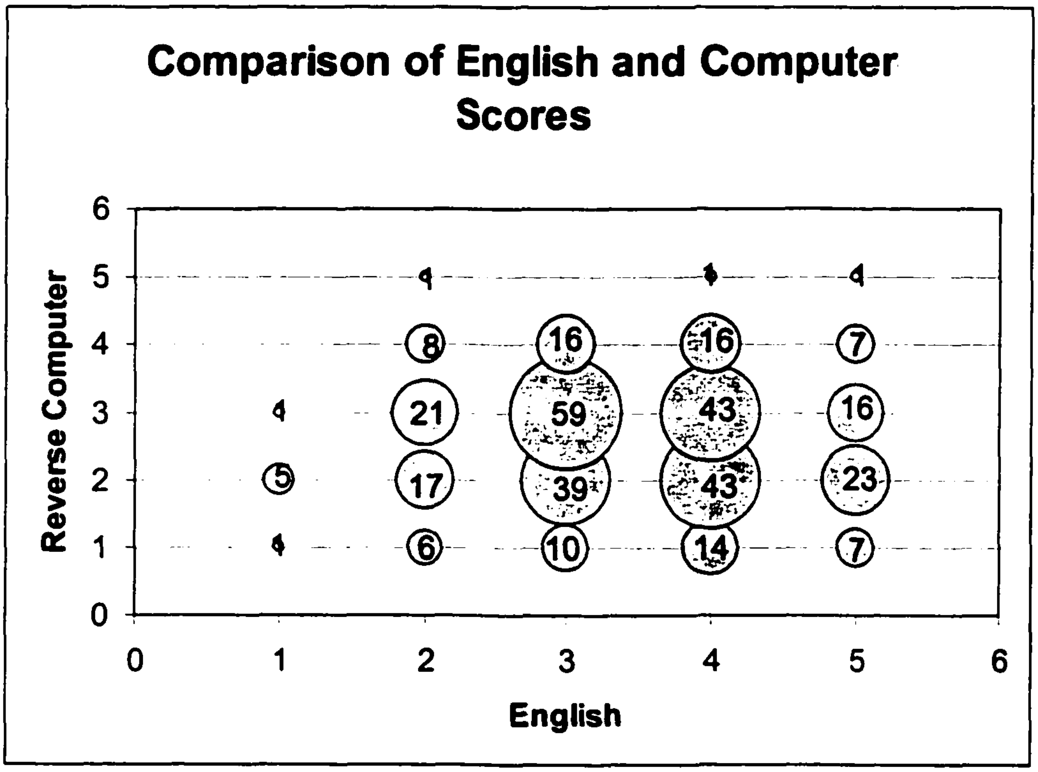

Figure 1. Plot of confidence in English skills versus computer skills

The low Cronbach's alpha value of the LANG scale is a result of two issues: 1) having only two items in the scale (the more items in a scale the higher the reliability) and 2) the wide dispersion and lack of correlation between student's perceptions on English language and computer skills. Three options on how to proceed in regards to the LANG scale were considered: 1) Continue to include the Language scale, realizing its shortcomings, 2) Remove these two items from any subsequent analysis, or 3) Merge these items into the two scales recommended by the forced two-factor analysis. Since this was an initial exploration into the relationship between these factors and learning communities, the decision was made to retain these two items and not eliminate them from the study. It was also decided to use the initially recommended three-factor grouping (option 1), rather than lowering the reliability of the other two scales.

Analysis of Differences between Learning Community and Non-Learning Community Students

The second stage of analysis was to investigate whether there were any differences between students choosing to participate in the learning communities and those choosing not to participate. The two groups were compared on the demographic variables and the scales developed through factor analysis. These comparisons were done using the initial survey, given during the first month of the fall semester. Table 12 provides information on mean and standard deviation for each of the demographic variables and survey scales. It also highlights (bolded) those variables which had a significant ($p < 0.05$) difference between learning community and non-learning community means. The data are separated based on whether or not the student participated in the learning community.

Table 12. Learning community versus non-learning community demographic and initial survey means

Variable or scale	Learning community (N=88) Mean	Learning community Std. Deviation	Non-Learning community (N=215) Mean	Non-learning community Std. Deviation	Significance $p < 0.05$ (bolded)
Class Size	229.77	210.99	261.02	189.75	0.209
Father's Education	3.39	1.14	3.47	1.22	0.603
Mother's Education	3.25	1.01	3.40	1.06	0.244
High School Involvement	3.75	0.95	3.61	1.06	0.298
Gender (Female percentage)	0.148	0.357	0.154	0.361	0.899
Minority	0	0.000	0.03	0.178	0.087
Citizen	0.989	0.107	0.986	0.118	0.858
Iowa Resident	0.716	0.454	0.702	0.458	0.814
ACT Composite	25.57	3.14	26.74	3.77	**0.011**
ACT Math	26.73	3.53	27.94	3.88	**0.012**
ACT English	23.65	3.65	25.13	4.48	**0.006**
High School Rank	79.68	13.94	74.13	22.68	**0.034**
Semesters of High School Math	9.25	1.24	9.09	1.61	0.413
Commitment to engineering	5.52	1.65	5.53	1.81	0.983
Self Efficacy Courses					
LIFESCIENCE	6.83	1.48	6.97	1.47	0.450
HGHMATH	7.56	1.30	7.85	1.32	0.087
BASMATH	9.06	0.991	9.35	0.929	**0.019**
BASAPPL	7.61	1.247	7.97	1.272	**0.025**
Self Efficacy Careers					
TANGAPP	6.89	1.692	6.84	1.807	0.836
MATHAPP	6.89	1.549	7.08	1.669	0.343
SCIENCE	5.78	2.020	6.08	2.034	0.235
Outcome Expectations					
SOCIAL	6.58	1.682	6.88	1.682	0.156
VALUE	7.48	1.307	7.77	1.202	0.058
ENJOY	5.99	1.392	6.13	1.781	0.487
RELVAL	6.25	1.348	6.28	1.384	0.891
Confidences					
ACCONF	7.78	1.062	7.82	1.268	0.780
HOTHINK	3.71	0.515	3.89	0.552	**0.010**
MANAGE	3.79	0.634	3.76	0.653	0.725
LANG	2.98	0.620	3.03	0.676	0.509

Significant differences between students choosing to participate in learning communities and those choosing not to participate were observed on seven measures: ACT composite, ACT math, ACT English, High School Rank, Basic Math Courses Self-Efficacy, Basic Applied Math Courses Self-Efficacy, and Higher Order Thinking Skill Confidence. For high school rank, students participating in the learning community had significantly higher scores. For the remaining six significant variables, students choosing not to participate in the learning community had higher scores. Table 13 highlights these differences between the two populations of students at the beginning of the semester.

Table 13. Initial survey variables with significant differences

Variable	Learning Community Mean	Non-Learning Community Mean	F	Significance ($p < 0.05$)
ACT Composite	25.57	**26.74**	6.604	0.0106
ACT Math	26.72	**27.94**	6.463	0.0115
ACT English	23.65	**25.13**	7.530	0.0064
Basic Math Courses Self-Efficacy	9.06	**9.35**	5.571	0.0189
Basic Applied Math Courses Self-Efficacy	7.61	**7.97**	5.054	0.0253
Higher Order Thinking Skills	3.71	**3.89**	6.720	0.0100
High School Rank	**79.68**	74.13	4.561	0.0335

While there were some significant differences between the two groups on individual items, through discriminant analysis it is possible to determine if through the combination of all these items there is a difference between the two groups as a whole. Of the 356 students in the data set, there were 53 students (14.9%) that had one or more of the discriminating variables missing. A discriminant analysis was completed on the remaining 303 students. The overall Wilks' λ was significant at $p < 0.05$; Lambda = 0.851, $\chi^2 = 46.29$, and p = 0.022. This indicates that combining the various demographic background variables with the self-efficacy, outcome expectations, commitment, and confidence scales that there were significant differences between students choosing to participate in learning communities and those choosing not to participate. Using the discriminant function to predict group membership resulted in 73.9% of the individuals being properly classified.

Relationships between Variables and Performance Outcomes

The stated goals of the learning community were to improve the retention of students in engineering and improve student academic performance. The third phase of analysis investigated the relationships between the variables and the performance outcomes. Performance outcomes were defined to be retention at the end of one-year, fall semester math grades, fall semester grade point average, spring semester grade point average, and spring semester cumulative grade point average.

Retention

The initial motivation for many learning communities in engineering was to address the low retention and graduation rate. Historically, first-year retention at Iowa State was 72%, with only about half the students actually graduating (Moller-Wong, 1995; College of Engineering, 2001). Learning communities were viewed as a method of restructuring the learning experience to potentially increase those rates.

Using a standard independent t-test, there appears to be a significant difference between the retention of students participating in the Undeclared Engineering Learning Communities and students not participating in learning communities. The mean retention in engineering was 0.7510 (N = 257, std. deviation 0.4333) for students not participating and 0.8469 (N = 98, std. deviation = 0.3619) for students participating. Using an independent samples t-test, there was a significant difference in retention between the two groups (t = -2.111, d.f .= 208, p = 0.036).

However, there are many factors that affect whether a student succeeds and graduates in engineering; so to analyze the effects of just one program, such as learning communities, in isolation is not very useful in predicting the retention of a student. To assess the impact the Undeclared Engineering Learning Communities had on student retention, this study looked at a more complete model of factors affecting retention, with learning community participation being one of those factors. An initial logistic regression analysis was completed to determine which combination of background, performance, and survey scale variables could be used to predict successful one-year retention in engineering. The initial model, including all variables, was not a good fit based on the Hosmer and Lemeshow test (χ^2 = 8.433, p = 0.392). The variables, regression values, and significance of each variable for this model are listed in Table 14.

The first inclination was to develop a model based on the items that showed significance in the complete model. These variables were COMMIT, Fall Math Grade, High School Rank, and Residence Code. This model was even less successful in predicting retention in engineering, with a χ^2 goodness of fit = 5.013, p = 0.756.

Various combinations of variables were considered, and in all cases the goodness of fit test was not significant. In all of these models the COMMIT1 variables was listed as the most significant variable. This variable was an assessment of commitment to engineering and a new scale variable created for this survey. Taking this into consideration, a logistic regression analysis was run on all variables excluding the COMMIT variable. This yielded a model that was significant at predicting retention, χ^2 = 21.979, p = 0.005. Table 15 lists the variables in this model and highlights the significant variables in the model. Based on this model, five factors were significant in this model to predict retention: high school rank, residence code (Iowa resident or not), fall math grades, ACCONF (measuring general academic confidence), and RELVAL (important relationships related to math outcome expectations).

Table 14. Logistic regression complete model: variables and significance

Variable	Variable Description	B	S.E.	Wald	Sig.
CLASSIZE	Number of students in high school graduating class	-0.001	0.001	1.370	0.242
DADED	Level of education for father	-0.077	0.194	0.157	0.692
MOMED	Level of education for mother	0.381	0.219	3.032	0.082
HSINVOLV	Involvement in high school	-0.146	0.209	0.491	0.484
UNLTMFLA	Undeclared Engineering Learning Community	0.571	0.451	1.604	0.205
GENDER	1=Female, 0=Male	-0.135	0.557	0.059	0.809
MINORITY	1=Minority, 0=Non-minority	-0.647	1.118	0.335	0.563
CITIZEN	1=US Citizen, 0=Non-citizen	-5.386	17.259	0.097	0.755
RES_CD	Iowa resident	-1.109	0.538	4.241	**0.039**
ACT_CMPS	ACT Composite Score	0.066	0.142	0.215	0.643
ACT_MATH	ACT Math Score	-0.021	0.087	0.061	0.805
ACT_ENGL	ACT English Score	-0.028	0.102	0.075	0.784
HS_RANK	High School Percentile Rank	0.026	0.013	4.297	**0.038**
HSMATH	Terms of high school math	0.035	0.164	0.046	0.830
F00SEM_G	Fall Semester 2000 Term GPA	-0.182	0.551	0.109	0.741
S01SEM_G	Spring Semester 2001 Term GPA	-0.793	0.761	1.086	0.297
S01CMLTV	Spring Semester 2001 Cumulative GPA	0.434	1.010	0.184	0.668
FALLMATH	Fall Semester 2000 Math GPA	0.566	0.284	3.981	**0.046**
ACCONF1	Confidence scale initial survey	0.236	0.255	0.854	0.355
HOTHINK1	Confidence scale initial survey	0.366	0.502	0.532	0.466
MANAGE1	Confidence scale initial survey	-0.291	0.355	0.673	0.412
LANG1	Confidence scale initial survey	-0.478	0.318	2.259	0.133
LIFESCI1	Course self-efficacy initial survey	0.148	0.231	0.410	0.522
HGHMATH1	Course self-efficacy initial survey	-0.111	0.269	0.171	0.679
BASMATH1	Course self-efficacy initial survey	-0.010	0.281	0.001	0.972
BASAPPL1	Course self-efficacy initial survey	-0.164	0.261	0.398	0.528
TANGAPP1	Career self-efficacy initial survey	-0.051	0.187	0.075	0.784
MATHAPP1	Career self-efficacy initial survey	0.115	0.247	0.215	0.643
SCIENCE1	Career self-efficacy initial survey	-0.188	0.163	1.321	0.250
SOC1	Outcome expectations initial survey	-0.019	0.136	0.019	0.890
VALUE1	Outcome expectations initial survey	0.063	0.202	0.099	0.753
ENJOYS1	Outcome expectations initial survey	-0.005	0.165	0.001	0.974
RELVAL1	Outcome expectations initial survey	0.314	0.178	3.128	0.077
COMMIT1	Commitment to engineering initial survey	0.388	0.139	7.862	**0.005**

Table 15. Logistic regression best-fit model: variables and significance

Variable	Variable Description	B	S.E.	Wald	Sig. (p)
CLASSIZE	Number of students in high school graduating class	-0.002	0.001	1.946	0.163
DADED	Level of education for father	-0.150	0.189	0.628	0.428
MOMED	Level of education for mother	0.348	0.214	2.629	0.105
HSINVOLV	Involvement in high school	-0.148	0.203	0.532	0.466
UNLTMFLA	Undeclared Engineering Learning Community	0.547	0.440	1.547	0.214
GENDER	1=Female, 0=Male	-0.370	0.537	0.476	0.490
MINORITY	1=Minority, 0=Non-minority	-1.111	1.089	1.040	0.308
CITIZEN	1=US Citizen, 0=Non-citizen	-5.950	16.629	0.128	0.720
RES_CD	Iowa resident	-1.208	0.532	5.162	**0.023**
ACT_CMPS	ACT Composite Score	-0.011	0.137	0.006	0.938
ACT_MATH	ACT Math Score	-0.008	0.085	0.010	0.922
ACT_ENGL	ACT English Score	0.012	0.097	0.015	0.902
HS_RANK	High School Percentile Rank	0.024	0.012	3.854	**0.050**
HSMATH	Terms of high school math	0.072	0.160	0.200	0.655
F00SEM_G	Fall Semester 2000 Term GPA	-0.294	0.531	0.306	0.580
S01SEM_G	Spring Semester 2001 Term GPA	-0.900	0.749	1.442	0.230
S01CMLTV	Spring Semester 2001 Cumulative GPA	0.633	0.991	0.408	0.523
FALLMATH	Fall Semester 2000 Math GPA	0.552	0.271	4.140	**0.042**
ACCONF1	Confidence scale initial survey	0.481	0.240	4.013	**0.045**
HOTHINK1	Confidence scale initial survey	0.352	0.492	0.512	0.474
MANAGE1	Confidence scale initial survey	-0.196	0.347	0.319	0.572
LANG1	Confidence scale initial survey	-0.524	0.308	2.891	0.089
LIFESCI1	Course self-efficacy initial survey	0.032	0.222	0.020	0.886
HGHMATH1	Course self-efficacy initial survey	-0.124	0.267	0.218	0.641
BASMATH1	Course self-efficacy initial survey	-0.089	0.271	0.107	0.743
BASAPPL1	Course self-efficacy initial survey	-0.141	0.248	0.323	0.570
TANGAPP1	Career self-efficacy initial survey	-0.090	0.178	0.255	0.613
MATHAPP1	Career self-efficacy initial survey	0.147	0.240	0.376	0.540
SCIENCE1	Career self-efficacy initial survey	-0.175	0.160	1.198	0.274
SOC1	Outcome expectations initial survey	0.036	0.131	0.074	0.786
VALUE1	Outcome expectations initial survey	0.156	0.192	0.665	0.415
ENJOYS1	Outcome expectations initial survey	-0.049	0.158	0.095	0.758
RELVAL1	Outcome expectations initial survey	0.442	0.169	6.817	**0.009**

Academic Performance

In addition to improving retention, the other goal of the Undeclared Engineering Learning Community was to improve academic performance. Academic performance is measured by grade earned in math courses fall semester and by grade point averages for fall and spring semester. Due to the bimodal nature of the grade distributions, with a significant number of 0.0 or F's, the grade point averages were translated into grade codes. The codes represented ordinal rankings of grades, with 0 = 0.0, 1 = 0.01 to 1.0, 2 = 1.1 to 2.0, 3 = 2.1 to 3.0, and 4 = 3.1 to 4.0. Discriminant analysis was used to determine whether the performance could be predicted based on participation in the learning community. Of the 356 students in the study, 19 (or 5.3%) were missing at least one of the variables. The discriminant analysis was completed on the remaining 337 students. Table 16 provides information on the mean, standard deviation, and significant differences comparing the mean grade performance codes for students participating in the learning community and those not participating in the learning community.

The analysis shows that there was not a statistically significant difference in individual academic performance outcomes (as measured by grade point codes) between students participating in the learning communities and those not participating in the learning community. In addition, the discriminant analysis showed no overall difference in academic performance for this variables, with a Wilks' λ value of 0.983 ($\chi^2 = 5.613$, $p = 0.230$).

Table 16. Differences in academic performance between learning community and non-learning community students

Grade Performance Code	Learning community (N=98) Mean	Learning community Std. Deviation	Non-Learning community (N=239) Mean	Non-learning community Std. Deviation	Significance
Fall GPA Code	3.03	0.818	3.10	0.900	0.533
Spring GPA Code	3.03	0.989	2.96	1.043	0.580
Spring Cum GPA Code	3.13	0.833	3.03	0.976	0.358
Fall Math GPA Code	2.58	1.209	2.56	1.370	0.874

Comparison of Changes from Initial Survey to Follow-up Survey

One of the hypotheses of the study was that the change in self-efficacy, outcome expectations and commitment from the initial survey to the follow-up survey would be more positive for students participating in the learning community as compared to students not participating. Another similar hypothesis was that this positive difference would also be true when comparing students retained in engineering versus students not retained in engineering. Repeated measures analysis was done to compare the results of the initial survey with the follow-up survey. Of the 356 students completing the initial survey, 130 completed the follow-up survey. The results from these 130 students are what were used for the comparison purposes. As shown in Table 17, there were significant differences between the initial survey response and the follow-up response when comparing changes to responses from within subjects. These differences were true for all but one variable, LANG. However, as Tables 17 and 18 show, there were no significant differences between subjects when comparing learning community students and non-learning community students.

These results of the repeated measures analysis show that there are significant changes from the initial survey to the follow-up survey. Students experienced a decrease in self-efficacy, confidence, commitment, and outcome expectations from the beginning of the year to the end of the first year. However, there was no significant difference in this decrease between students participating in the Undeclared Engineering Learning Communities and students not participating.

A similar repeated measures analysis was completed comparing students retained in engineering and students not retained in engineering. For these students there once again were significant differences for all variables (except LANG) in individual student scores between fall and spring semester. However, in contrast to the learning community analysis, there were significant differences between the fall and spring semester scores when comparing students retained in engineering and students not retained in engineering. Students retained in engineering experienced significantly less of a decline in self-efficacy, commitment, confidence, and outcome expectations as compared to students not retained in engineering. Table 19 and Table 20 show the results of the repeated measured analysis for each of the variables.

Table 17. Comparison within subject for changes from initial survey to follow-up survey, grouping by learning community status

	Initial Survey		Follow-up Survey							
Variable	**Non-LC**	**LC**	**Non-LC**	**LC**	**F var.**	**Sign.**	**eta sq**	**F var*LC**	**Sign.**	**eta sq**
ACCONF	7.85	7.78	7.12	6.98	22.49	**0.000**	0.149	0.043	0.836	0.000
COMMIT	5.54	5.49	5.19	5.15	5.48	**0.021**	0.041	0.001	0.973	0.000
LIFESCI	6.96	6.80	6.63	6.40	8.26	**0.005**	0.062	0.077	0.782	0.001
HGHMATH	7.87	7.43	7.40	6.81	19.48	**0.000**	0.134	0.324	0.57	0.003
BASMATH	9.25	9.00	8.90	8.62	12.95	**0.000**	0.092	0.035	0.852	0.000
BASAPPL	7.91	7.68	7.62	7.23	8.45	**0.004**	0.062	0.39	0.533	0.003
HOTHINK	3.89	3.63	3.49	3.31	30.71	**0.000**	0.195	0.307	0.581	0.002
MANAGE	3.77	3.81	3.61	3.61	6.30	**0.013**	0.047	0.067	0.797	0.001
LANG	3.00	3.04	3.05	3.08	0.81	0.370	0.006	0.044	0.834	0.000
SOC	7.05	6.68	6.26	5.78	52.44	**0.000**	0.291	0.215	0.644	0.002
VALUE	7.88	7.40	7.18	6.68	39.60	**0.000**	0.236	0.609	0.437	0.005
ENJOYS	6.46	5.86	5.61	5.16	38.80	**0.000**	0.233	0.578	0.448	0.004
RELVAL	6.35	6.16	5.98	5.59	12.37	**0.001**	0.088	0.505	0.479	0.004
TANGAPP	6.84	6.90	6.53	6.31	10.08	**0.002**	0.074	0.979	0.324	0.008
MATHAPP	7.09	6.88	6.62	6.10	20.76	**0.000**	0.141	1.327	0.252	0.010
SCIENCE	6.29	5.72	5.68	5.39	9.02	**0.003**	0.067	0.763	0.384	0.006

Table 18. Comparison between subjects in changes from initial survey to follow-up survey, grouping by learning community status

	Initial Survey		Follow-up Survey				
Variable	**Non-LC**	**LC**	**Non-LC**	**LC**	**F LC**	**Sign LC**	**eta sq**
ACCONF	7.85	7.78	7.123	6.98	0.152	0.698	0.001
COMMIT	5.54	5.49	5.19	5.15	0.02	0.888	0.000
LIFESCI	6.96	6.8	6.63	6.4	0.455	0.501	0.004
HGHMATH	7.87	7.43	7.4	6.81	3.243	0.074	0.025
BASMATH	9.25	9	8.9	8.62	1.477	0.266	0.011
BASAPPL	7.91	7.68	7.62	7.23	1.544	0.216	0.012
HOTHINK	3.89	3.63	3.49	3.31	2.783	0.098	0.021
MANAGE	3.77	3.81	3.61	3.61	0.016	0.888	0.000
LANG	3	3.04	3.05	3.08	0.106	0.746	0.001
SOC	7.05	6.68	6.26	5.78	1.897	0.171	0.015
VALUE	7.88	7.4	7.18	6.68	3.783	0.054	0.029
ENJOYS	6.46	5.86	5.61	5.16	2.885	0.092	0.022
RELVAL	6.35	6.16	5.98	5.59	1.162	0.283	0.009
TANGAPP	6.84	6.9	6.53	6.31	0.045	0.832	0.000
MATHAPP	7.09	6.88	6.62	6.1	1.038	0.31	0.008
SCIENCE	6.29	5.72	5.68	5.39	1.238	0.268	0.010

Figures 2 and 3 illustrate the differences between the declines for the learning community and retention repeated measures analysis in a graphical form. Figure 2 shows the mean scores of each variable on the initial and follow-up surveys for students grouped by learning community participation. Figure 3 shows similar information for students grouped by retention in engineering.

Table 19. Comparison within subject for changes from initial survey to follow-up survey, grouping by retention in engineering

	Initial Survey		Follow-up Survey							
Variable	**Not Retained**	**Retained**	**Not Retained**	**Retained**	**F var.**	**Sign.**	**eta sq**	**F var*reten**	**Sign.**	**eta sq**
ACCONF	7.11	8.09	4.79	7.91	74.29	0.000	0.367	54.596	0.000	0.299
COMMIT	4.36	5.95	3.22	5.89	15.56	0.000	0.108	12.711	0.001	0.090
LIFESCI	6.69	6.99	5.42	6.97	26.642	0.000	0.175	25.793	0.000	0.170
HGHMATH	7.00	7.98	5.60	7.78	43.533	0.000	0.254	24.128	0.000	0.159
BASMATH	9.07	9.20	7.78	9.18	48.533	0.000	0.275	45.711	0.000	0.263
BASAPPL	7.93	7.80	6.49	7.86	32.949	0.000	0.206	38.768	0.000	0.234
HOTHINK	3.53	3.89	2.39	3.82	151.701	0.000	0.544	116.877	0.000	0.479
MANAGE	3.76	3.79	2.77	3.92	52.523	0.000	0.293	88.206	0.000	0.410
LANG	2.97	3.03	2.89	3.13	0.010	0.922	0.000	3.148	0.078	0.024
SOC	6.52	7.07	5.11	6.46	71.117	0.000	0.357	11.153	0.001	0.080
VALUE	7.09	7.94	5.43	7.59	88.218	0.000	0.408	36.58	0.000	0.222
ENJOYS	5.42	6.56	3.91	6.02	65.633	0.000	0.339	15.023	0.000	0.105
RELVAL	5.61	6.53	4.21	6.45	32.436	0.000	0.202	25.556	0.000	0.166
TANGAPP	6.41	7.02	4.91	7.04	28.315	0.000	0.198	32.24	0.000	0.204
MATHAPP	6.39	7.25	4.64	7.12	54.982	0.000	0.304	41.061	0.000	0.246
SCIENCE	5.80	6.21	4.21	6.10	30.059	0.000	0.193	22.598	0.000	0.152

Table 20. Comparison between subjects in changes from initial survey to follow-up survey, grouping by retention in engineering

	Initial Survey		Follow-up Survey				
Variable	**Not Retained**	**Retained**	**Not Retained**	**Retained**	**F Retained**	**Sign**	**eta sq**
ACCONF	7.85	7.78	7.123	6.98	83.523	**0.000**	0.395
COMMIT	5.54	5.49	5.19	5.15	51.856	**0.000**	0.288
LIFESCI	6.96	6.8	6.63	6.40	9.467	**0.003**	0.070
HGHMATH	7.87	7.43	7.40	6.81	32.242	**0.000**	0.201
BASMATH	9.25	9.00	8.90	8.62	11.477	**0.001**	0.082
BASAPPL	7.91	7.68	7.62	7.23	5.587	**0.020**	0.042
HOTHINK	3.89	3.63	3.49	3.31	61.291	**0.000**	0.326
MANAGE	3.77	3.81	3.61	3.61	88.206	**0.000**	0.410
LANG	3.00	3.04	3.05	3.08	1.808	0.181	0.014
SOC	7.05	6.68	6.26	5.78	80481	**0.004**	0.062
VALUE	7.88	7.40	7.18	6.68	39.147	**0.000**	0.234
ENJOYS	6.46	5.86	5.61	5.16	28.023	**0.000**	0.180
RELVAL	6.35	6.16	5.98	5.59	37.29	**0.000**	0.226
TANGAPP	6.84	6.90	6.53	6.31	14.966	**0.000**	0.106
MATHAPP	7.09	6.88	6.62	6.10	22.71	**0.000**	0.153
SCIENCE	6.29	5.72	5.68	5.39	8.213	**0.005**	0.061

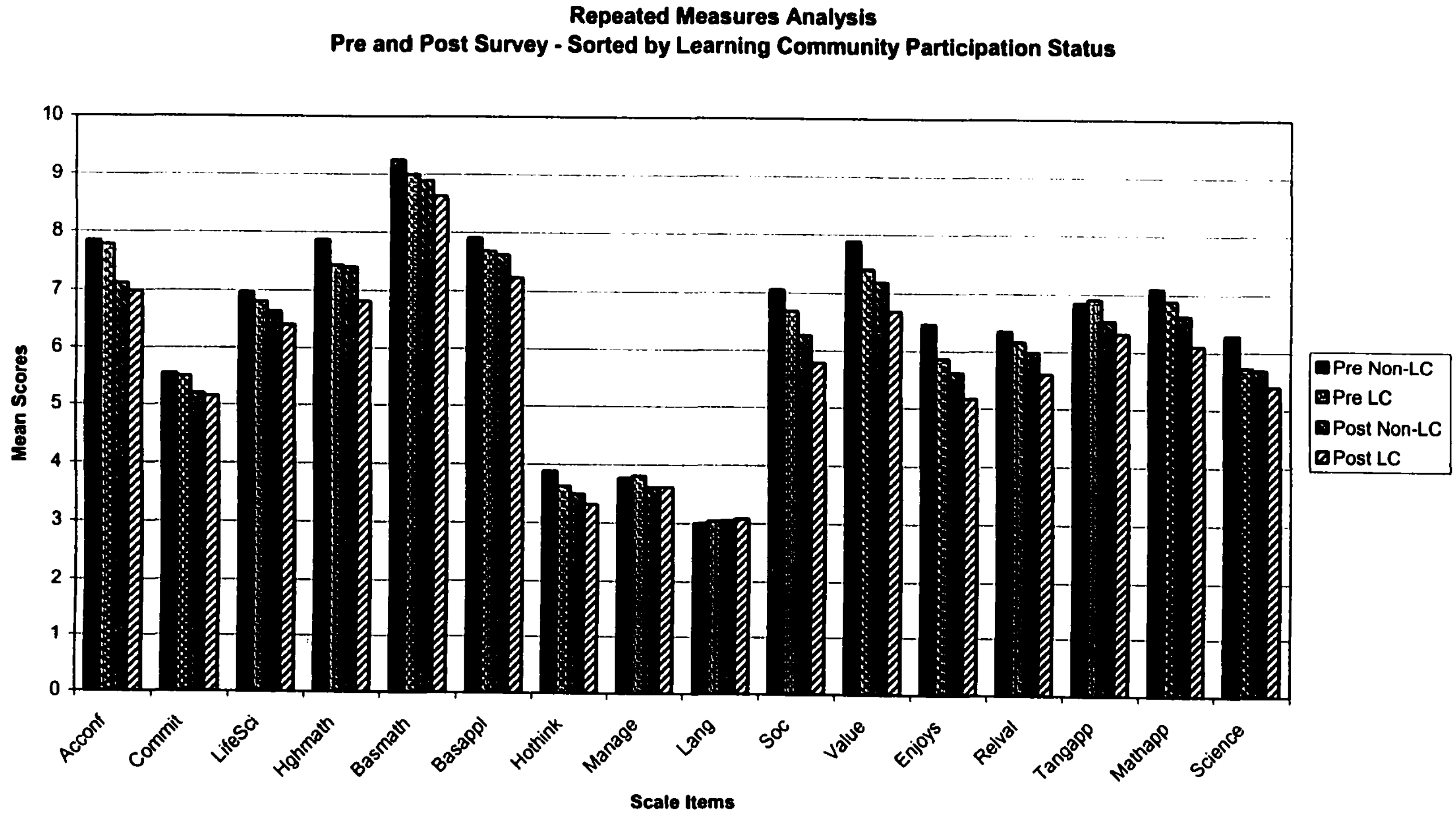

Figure 2. Comparison of survey results, initial (pre) and follow-up (post) surveys, grouped by learning community status

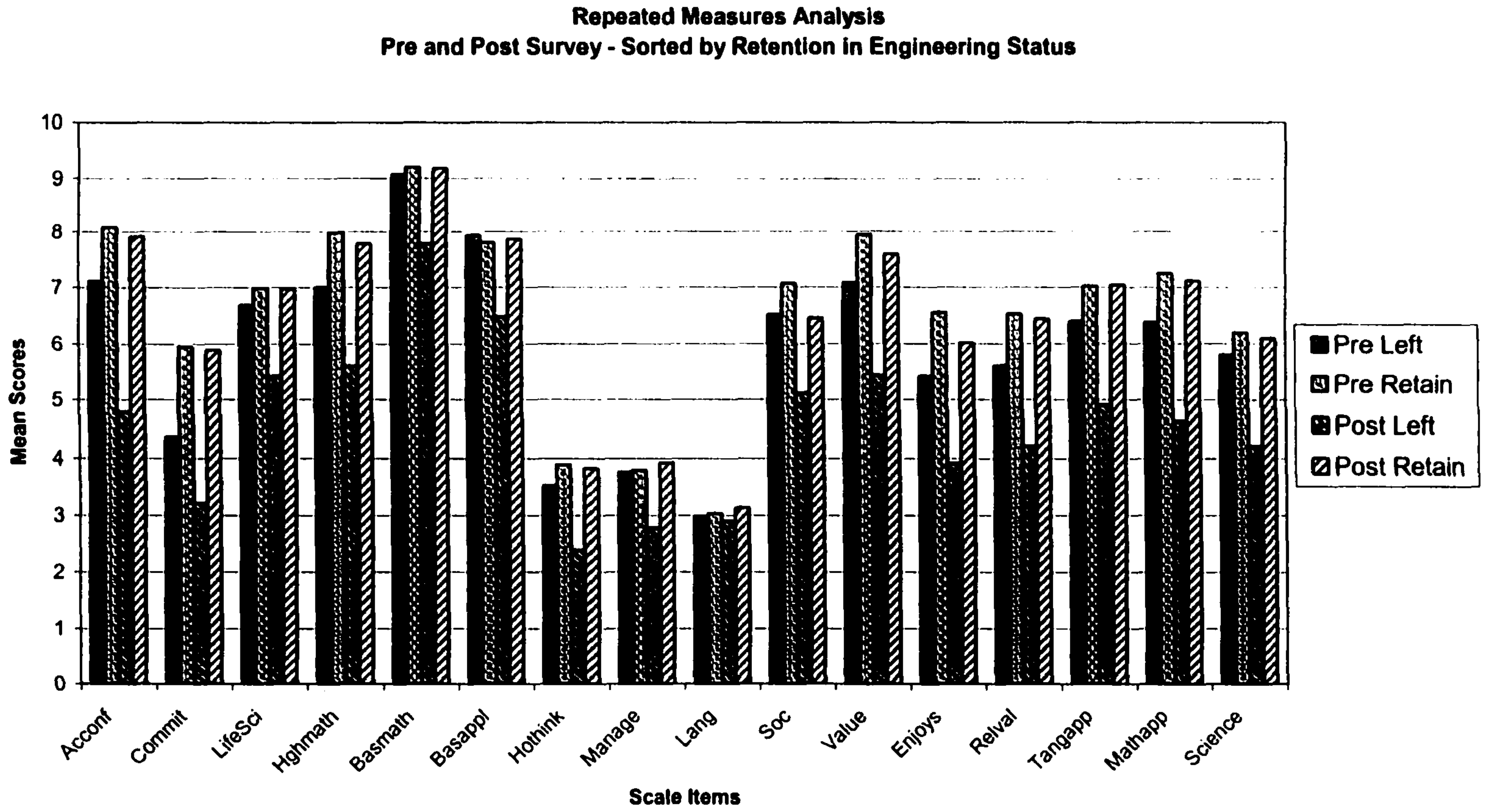

Figure 3. Comparison of survey results, initial (pre) and follow-up (post) surveys, grouped by retention in engineering

CHAPTER V: DISCUSSION

The success of students in engineering is critical for Iowa State University, our country and the global economy. At Iowa State University, only about half the students who enter engineering graduate with a bachelor's degree in engineering. Iowa State University is the ninth largest engineering college in the United States, and therefore provides an important function for the country in educating engineers for an increasingly technological society. According to a report from the National Science Board of the National Science Foundation, "The fields of natural sciences and engineering (NS&E) command special attention because of their importance to the conduct of much of the nation's research and development and to the development of industrial innovation. Other countries are building up the NS&E capabilities of their younger cohorts at a greater rate than the United States has been able to achieve. They have been able to raise—by large increments—the rate at which their college-age youth earn first university NS&E degrees. By contrast, in the United States, this rate has fluctuated between 4 and 5 percent of the Nation's 24-year olds for the past four decades and barely reached 6 percent in the late 1990s. ... During the 2000–2010 period, employment in science and engineering occupations is expected to increase about three times faster than the rate for all occupations. Although the economy as a whole is expected to provide approximately 15 percent more jobs over this decade, employment opportunities for S&E jobs are expected to increase by about 47 percent (about 2.2 million jobs)" (National Science Board, 2002). Iowa State University, as one of the largest engineering colleges in the nation, needs to be proactive in its efforts to graduate more engineers to meet these demands.

In addition to meeting industry needs for engineers, the successful retention of students in engineering is critical to the financial success of the College of Engineering. With graduation rates of around 50%, approximately 700 students that start engineering each year do not graduate in engineering, with 400 of those students leaving the college during their first year of school. With shrinking state funding of the institution, the university must rely more heavily on student tuition to fund the operations of the institution. The loss of tuition revenue from the students leaving engineering is significant for the institution and the college.

If learning community participation and/or increasing student self-efficacy can increase the number of students graduating in engineering, then it is critical for the College of Engineering to understand these concepts and the relationships between them, in order to meet industry demands for engineers and maintain a tuition revenue stream for Iowa State University.

There is a growing body of evidence to suggest that learning communities can have a positive impact on student retention and performance (Doering, 1999; Gablenick et al., 1990; Lenning & Ebbers, 1999; Tinto, 1993). Learning communities attempt to eliminate barriers of isolation and provide support structures that improve student satisfaction and success. Similarly, there have been numerous studies that demonstrate that student self-efficacy, confidence, and outcomes expectations can affect student retention and success in engineering (Betz & Hackett, 1983, Lent et al., 1984, 1986, 1993; Schaefers, 1993). If learning communities increase retention and success, and if self-efficacy, confidence, and outcome expectations are correlated with retention and success, the next logical question might be, "What are the relationships between learning communities and self-efficacy, confidence, and outcome expectations?" This current study attempted to answer that question for the Undeclared Engineering Learning Communities at Iowa State University.

Students Self-Selecting into Learning Communities

One of the first areas considered was whether there were any differences between the types of students selecting to participate in the Undeclared Engineering Learning Communities those students not selecting to participate. When comparing across a wide range of demographic variables and measures of self-efficacy, confidence, and outcome expectations, there were significant differences between students in the two groups.

Students that did not choose to participate in the Undeclared Engineering Learning Communities had higher ACT composite, ACT math, and ACT English scores. In contrast students choosing to participate in the Undeclared Engineering Learning Community had statistically higher high school ranks than students not participating. This leads to a conflict among variables that might normally be used to measure a student's incoming academic ability. Based on ACT scores, students who elected to participate in the learning communities had weaker academic ability or preparation; however, they have compensated for that lack of ability (through some method such as extra effort or dedication) to achieve higher class ranks than the students not participating. This dichotomy may give some indication about the motivation to excel or achieve within the group of students who chose to participate in the learning community. Also as prior research has demonstrated, high school rank can be a key predictor of student retention (Astin, 1977, p. 31). Therefore, when comparing retention results between students participating and not participating, there is a bias in favor of students participating based on their higher high school ranks.

In the areas of commitment to engineering, academic confidence, or self-efficacy, for most measures there were no significant differences between the two groups of students as they entered their first semester in engineering. Of the sixteen scales, there were significant differences in only three: confidence in ability to earn a "B" in basic mathematics courses (BASMATH), confidence in ability to earn a "B" in basic applied mathematics courses (BASAPPL), and confidence in abilities related to higher order thinking (HOTHINK). In all three of these areas, students not electing to participate had higher confidence in themselves as compared to students participating in the learning communities. For all but one of the remaining scales students choosing not to participate had higher scores, but not significantly higher. The only scale for which learning community students had a higher score was MANAGE. This scale asked students to describe their ability, as compared to peers, to work cooperatively, balance multiple tasks, and provide leadership.

In the other demographic questions, students participating in learning communities tended to be from smaller high schools and from families with parents having lower educational attainments. The students also tended to have experienced a higher level of involvement in high school, though none of these differences were statistically significant as compared to students not participating in learning communities.

In contrast to the hypothesis, students electing to participate in the engineering undeclared learning communities did not have higher self-efficacy, commitment to engineering, academic confidences, or outcome expectations. Based on the demographic variables, it appears that students who choose to participate in learning communities may be more motivated to achieve (as evidenced by higher high school ranks) in spite of lower academic ability (as evidenced by ACT scores). Combining the fact that learning community students scored higher on their high school involvement and the teamwork/leadership area, might indicate a trend that students choosing to participate in learning communities are "natural joiners" that have found previous success through participating in group activities.

Although there were few significant differences on individual self-efficacy scales, the discriminant analysis indicated that, through the combination of demographic variables and self-efficacy, confidence, commitment, and outcome expectations scales, there was a significant difference between the students choosing to participate and those choosing not to participate in the learning communities.

Success of the Undeclared Engineering Learning Community

On the surface, the Undeclared Engineering Learning Communities seem to have a strong relationship with increasing retention in engineering. The one-year retention rate for learning community students was 84.69%, versus a one-year retention of 75.10% for non-learning community students. When considering just this one variable, learning community participation is significantly related to a positive retention result. However, when analyzed through logistic regression, considering a wide array of potential variables, learning community participation is not significant in predicting retention. Other factors, such as fall math grades, high school rank, residence state, general academic confidence, and valued relationships related to math outcome expectations are more significant in predicting retention in engineering than participation in the learning community. So the hypothesis that students participating in the engineering learning community would be retained in engineering at a higher rate than non-learning community students is supported. However, due to the complexity of factors that can contribute to retention, there is no predictive relationship that can be drawn based on the results of this study.

With regards to academic achievement, as measured by grade point averages for fall semester, spring semester, spring cumulative, and fall math grades, there was no significant difference between students participating in the learning community and those not participating. Therefore the hypotheses that participation in the learning community would positively affect performance in these areas were not supported. Considering that these were some of the main outcomes that the Undeclared Engineering Learning Community hoped to achieve, this is disheartening. Although the grade point averages were not significantly different, there may be some factor of academic preparedness to investigate related to grade point performance. As measured by ACT scores, students not participating might be expected to earn higher grade points in college. In contrast, using high school class rank, students participating in the learning community might be expected to earn higher grade points in college. Further analysis into the interactions of ACT scores, high school ranks, and learning community participation as they relate to grade point performance could provide more insight into any potential effects the learning community might have on academic performance.

The existing intervention program of providing extra collaborative learning experiences in mathematics did not result in significantly higher grades for students participating in the community. This is in contrast to other programs that have shown significant improvement in academic performance using peer facilitated cooperative study groups (Smith, 1995, 1998), academic excellence workshops (Treisman, 1985) and supplemental instruction (Martin & Arendale, 1994). It is also in contrast to the findings of earlier learning community research, which showed that students participating in learning communities earned higher grade point averages in comparison to students not participating (Doering, 1999).

Changes in Self-Efficacy, Commitment, Confidence, and Outcome Expectation

Another area of research for this study was to investigate the changes in self-efficacy, commitment to engineering, confidence, and outcome expectations from the beginning of the fall semester to the end of the spring semester (one academic year). For all areas, the spring results showed that students were less confident than they had been at the beginning of the fall semester. Much of this can be attributed to students having unrealistic expectations of their abilities. Students entering engineering have typically been high achievers in high school, as demonstrated by their high ACT scores and class ranks. They have excelled previously in high school and on standardized tests. These past experiences are used to develop a frame of reference for their perceived abilities; they are confident in their abilities. However, after experiencing a year of the rigors of the engineering curriculum, students begin to adjust their "high school" frame of reference to a "college" frame of reference. They may have been valedictorians of their high school; but now their peer group in engineering is composed of many other valedictorians. The level of academic achievement/competition is much higher than they are used to experiencing. Therefore, it is not unexpected that students would rate their confidence lower in the spring than they had in the fall. These differences were statistically significant for all but one measure, language skills (LANG).

The initial hypothesis was that changes in these areas would be more positive for students participating in learning communities as compared to students not participating. Using repeated measures analysis, there was no significant difference between students participating in learning communities and those not participating. Participation in the Undeclared Engineering Learning Community did not lessen the decline in self-efficacy, commitment, confidence, or outcome expectations.

However, using repeated measures analysis, there was a significant difference between the initial and follow-up survey results when comparing students retained in engineering versus students not retained in engineering. The changes in the confidence, commitment, self-efficacy, and outcome expectations for all but the language skills variable were related to retention. The students retained in engineering experienced a significantly smaller drop in these values from fall to spring semester as compared to students that left engineering.

Relationship among Self-Efficacy, Learning Community, and Success in Engineering

For this study, the Undeclared Engineering Learning Communities did not create a differentially positive impact on students' self-efficacy, confidence, or commitment to engineering. There was not a significant difference in the decrease in these variables over time, between learning community students and non-learning community students. However there are two parallel finds that deserve consideration: 1) The retention in engineering rate for students in the learning community was higher than the rate for students not in the learning communities and 2) There was a significant difference between the decline of the self-efficacy and confidence variables over time between students retained in engineering and students not retained in engineering. Students participating in learning communities were retained in engineering at a higher rate; and students retained in engineering had higher self-efficacy, commitment, confidence, and outcome expectations at the end of the first year. The research confirmed these two hypotheses. However, the research results did not confirm the linking of these two; it did not confirm that students in learning communities had higher self-efficacy, commitment, confidence, or outcome expectations at the end of the year compared to students not in learning communities. In contrast to some qualitative research where students expressed a "surge in confidence" from participating in a learning community experience, this quantitative study did not confirm that change (Gablenick et al., 1990).

Review of Hypotheses

Based on the research in this study, the following is a summary of the proofs of the hypotheses.

- Students that select to participate in the Undeclared Engineering Learning Community did not have a higher incoming self-efficacy, confidence, outcome expectations, and commitment to engineering than students choosing not to participate in the learning community. However, when combining these factors with demographic factors, there was a significant difference between students choosing to participate in learning communities versus students choosing not to participate.
- Students participating in the Undeclared Engineering Learning Community were retained in engineering at a higher rate than students not participating in the learning community.
- Students participating in the Undeclared Engineering Learning Community did not earn higher cumulative, term, and math grade point averages than students not participating in the learning community.
- At the end of the first year, students participating in the Undeclared Engineering Learning Community did not have a positive change in self-efficacy, confidence, outcome expectations, and commitment to engineering compared to students not

choosing to participate in the learning community. For both groups of students the values of these scales were significantly lower after six months.

- At the end of the first year, students retained in engineering did have a positive change in self-efficacy, confidence, outcome expectations, and commitment to engineering compared to students not retained in engineering.

Summary and Implications

The underlying goal of this research study was to gain a better understanding of the learning communities for undeclared engineering students and to be able to use this new knowledge to improve the academic success of undeclared engineering students at Iowa State. The results of the research study were mixed, with some results supporting initial hypotheses and others not supporting the hypotheses. In addition, there were several key areas uncovered that will warrant further investigation.

Based on the research in this study, there was a significant difference between the group of students choosing to participate in the Undeclared Engineering Learning Communities and students choosing not to participate. In many areas it appears that the students choosing not to participate in the community have stronger preparation, ability, and confidence in themselves. They have also proven to be successful as individuals, as evidenced by their higher ACT scores, while it appears that students selecting to participate may be more motivated to work in or lead groups. Since prior research and the research in this study have shown that participation in learning communities is correlated with higher retention, it would be worth investigating in more detail the reasons why students choose to enroll (or not enroll) in the Undeclared Engineering Learning Community. There may be a need to adjust the marketing, structure, or content of the Undeclared Engineering Learning Communities to make them appealing to a wider audience of students. It is quite possible that the higher ability students perceive the learning community as remedial and are therefore not choosing to participate. Also, the reasons that students choose to participate in the learning community may have some effect on the outcomes seen as a result of participation. For example, a student choosing to participate "because my mother said I should" may see different changes in self-efficacy and academic performance as a result of participating in the learning community than a student choosing to participate "because I learn better working in groups."

One of the stated goals of the Undeclared Engineering Learning Communities was to increase academic performance, with a particular emphasis on the performance in mathematics. This study showed that there was no significant difference in performance, as measured by term, cumulative, or math grade point averages between students participating and those not participating. This indicates that the coordinators for the learning communities need to re-evaluate the structure of the supplemental group collaborative study sessions. The program needs to re-evaluate the content, structure, frequency, and purpose of these sessions to see if they are meeting the needs of the participants and to ensure that these are in-line with established programs that have shown success. Not only did learning community participation not correlate with higher grades, it also did not impact the decline in math self-efficacy or outcome expectations associated with mathematics. Even if the grade performance had not proven to be significant, if students that participated in the learning community had higher confidence in the math abilities based on participation in the community, the community might have made an impact in the math area. However, this learning community that included extra group time on math did not seem to have an affect on math either in terms of grades or confidence. This is in contrast to success that others have found using similar peer-facilitated small group workshops for mathematics (Martin & Arendale, 1994; Smith, 1995; 1998; Treisman, 1985).

If participation in the community is not affecting math performance or confidence, a more thorough study of the effects of the community on the students would be beneficial. What benefits are the students getting out of the extra time devoted to math group study? Is group study in math a critical component of the community, or is it just the need to develop a group of friends? Would the community be just as effective (or maybe more effective) in terms of retention if the group time was devoted to something other than math?

Since fall math term grade point average was significant in the model to predict retention and the existing learning community model did not affect fall math grades, how should the learning community model be changed to impact fall math grades? The results from this study indicate that a much more thorough analysis of the math component of this learning community is needed.

There have been several previous studies that investigated student satisfaction related to participation in a learning community (Goldberg et al., 2001;

Mickelson et al., 2001). There have also been studies that document the success of the communities related to student retention and academic performance (Doering, 1999; Goldberg, 2001). The goal of this research was to try to go beyond satisfaction or demonstration of individual success, to understand potential underlying reasons for why or how the undeclared engineering learning community is successful. What seemed like the logical merging of retention research in the area of self-efficacy, confidence, and outcomes expectations with the area of learning communities did not prove significant for this particular course-based learning community. The study did confirm, similar to previous research, that participation in the learning community was related to higher retention rates in engineering (Doering, 1999). The study also confirmed that students retained in engineering experienced less of a drop in self-efficacy, confidence, and outcome expectations at the end of their first year compared to students not retained in engineering (Schaefers, 1993). However, the study did not confirm the hypothesis that participation in the learning community would positively affect student self-efficacy, confidence, or outcome expectations for the learning community as structured for this study.

In spite of this lack of relationships between these two research areas, the results of this study have opened up additional questions to answer, as the college attempts to refine the Undeclared Engineering Learning Community: If participating in the learning community did not impact student self-efficacy, commitment, confidence, or outcome expectations in students, what changes did occur within students as a result of their participation in the learning community that causes their retention rate in engineering to be higher? Referring back to Astin's theory of student involvement, is the key to the learning community strictly the connection and involvement that the student gains from participating in the community? If so, should the learning community be structured differently? What are the key components of that make this particular community successful? Is the connection with math courses a critical component? Should the learning community meet as a group more than once a week?

Although there was no significant change in self-efficacy, confidence, or outcome expectations as a result of participating in the Undeclared Engineering Learning Community, there are still areas to explore. This learning community structure was fairly minimal; it involved two courses and a peer mentor. If the same analysis was completed on a totally integrated, team-taught, 12-credit learning community, it is possible that the results would be different. It might be that the Undeclared Engineering Learning Community structure is not different enough from the non-learning community experience to generate significant differences. It would be beneficial to conduct this same study on the wide variety of different learning communities in the College of Engineering (or even across the university) to see if more involved/integrated learning communities do have a significant effect on self-efficacy. When evaluating these various learning communities, it might also be possible to identify which components of a learning community structure have an impact on self-efficacy, confidence or outcome expectations.

To re-validate the results of this study, it is recommended that a similar study be completed in subsequent years. The current study included results from 130 students for both the initial and the follow-up survey. Of these 130 students, there were 35 students not retained in engineering and 95 students retained in engineering; and there were 45 students that participated in the learning community and 85 that did not participate. Expansion of this research to include additional students and a longitudinal analysis looking at long-term effects would be beneficial for the college. Although there were not significant differences in self-efficacy at the end of the first year, significant differences might show up later in the college career (junior or senior years). It would also be beneficial to incorporate some aspects of qualitative research, such as focus groups, individual interviews, or observations of the small group workshops to gain insights into why the communities are successful.

Through these continuing investigations it may be possible to identify the key elements of the Undeclared Engineering Learning Community that are contributing to the success. Then the college can incorporate those elements into other programming that would appeal to and assist in the retention of all engineering students, not just those choosing to participate in the learning communities.

Since learning community participation and student self-efficacy have been proven to be significant factors related to retention of engineering students, it is critical for the faculty and staff in the College of Engineering to continue to gain insight into how these concepts can be utilized in program development to ensure the greatest success for undeclared engineering students at Iowa State University.

APPENDIX I. Human Subjects Approval

IRB

Information for Review of Research Involving Human Subjects SEP 0 1 2000

Iowa State University

(Please type and use the attached instructions for completing this form)

1. Title of Project Survey of Undeclared Engineering Students

2. I agree to provide the proper surveillance of this project to insure that the rights and welfare of the human subjects are protected. I will report any adverse reactions to the committee. Additions to or changes in research procedures after the project has been approved will be submitted to the committee for review. I agree to request renewal of approval for any project continuing more than one year.

Karen Zunkel	8/31/00	Karen Zunkel
Typed name of principal investigator	Date	Signature of principal investigator
Engineering Undergraduate Programs	110 Marston	
Department	Campus address	
294-1684		
Phone number to report results		

3. Signatures of other investigators | Date | Relationship to principal investigator

Signatures of other investigators	Date	Relationship to principal investigator
Larry Ebbers (Larry Ebbers)	8/31/00	Major Professor

4. Principal investigator(s) (check all that apply)
☐ Faculty X Staff X Graduate student ☐ Undergraduate student

5. Project (check all that apply)
X Research X Thesis or dissertation ☐ Class project ☐ Independent Study (490, 590, Honors project)

6. Number of subjects (complete all that apply)

adults, non-students: ____ # minors under 14: ____ # minors 14 - 17: ____

ISU students: 900 (450 surveyed) other (explain): ____

7. Brief description of proposed research involving human subjects: (See instructions, item 7. Use an additional page if needed.)

This project will investigate the relationships among student math/science self-efficacy, outcomes expectations, various demographic variables, academic performance, and retention of undeclared engineering students. The purpose is to determine differences between students who chose to participate in learning communities and those who choose not to participate. Academic performance, demographic, and retention data will be collected through the regular information shared with the College of Engineering from the Office of the Registrar. This data will be collected for undeclared engineering student records from Fall 1999 – Spring 2001. In addition, a survey composed of validated instruments on self-efficacy and outcomes expectations will be given to students in the undeclared sections of Engineering 101 Fall semester 2000.

(Please do not send research, thesis, or dissertation proposals.)

8. Informed Consent: X Signed informed consent will be obtained. (Attach a copy of your form.)
Modified informed consent will be obtained. (See instructions, item 8.)
X Not applicable to this project.

(Note: Informed consent for students completing survey fall 2000. Baseline records from students Fall 1999 consent is not applicable; those students will not be contacted or surveyed.)

9. Confidentiality of Data: Describe below the methods you will use to ensure the confidentiality of data obtained. (See instructions, item 9.)

Once the data file of academic information is linked to the survey data, the identifying social security number will be removed from the data sets. The page of the survey with social security number will be removed from the completed survey document after the matching is complete. Until the data set is completed, the survey instruments will be stored in a locked file cabinet. The computer data files will be stored in the personal directory on a secure server in the College of Engineering.

10. What risks or discomfort will be part of the study? Will subjects in the research be placed at risk or incur discomfort? Describe any risks to the subjects and precautions that will be taken to minimize them. (The concept of risk goes beyond physical risk and includes risks to subjects' dignity and self-respect as well as psychological or emotional risk. See instructions, item 10.)

None

11. **CHECK ALL** of the following that apply to your research:

- ☐ A. Medical clearance necessary before subjects can participate
- ☐ B. Administration of substances (foods, drugs, etc.) to subjects
- ☐ C. Physical exercise or conditioning for subjects
- ☐ D. Samples (blood, tissue, etc.) from subjects
- ☐ E. Administration of infectious agents or recombinant DNA
- ☐ F. Deception of subjects
- ☐ G. Subjects under 14 years of age and/or ☐ Subjects 14 - 17 years of age
- ☐ H. Subjects in institutions (nursing homes, prisons, etc.)
- ☐ I. Research must be approved by another institution or agency (Attach letters of approval)

If you checked any of the items in 11, please complete the following in the space below (include any attachments):

Items A–E Describe the procedures and note the proposed safety precautions.

Items D–E The principal investigator should send a copy of this form to Environmental Health and Safety, 118 Agronomy Lab for review.

Item F Describe how subjects will be deceived; justify the deception; indicate the debriefing procedure, including the timing and information to be presented to subjects.

Item G For subjects under the age of 14, indicate how informed consent will be obtained from parents or legally authorized representatives as well as from subjects.

Items H–I Specify the agency or institution that must approve the project. If subjects in any outside agency or institution are involved, approval must be obtained prior to beginning the research, and the letter of approval should be filed.

Last name of Principal Investigator Zunkel

Checklist for Attachments and Time Schedule

The following are attached (please check):

12. ☑ Letter or written statement to subjects indicating clearly:
    - a) the purpose of the research
    - b) the use of any identifier codes (names, #'s), how they will be used, and when they will be removed (see item 17)
    - c) an estimate of time needed for participation in the research
    - d) if applicable, the location of the research activity
    - e) how you will ensure confidentiality
    - f) in a longitudinal study, when and how you will contact subjects later
    - g) that participation is voluntary; nonparticipation will not affect evaluations of the subject

13. ☑ Signed consent form (if applicable)

14. ☐ Letter of approval for research from cooperating organizations or institutions (if applicable)

15. ☑ Data-gathering instruments

16. Anticipated dates for contact with subjects:

First contact	**Last contact**
September/11/2000	September/22/2000
Month/Day/Year	Month/Day/Year

17. If applicable: anticipated date that identifiers will be removed from completed survey instruments and/or audio or visual tapes will be erased:

July/1/2001
Month/Day/Year

18. Signature of Departmental Executive Officer — Date — Department or Administrative Unit

Loren Zachary (Asst. Dean) 9/1/00 — Engineering Undergraduate Programs

19. Decision of the University Human Subjects Review Committee:
☐ Project approved ☐ Project not approved ☐ No action required

Name of Human Subjects in Research Committee Chair — Date — Signature of Committee Chair

Patricia M. Keith — 9-7-00 — PMKeith

APPENDIX II. Initial Fall Survey

Survey of Students Enrolled in Engineering 101 – Undeclared Sections
Fall 2000

This survey is being completed to better understand and advise students enrolled in the undeclared sections of Engineering 101. All information in this study will be kept confidential. Information contained in this survey will be summarized; no individual student's information will be shared or reported.

Your social security number will be used to match data in this survey with demographic data and academic data in university records. (By doing this, we shorten the time for you to complete the survey, by not asking you questions about your high school rank, ACT test scores, home town, GPA, etc.) It will also allow us to keep track of any changes in majors you may have between now and the end of this school year.

Your completion of this survey is voluntary and you are free to withdraw your consent at any time. Your completion of this survey will not affect your performance in Engineering 101. It should take you less than 15 minutes to complete the survey. We really appreciate you taking the time to complete this survey! The more students who complete the survey, the better we will be able to advise and understand our students in the future.

If you have any questions, please feel free to contact Karen Zunkel, 110 Marston, 4-1684, kzunkel@iastate.edu.

In addition to the information provided in this questionnaire, you have my permission to obtain information in my university records, concerning ACT, GPA, and other demographic and academic information obtained from my admissions and Registrar's records. I understand that this information will be kept confidential

Signed ______________________________ Date ____________________

Social Security Number ____________________

This page will be removed from the survey after data files from the Registrar have been matched to this survey.

Engineering 101 Survey – Fall 2000

Demographic information

Number of students in high school graduating class ________

Highest level of academic attainment by your father (please check one)

- ___ Some high school
- ___ High school graduate
- ___ 2 years in college, community college, or technical degree
- ___ Bachelors degree (4 years)
- ___ Master's degree
- ___ Doctoral or professional degree (Ph.D., M.D., J.D., etc.)

Highest level of academic attainment by your mother (please check one)

- ___ Some high school
- ___ High school graduate
- ___ 2 years in college, community college, or technical degree
- ___ Bachelors degree (4 years)
- ___ Master's degree
- ___ Doctoral or professional degree (Ph.D., M.D., J.D., etc.)

Please rate your level of involvement in high school activities:

- ___ Very low (not involved in school or community activities)
- ___ Low
- ___ Average
- ___ High
- ___ Very high (very involved in school or community activities)

Interests and Confidence in Engineering

On the remaining survey questions, please do not spend too much time on any one item. We are most interested in your immediate response. Using the scales provided, please circle the number to select your response.

Please indicate how **confident you feel in your ability to do each of the following things.**

		No confidence at all									Complete Confidence
1.	Complete an engineering degree	1	2	3	4	5	6	7	8	9	10
2.	Complete your degree on time (4 or 5 years)	1	2	3	4	5	6	7	8	9	10
3.	Achieve a cumulative GPA of 3.0 by graduation	1	2	3	4	5	6	7	8	9	10
4.	Understand the materials in your classes	1	2	3	4	5	6	7	8	9	10
5.	Work closely on a research team with faculty or graduate students	1	2	3	4	5	6	7	8	9	10
6.	Get a good job in your field with your degree	1	2	3	4	5	6	7	8	9	10

Engineering 101 Survey – Fall 2000

Please rate your **confidence in your ability to complete the following courses with a "B" grade or better**.

	Course	1 (No confidence at all)	2	3	4	5	6	7	8	9	10 (Complete Confidence)
1.	Advanced calculus	1	2	3	4	5	6	7	8	9	10
2.	Computer science	1	2	3	4	5	6	7	8	9	10
3.	Business administration	1	2	3	4	5	6	7	8	9	10
4.	Biochemistry	1	2	3	4	5	6	7	8	9	10
5.	Calculus	1	2	3	4	5	6	7	8	9	10
6.	Zoology	1	2	3	4	5	6	7	8	9	10
7.	Accounting	1	2	3	4	5	6	7	8	9	10
8.	Geometry	1	2	3	4	5	6	7	8	9	10
9.	Algebra I	1	2	3	4	5	6	7	8	9	10
10.	Algebra II	1	2	3	4	5	6	7	8	9	10
11.	Philosophy	1	2	3	4	5	6	7	8	9	10
12.	College algebra	1	2	3	4	5	6	7	8	9	10
13.	Statistics	1	2	3	4	5	6	7	8	9	10
14.	Physiology	1	2	3	4	5	6	7	8	9	10
15.	Trigonometry	1	2	3	4	5	6	7	8	9	10
16.	Economics	1	2	3	4	5	6	7	8	9	10
17.	Human anatomy	1	2	3	4	5	6	7	8	9	10
18.	Botany	1	2	3	4	5	6	7	8	9	10
19.	Environmental studies	1	2	3	4	5	6	7	8	9	10
20.	Engineering	1	2	3	4	5	6	7	8	9	10
21.	Genetics	1	2	3	4	5	6	7	8	9	10
22.	Physics	1	2	3	4	5	6	7	8	9	10
23.	Chemistry	1	2	3	4	5	6	7	8	9	10

Compared to other students entering college in engineering, please rate yourself on each of the following traits. We want the most accurate estimate of how you see yourself.

	Trait	Lowest 10%	Below Average	Average	Above Average	Highest 10%
1.	Overall academic ability	1	2	3	4	5
2.	Analytical and problem-solving skills	1	2	3	4	5
3.	Ability to think critically	1	2	3	4	5
4.	English writing skills	1	2	3	4	5
5.	Mathematical ability	1	2	3	4	5
6.	Computer skills	1	2	3	4	5
7.	Ability to work independently	1	2	3	4	5
8.	Scientific reasoning	1	2	3	4	5
9.	Ability to work cooperatively (in a team)	1	2	3	4	5
10.	Leadership ability	1	2	3	4	5
11.	Ability to balance involvement in multiple tasks	1	2	3	4	5

Engineering 101 Survey – Fall 2000

Please indicate the extent to which **you agree or disagree with the following statements**, using the 10-point scale below. "Math-related" classes include any math, engineering, or physical science classes.

	Statement	Strongly Disagree	Disagree			Unsure		Agree			Strongly Agree
		1	2	3	4	5	6	7	8	9	10
1.	Doing well in math enhances my career opportunities	1	2	3	4	5	6	7	8	9	10
2.	In math-related majors, there is no time to have fun.	1	2	3	4	5	6	7	8	9	10
3.	People I look up to approve of my taking college math courses.	1	2	3	4	5	6	7	8	9	10
4.	Taking a math related course would increase my overall GPA.	1	2	3	4	5	6	7	8	9	10
5.	Math classes are enjoyable to me.	1	2	3	4	5	6	7	8	9	10
6.	Taking math courses will help me keep my career options open.	1	2	3	4	5	6	7	8	9	10
7.	Doing well at math will increase my sense of self-worth.	1	2	3	4	5	6	7	8	9	10
8.	I would have to sacrifice leisure activities to remain in a math-related major.	1	2	3	4	5	6	7	8	9	10
9.	Choosing a math-related major would lead to the kind of career I want.	1	2	3	4	5	6	7	8	9	10
10.	I have known for a long time that engineering is the right major for me.	1	2	3	4	5	6	7	8	9	10
11.	Good math performance is valued by my family.	1	2	3	4	5	6	7	8	9	10
12.	Taking college math courses produces positive consequences for me.	1	2	3	4	5	6	7	8	9	10
13.	It is difficult to pursue a math-related major and still have a social life.	1	2	3	4	5	6	7	8	9	10
14.	My friends respect me for enrolling in math classes.	1	2	3	4	5	6	7	8	9	10
15.	Pursuing a math-related major enables me to meet the kind of people I value most.	1	2	3	4	5	6	7	8	9	10
16.	I would have to make sacrifices I my relationships to remain in a math-related major.	1	2	3	4	5	6	7	8	9	10
17.	I often wonder if engineering is right for me.	1	2	3	4	5	6	7	8	9	10
18.	I get excited about college math classes.	1	2	3	4	5	6	7	8	9	10
19.	Majoring in a math-related field leaves me with little time for family and friends.	1	2	3	4	5	6	7	8	9	10
20.	Math classes have been some of the best classes I have taken in school.	1	2	3	4	5	6	7	8	9	10
21.	The rewards of a degree in a math-related field are worth the sacrifices.	1	2	3	4	5	6	7	8	9	10
22.	I feel confident that I will graduate with an engineering degree.	1	2	3	4	5	6	7	8	9	10
23.	There are many majors besides engineering that interest me.	1	2	3	4	5	6	7	8	9	10

Engineering 101 Survey – Fall 2000

Please rate your **confidence in your ability to complete a degree in the following majors.**

	No confidence at all									Complete Confidence
1. Agricultural Engineering	1	2	3	4	5	6	7	8	9	10
2. Aerospace Engineering	1	2	3	4	5	6	7	8	9	10
3. Architecture	1	2	3	4	5	6	7	8	9	10
4. Landscape Architecture	1	2	3	4	5	6	7	8	9	10
5. Astronomy	1	2	3	4	5	6	7	8	9	10
6. Chemical Engineering	1	2	3	4	5	6	7	8	9	10
7. Chemistry	1	2	3	4	5	6	7	8	9	10
8. Civil Engineering	1	2	3	4	5	6	7	8	9	10
9. Statistics	1	2	3	4	5	6	7	8	9	10
10. Computer Science	1	2	3	4	5	6	7	8	9	10
11. Geology	1	2	3	4	5	6	7	8	9	10
12. Mathematics	1	2	3	4	5	6	7	8	9	10
13. Physics	1	2	3	4	5	6	7	8	9	10
14. Computer Engineering	1	2	3	4	5	6	7	8	9	10
15. Construction Engineering	1	2	3	4	5	6	7	8	9	10
16. Electrical Engineering	1	2	3	4	5	6	7	8	9	10
17. Engineering Science	1	2	3	4	5	6	7	8	9	10
18. Industrial Engineering	1	2	3	4	5	6	7	8	9	10
19. Materials Engineering	1	2	3	4	5	6	7	8	9	10
20. Mechanical Engineering	1	2	3	4	5	6	7	8	9	10
21. Engineering operations (an individually developed program)	1	2	3	4	5	6	7	8	9	10

Thanks for taking the time to complete this survey!

APPENDIX III. Spring Follow-up Survey

Survey of Students Enrolled in Engineering 101 – Undeclared Sections
Fall 2000 – Spring 2001 Follow-up

This survey is follow-up survey to students who were enrolled in the undeclared sections of ENGR 101 during Fall Semester 2000. *All information in this study will be kept confidential. Information contained in this survey* will be summarized; no individual student's information will be shared or reported. Please complete this survey even if you are not enrolled in engineering anymore.

Your social security number will be used to match data in this survey with the survey completed during ENGR 101 this past fall semester.

It should take you less than 15 minutes to complete the survey. We really appreciate you taking the time to complete this survey! The more students who complete the survey, the better we will be able to advise and understand our students in the future.

If you have any questions, please feel free to contact Karen Zunkel, 110 Marston, 4-1684, kzunkel@iastate.edu.

Please return the survey in the enclosed return envelope. Postage is provided – just complete the survey and drop it back in the mail. Thanks! *Enjoy the last half of spring semester!*

****

SSN ______________________________ (used to match survey results with fall survey results)

Current major ______________________________

Interests and Confidence in Engineering

On the remaining survey questions, please do not spend too much time on any one item. We are most interested in <u>your immediate response</u>. Using the scales provided, please circle the number to select your response.

Please indicate how **confident you feel in your ability to do each of the following things.**

	No confidence at all									Complete Confidence
1. Complete an engineering degree	1	2	3	4	5	6	7	8	9	10
2. Complete your degree on time (4 or 5 years)	1	2	3	4	5	6	7	8	9	10
3. Achieve a cumulative GPA of 3.0 by graduation	1	2	3	4	5	6	7	8	9	10
4. Understand the materials in your classes	1	2	3	4	5	6	7	8	9	10
5. Work closely on a research team with faculty or graduate students	1	2	3	4	5	6	7	8	9	10
6. Get a good job in your field with your degree	1	2	3	4	5	6	7	8	9	10

Engineering 101 Survey – Fall 2000

Please rate your confidence in your ability to complete the following courses with a "B" grade or better.

	No confidence at all									Complete Confidence
1. Advanced calculus	1	2	3	4	5	6	7	8	9	10
2. Computer science	1	2	3	4	5	6	7	8	9	10
3. Business administration	1	2	3	4	5	6	7	8	9	10
4. Biochemistry	1	2	3	4	5	6	7	8	9	10
5. Calculus	1	2	3	4	5	6	7	8	9	10
6. Zoology	1	2	3	4	5	6	7	8	9	10
7. Accounting	1	2	3	4	5	6	7	8	9	10
8. Geometry	1	2	3	4	5	6	7	8	9	10
9. Algebra I	1	2	3	4	5	6	7	8	9	10
10. Algebra II	1	2	3	4	5	6	7	8	9	10
11. Philosophy	1	2	3	4	5	6	7	8	9	10
12. College algebra	1	2	3	4	5	6	7	8	9	10
13. Statistics	1	2	3	4	5	6	7	8	9	10
14. Physiology	1	2	3	4	5	6	7	8	9	10
15. Trigonometry	1	2	3	4	5	6	7	8	9	10
16. Economics	1	2	3	4	5	6	7	8	9	10
17. Human anatomy	1	2	3	4	5	6	7	8	9	10
18. Botany	1	2	3	4	5	6	7	8	9	10
19. Environmental studies	1	2	3	4	5	6	7	8	9	10
20. Engineering	1	2	3	4	5	6	7	8	9	10
21. Genetics	1	2	3	4	5	6	7	8	9	10
22. Physics	1	2	3	4	5	6	7	8	9	10
23. Chemistry	1	2	3	4	5	6	7	8	9	10

Compared to other students entering college in engineering, please rate yourself on each of the following traits. We want the most accurate estimate of how you see yourself.

	Lowest 10%	Below Average	Average	Above Average	Highest 10%
1. Overall academic ability	1	2	3	4	5
2. Analytical and problem-solving skills	1	2	3	4	5
3. Ability to think critically	1	2	3	4	5
4. English writing skills	1	2	3	4	5
5. Mathematical ability	1	2	3	4	5
6. Computer skills	1	2	3	4	5
7. Ability to work independently	1	2	3	4	5
8. Scientific reasoning	1	2	3	4	5
9. Ability to work cooperatively (in a team)	1	2	3	4	5
10. Leadership ability	1	2	3	4	5
11. Ability to balance involvement in multiple tasks	1	2	3	4	5

Engineering 101 Survey – Fall 2000

Please indicate the extent to which you **agree or disagree with the following statements**, using the 10-point scale below. "Math-related" classes include any math, engineering, or physical science classes.

	Strongly Disagree	Disagree			Unsure		Agree		Strongly Agree	
	1	2	3	4	5	6	7	8	9	10
1. Doing well in math enhances my career opportunities	1	2	3	4	5	6	7	8	9	10
2. In math-related majors, there is no time to have fun.	1	2	3	4	5	6	7	8	9	10
3. People I look up to approve of my taking college math courses.	1	2	3	4	5	6	7	8	9	10
4. Taking a math related course would increase my overall GPA.	1	2	3	4	5	6	7	8	9	10
5. Math classes are enjoyable to me.	1	2	3	4	5	6	7	8	9	10
6. Taking math courses will help me keep my career options open.	1	2	3	4	5	6	7	8	9	10
7. Doing well at math will increase my sense of self-worth.	1	2	3	4	5	6	7	8	9	10
8. I would have to sacrifice leisure activities to remain in a math-related major.	1	2	3	4	5	6	7	8	9	10
9. Choosing a math-related major would lead to the kind of career I want.	1	2	3	4	5	6	7	8	9	10
10. I have known for a long time that engineering is the right major for me.	1	2	3	4	5	6	7	8	9	10
11. Good math performance is valued by my family.	1	2	3	4	5	6	7	8	9	10
12. Taking college math courses produces positive consequences for me.	1	2	3	4	5	6	7	8	9	10
13. It is difficult to pursue a math-related major and still have a social life.	1	2	3	4	5	6	7	8	9	10
14. My friends respect me for enrolling in math classes.	1	2	3	4	5	6	7	8	9	10
15. Pursuing a math-related major enables me to meet the kind of people I value most.	1	2	3	4	5	6	7	8	9	10
16. I would have to make sacrifices I my relationships to remain in a math-related major.	1	2	3	4	5	6	7	8	9	10
17. I often wonder if engineering is right for me.	1	2	3	4	5	6	7	8	9	10
18. I get excited about college math classes.	1	2	3	4	5	6	7	8	9	10
19. Majoring in a math-related field leaves me with little time for family and friends.	1	2	3	4	5	6	7	8	9	10
20. Math classes have been some of the best classes I have taken in school.	1	2	3	4	5	6	7	8	9	10
21. The rewards of a degree in a math-related field are worth the sacrifices.	1	2	3	4	5	6	7	8	9	10
22. I feel confident that I will graduate with an engineering degree.	1	2	3	4	5	6	7	8	9	10
23. There are many majors besides engineering that interest me.	1	2	3	4	5	6	7	8	9	10

Engineering 101 Survey – Fall 2000

Please rate your **confidence in your ability to complete a degree in the following majors.**

		No confidence at all									Complete Confidence
1.	Agricultural Engineering	1	2	3	4	5	6	7	8	9	10
2.	Aerospace Engineering	1	2	3	4	5	6	7	8	9	10
3.	Architecture	1	2	3	4	5	6	7	8	9	10
4.	Landscape Architecture	1	2	3	4	5	6	7	8	9	10
5	Astronomy	1	2	3	4	5	6	7	8	9	10
6.	Chemical Engineering	1	2	3	4	5	6	7	8	9	10
7.	Chemistry	1	2	3	4	5	6	7	8	9	10
8.	Civil Engineering	1	2	3	4	5	6	7	8	9	10
9.	Statistics	1	2	3	4	5	6	7	8	9	10
10.	Computer Science	1	2	3	4	5	6	7	8	9	10
11.	Geology	1	2	3	4	5	6	7	8	9	10
12.	Mathematics	1	2	3	4	5	6	7	8	9	10
13.	Physics	1	2	3	4	5	6	7	8	9	10
14.	Computer Engineering	1	2	3	4	5	6	7	8	9	10
15.	Construction Engineering	1	2	3	4	5	6	7	8	9	10
16.	Electrical Engineering	1	2	3	4	5	6	7	8	9	10
17.	Engineering Science	1	2	3	4	5	6	7	8	9	10
18.	Industrial Engineering	1	2	3	4	5	6	7	8	9	10
19.	Materials Engineering	1	2	3	4	5	6	7	8	9	10
20.	Mechanical Engineering	1	2	3	4	5	6	7	8	9	10
21.	Engineering operations (an individually developed program)	1	2	3	4	5	6	7	8	9	10

Thanks for taking the time to complete this survey!

APPENDIX IV. Math and Science Self-Efficacy Items

Self-Efficacy Math Courses Items

Please rate your confidence in your ability to complete the following courses with a "B" grade or better. (Scale from 1 = No confidence at all to 10 = Complete confidence.)

Advanced calculus
Computer science
Business administration
Biochemistry
Calculus
Zoology
Accounting
Geometry
Algebra I
Algebra II
Philosophy
College algebra
Statistics
Physiology
Trigonometry
Economics

Self-Efficacy Science Courses Items

Please rate your confidence in your ability to complete the following courses with a "B" grade or better. (Scale from 1 = No confidence at all to 10 = Complete confidence.)

Human anatomy
Botany
Environmental studies
Engineering
Genetics
Physics
Chemistry

Self-Efficacy Math and Science Occupations Items

Please rate your confidence in your ability to complete a degree in the following majors. (Scale from 1 = No confidence at all to 10 = Complete confidence.)

Agricultural Engineering
Aerospace Engineering
Architecture
Landscape Architecture
Astronomy
Chemical Engineering
Chemistry
Civil Engineering
Statistics
Computer Science
Geology
Mathematics
Physics
Computer Engineering
Construction Engineering
Electrical Engineering
Engineering Science
Industrial Engineering
Materials Engineering
Mechanical Engineering
Engineering Operations

APPENDIX V. General Academic Confidence Items

Academic Confidence

Please indicate how confident you feel in your ability to do each of the following things. (Scale from 1 = No confidence at all to 10 = Complete confidence.)

Complete an engineering degree

Complete your degree on time (4 or 5 years)

Achieve a cumulative GPA of 3.0 by graduation

Understand materials in your classes

Work closely on a research team with faculty or graduate students

Get a good job in your field with your degree

Academic Skills Confidence

Compared to other students entering the college of engineering, please rate yourself on each of the following traits. We want the most accurate estimate of how you see yourself. (Scale: 1 = Lowest 10%, 2 = Below Average, 3 = Average, 4 = Above Average, 5 = Highest 10%)

Overall academic ability

Analytical and problem-solving skills

Ability to think critically

English writing skills

Mathematical ability

Computer skills

Ability to work independently

Scientific reasoning

Ability to work cooperatively (in a team)

Leadership ability

Ability to balance involvement in multiple tasks

APPENDIX VI. Math and Science Outcome Expectation Items

Math and Science Outcome Expectations

Please indicate the extent to which your agree or disagree with the following statements, using the 10-point scale below. "Math-related" classes include any math, engineering or physical science classes. (Scale 1 = Strongly disagree, 3 = Disagree, 5-6 = Unsure, 8 = Agree, 10 = Strongly agree.)

Doing well in math enhances my career opportunities.

In math-related majors, there is no time to have fun. *

People I look up to approve of my taking college math courses.

Taking a math related course would increase my overall GPA.

Math classes are enjoyable to me.

Taking math courses will help me keep my career options open.

Doing well at math will increase my sense of self-worth.

I would have to sacrifice leisure activities to remain in a math-related major. *

Choosing a math-related major would lead to the kind of career I want.

Good math performance is valued by my family.

Taking college math courses produces positive consequences for me.

It is difficult to pursue a math-related major and still have a social life. *

My friends respect me for enrolling in math classes.

Pursing a math-related major enables me to meet the kind of people I value most.

I would have to make sacrifices in my relationships to remain in a math related major. *

I get excited about college math classes.

Majoring in a math-related field leaves me little time for family and friends. *

Math classes have been some of the best classes I have taken in school.

The rewards of a degree in a math-related field are worth the sacrifices.

* = Items that need to be reverse coded, so that the higher the score the more positive the outcome is related to math/science.

APPENDIX VII. Final Database Variables and Scale Items

Final Database Variables and Scale Items

Type of Variable	Variable Name	Variable Description
Demographic	CLASSIZE	Number of students in high school graduating class
Demographic	DADED	Level of education for father
Demographic	MOMED	Level of education for mother
Demographic	HSINVOLV	Involvement in high school activities
Demographic	UNLTMFLA	Undeclared Engineering Learning Community
Demographic	GENDER	1=Female, 0=Male
Demographic	MINORITY	1=Minority, 0=Non-minority
Demographic	CITIZEN	1=US Citizen, 0=Non-citizen
Demographic	RES_CD	Iowa resident
Demographic	ACT_CMPS	ACT Composite Score
Demographic	ACT_MATH	ACT Math Score
Demographic	ACT_ENGL	ACT English Score
Demographic	HS_RANK	High School Percentile Rank
Demographic	HSMATH	Terms of high school math
Performance	RETENTION	Retention in engineering at end of first year
Performance	F00SEM_G	Fall Semester 2000 Term GPA
Performance	S01SEM_G	Spring Semester 2001 Term GPA
Performance	S01CMLTV	Spring Semester 2001 Cumulative GPA
Performance	FALLMATH	Fall Semester 2000 Math GPA
Scale Fall	ACCONF1	Confidence scale initial survey
Scale Fall	HOTHINK1	Confidence scale initial survey
Scale Fall	MANAGE1	Confidence scale initial survey
Scale Fall	LANG1	Confidence scale initial survey
Scale Fall	LIFESCI1	Course self-efficacy initial survey
Scale Fall	HGHMATH1	Course self-efficacy initial survey
Scale Fall	BASMATH1	Course self-efficacy initial survey
Scale Fall	BASAPPL1	Course self-efficacy initial survey
Scale Fall	TANGAPP1	Career self-efficacy initial survey
Scale Fall	MATHAPP1	Career self-efficacy initial survey
Scale Fall	SCIENCE1	Career self-efficacy initial survey
Scale Fall	SOC1	Outcome expectations initial survey
Scale Fall	VALUE1	Outcome expectations initial survey
Scale Fall	ENJOYS1	Outcome expectations initial survey
Scale Fall	RELVAL1	Outcome expectations initial survey
Scale Fall	COMMIT1	Commitment to engineering initial survey
Scale Spring	ACCONF2	Confidence scale follow-up survey
Scale Spring	HOTHINK2	Confidence scale follow-up survey
Scale Spring	MANAGE2	Confidence scale follow-up survey
Scale Spring	LANG2	Confidence scale follow-up survey
Scale Spring	LIFESCI2	Course self-efficacy follow-up survey
Scale Spring	HGHMATH2	Course self-efficacy follow-up survey
Scale Spring	BASMATH2	Course self-efficacy follow-up survey

Final Database Variables and Scale Items (Continued)

Scale Spring	BASAPPL2	Course self-efficacy follow-up survey
Scale Spring	TANGAPP2	Career self-efficacy follow-up survey
Scale Spring	MATHAPP2	Career self-efficacy follow-up survey
Scale Spring	SCIENCE2	Career self-efficacy follow-up survey
Scale Spring	SOC2	Outcome expectations follow-up survey
Scale Spring	VALUE2	Outcome expectations follow-up survey
Scale Spring	ENJOYS2	Outcome expectations follow-up survey
Scale Spring	RELVAL2	Outcome expectations follow-up survey
Scale Spring	COMMIT2	Commitment to engineering follow-up survey

REFERENCES

Alford, E., & Rocheleau, D. (1998). Designing effective writing and presentation assignments for freshman engineering students. Proceedings of the 1998 Frontiers in Education Conference. Washington, D.C.: ASEE.

Al-Holou, N., Bilgutay, N.M., Corleto, C., Demel, J.T., Felder, R., Friar, K., Froyd, J. Hoit, M., Morgan, J., & Wells. D.L. (1999). First-year integrated curricula: Design alternatives and examples. Journal of Engineering Education, 88(4), 435-448.

Al-Holou, N., Bilgutay, N.M., Corleto, C., Demel, J.T., Felder, R., Friar, K., Froyd, J. Hoit, M., Morgan, J., & Wells. D.L. (1998). First year integrated curricula across the engineering education coalitions. Proceedings of the 1998 Frontiers in Education Conference. Washington, D.C.: ASEE.

Amon, C.H., Finger, S., Siewiorek, D.P. & Smailagic, A. (1996). Integrating design education, research, and practice at Carnegie Mellon: A multidisciplinary course in wearable computers. Journal of Engineering Education, 85(4), 279-286.

Astin, A.W. (1975). Preventing students from dropping out. San Francisco, CA: Jossey-Bass.

Astin, A.W. (1977). Four critical years: Effects of college on beliefs, attitudes, and knowledge. San Francisco, CA: Jossey-Bass.

Astin, A.W. (1984). Student involvement: A developmental theory for higher education. Journal of College Student Personnel, 25(4) 297-308.

Astin, A.W. (1985). Achieving educational excellence. San Francisco, CA: Jossey-Bass.

Astin, A.W. (1993). What matters in college? Four critical years revisited. San Francisco, CA: Jossey-Bass.

Astin, A.W. (1996). Involvement in learning revisited. Journal of College Student Development, 37(2) 123-134.

Avila, A., & Hinojosa, J. (1999). Integrating active and cooperative learning strategies to a redesigned microprocessor based system design course. Proceedings of the American Society for Engineering Education 1999 Annual Conference, Washington, D.C.: ASEE.

Becerra-Fernandez, I., Campbell, R., Roig, G., & Hopkins, G. (1997). Mentoring minority engineering students: A program at Florida International University. Proceedings of the American Society for Engineering Education 1997 Annual Conference, Washington, D.C.: ASEE.

Betz, N.E. & Hackett, G. (1983). The relationship of mathematics self-efficacy expectations to the selection of science-based college majors. Journal of Vocational Behavior, 23 329-345.

Bishop, S.L., & Besterfield-Sacre, M. (1996). Freshman engineering leadership team: Student mentors for recruitment and retention. Proceedings of the American Society for Engineering Education 1996 Annual Conference, Washington, D.C.: ASEE.

Bolding, K. (1999). Integrating engineering into a freshman liberal arts curriculum. Proceedings of the 1999 Frontiers in Education Conference. Washington, D.C.: ASEE.

Bordman, S., Hasan, I., & Tedesco, B. (1997). An assessment and teaching strategies of an integrated model for management and economics instruction for engineers. Proceedings of the American Society for Engineering Education 1997 Annual Conference, Washington, D.C.: ASEE.

Boyer Commission on Educating Undergraduates in the Research University (1998). Reinventing undergraduate education: A blueprint for America's research universities. Stony Brook, NY: State University of New York at Stony Brook for the Carnegie Foundation for the Advancement of Teaching.

Brent, R., Felder, R.M., Hirt, D., Switzer, D., & Holzer, S. (1999). A model program for promoting effective teaching in colleges of engineering. Proceedings of the American Society for Engineering Education 1999 Annual Conference, Washington, D.C.: ASEE.

Cabrera, A.F, Nora, A., Bernal, E.M., Terenzini, P.T., & Pascarella, E.T. (November 5-8, 1998). Collaborative learning: Preferences, gains in cognitive and affective outcomes, and openness to diversity among college students. Paper presented at the Annual Meeting of the Association for the Study of Higher Education, Miami, FL.

Catalano, G.D. & Catalano, K. (1999). Transformation: From teacher-centered to student-centered engineering education. Journal of Engineering Education, 88(1), 59-64.

Chonko, B.B. (1999). The impact of learning communities and University Orientation 101 on student involvement, satisfaction, achievement, and retention at the University of Akron (Ohio). Doctoral dissertation University of Akron; Akron, OH.

Clark, W. M. (1997). Using multimedia and cooperative learning in and out of the class. Proceedings of the 1997 Frontiers in Education Conference. Washington, D.C.: ASEE.

Claussen, T. (1997). Academic excellence by the Telemark model of cooperative learning. Proceedings of the 1997 Frontiers in Education Conference. Washington, D.C.: ASEE.

College of Engineering (2000) Blueprint for Excellence. Ames, IA: Iowa State University College of Engineering.

College of Engineering (2001). Persistence data for incoming freshman. Unpublished internal study. Ames, IA: Iowa State University.

Corleto, C., Kimball, J., Tipton, A., & McLauchlan, R. (1996). Foundation Coalition first year integrated engineering curriculum at Texas A & M University Kingsville: Development, implementation, and assessment. Proceedings of the 1996 Frontiers in Education Conference. Washington, D.C.: ASEE.

Corleto, C.R., Stewart, J. & Tipton, A. (1997). Evaluation of a first-year integrated engineering curriculum. Proceedings of the 1997 Frontiers in Education Conference. Washington, D.C.: ASEE.

Coulter-Kern, M.L. (2000). Using grounded theory to discover the differences between learning community and freestanding classes. Doctoral dissertation, University of Notre Dame: South Bend, IN.

Craven, K, Wayne, S., & Stiller, A. (1999). The freshman engineering experience at West Virginia University. Proceedings of the American Society for Engineering Education 1999 Annual Conference, Washington, D.C.: ASEE.

Crowley, L. (1998). Learning through inquiry: A creative pilot program for teaching communications in a learner-centered environment. Proceedings of the 1998 Frontiers in Education Conference. Washington, D.C.: ASEE.

Della-Piana, C.K., Vila, E.Q., Pinon, S. D. (1996). Using cooperative learning in a freshman summer engineering orientation course. Proceedings of the American Society for Engineering Education 1996 Annual Conference, Washington, D.C.: ASEE.

Demetry, C. & Groccia, J.E. (1997). A comparison assessment of students' experiences in two instructional formats of an introductory materials science course. Journal of Engineering Education, 86(3), 203-210.

Doering, L.J. (1999). Status of the freshman learning community initiative at Iowa State University. Master's thesis, Iowa State Univeristy.

Doyle, S.K., Edison, M.K., & Pascarella, E.T. (April 24-28, 2000). The influence of instructional processes on student cognitive development. Paper presented at the Annual Meeting of the American Educational Research Association. New Orleans, LA.

Dryud, M. A. (1999). Getting a grip on groups. Proceedings of the American Society for Engineering Education 1999 Annual Conference, Washington, D.C.: ASEE.

Duerden, S., Green, M., Garland, J., Doak, B., McCarter, J., Roedel, R.J., Evans, D.L., & Williams, P. (1997). Scaling up Arizona State University's first-year integrated program in engineering: Problems and solutions. Proceedings of the 1997 Frontiers in Education Conference. Washington, D.C.: ASEE.

Elias, S.M. & Loomis, R.J. (2000). Using an academic self-efficacy scale to address university major persistence. Journal of College Student Development, 41(4) 450-454.

Evans, D. (1995). Curriculum integration at Arizona State University. Proceedings of the 1995 Frontiers in Education Conference. Washington, D.C.: ASEE.

Felder, R. M., Beichner, R.J., Bernold, L.E., Burniston, E.E., Dail, P.R., & Fuller, H. (1998). Update on IMPEC: An integrated first-year engineering curriculum at NC State University. Proceedings of the American Society for Engineering Education 1998 Annual Conference, Washington, D.C.: ASEE.

Felder, R. M., Beichner, R.J., Bernold, L.E., Burniston, E.E., Dail, P.R., & Fuller, H. (1997). Update on IMPEC: An integrated first-year engineering curriculum at NC State University. Proceedings of the American Society for Engineering Education 1997 Annual Conference, Washington, D.C.: ASEE.

Felder, R. M., Bernold, L.E, Burniston, E.E, Dail, P.R, & Gastineau, J.E. (1996). IMPEC: An integrated first-year engineering curriculum. Proceedings of the

American Society for Engineering Education 1996 Annual Conference, Washington, D.C.: ASEE.

Felder, R. M., Bernold, L.E, Burniston, E.E, Dail, P.R, & Gastineau, J.E. (1996). Team-teaching in an integrated freshman engineering curriculum. Proceedings of the American Society for Engineering Education 1996 Annual Conference, Washington, D.C.: ASEE.

Felder, R., Bernhold, L., Burniston, E., Gasineau, J., & O'Neal, J. (1995). An integrated first-year engineering curriculum at North Carolina State University. Proceedings of the 1995 Frontiers in Education Conference, Washington, D.C.: ASEE.

Fentiman, A.W., &. Demel, J.T. (1995). Teaching students to document a design project and present the results. Journal of Engineering Education, 84(4), 329-334.

Fisher, W.W., Della-Piana, C.K., & Crowley, C. (1998). Using a project to link introduction to engineering, freshman composition, and pre-calculus for entering engineering students. Proceedings of the American Society for Engineering Education 1998 Annual Conference, Washington, D.C.: ASEE.

Fleming, W.J.B. (2001). The effects of campus ecology on incoming freshman students: Toward a model for residential learning community. Doctoral dissertation, Washington State University; Pullman, Washington.

Flores, B. & Della-Piana, C. (1998). Microelectronics - an introduction to formal cooperative learning. Proceedings of the 1998 Frontiers in Education Conference. Washington, D.C.: ASEE.

Friar, K. (1995). Curriculum integration at the University of Alabama. Proceedings of the 1995 Frontiers in Education Conference. Washington, D.C.: ASEE.

Froyd, J. (1995). Integrated, first-year curriculum in science, engineering, and mathematics - a ten-year process. Proceedings of the 1995 Frontiers in Education Conference. Washington, D.C.: ASEE.

Froyd. J.E., & Rogers, G.J. (1997). Evolution and evaluation of an integrated, first-year curriculum. Proceedings of the 1997 Frontiers in Education Conference. Washington, D.C.: ASEE.

Fulton, C., & Licklider, B. (1998). Re-engineering faculty development: Lessons LEA/RNed. Proceedings of the American Society for Engineering Education 1998 Annual Conference, Washington, D.C.: ASEE.

Gandhi, C. M.O. (1997). The women in science and engineering living option at Iowa State University: A program evaluation. Master's thesis, Iowa State University, Ames, IA.

Gandhi, C. M.O. (1999). A longitudinal evaluation of factors associated with retaining women in science and engineering. Doctoral dissertation. Iowa State University, Ames, IA.

Gabelnick, F., MacGregor, J., Matthews, R.S., & Smith, R.S. (1990). Learning communities: Creating connections among students, faculty, and disciplines. New Directions for Teaching and Learning No. 41. San Francisco, CA.: Jossey-Bass.

Gazel, J.E. (2001). Building community on campus: The interdependent theory and practice of the Multiracial Unity Living Experience (MRULE). Doctoral dissertation, Michigan State University. East Lansing, Michigan.

Goldberg, B.M.I. (2001). Effects of a first-semester learning community on the academic and social integration of nontraditional technical students at a commuting institution. Doctoral dissertation, Seton Hall University, South Orange, NJ.

Goldberg, B.M.I, Kist, T.M., & Lin, W.T (2001). The impact of a problem-solving, team-based, team-taught interdisciplinary learning community on non-traditional technical students at a commuting institution. Proceedings of the American Society for Engineering Education 2001 Annual Conference & Exposition.

Golde, C.M. & Pribbenow, D.A. (2000). Understanding faculty involvement in residential learning communities. Journal of College Student Development, 41(1), 27-40.

Gregg, M.H., Hirschfeld, D., & Watford, B. (1996). Student retention strategies: Gender clustering. Proceedings of the American Society for Engineering Education 1996 Annual Conference, Washington, D.C.: ASEE.

Gunn, C.J. (1996). Addressing the freshman need for an engineering experience. Proceedings of the American Society for Engineering Education 1996 Annual Conference, Washington, D.C.: ASEE.

Hackett, G., Betz, N.E., Casas, J.M., & Rocha-Singh, I.A. (1992). Gender, ethnicity, and social cognitive factors predicting the academic achievement of students in engineering. Journal of Counseling Psychology, 39(4) 527-538

Haller, C.J., Gallagher, V.J., Weldon, T.L., & Felder, R.M. (1999). Dynamics of peer interactions in cooperative learning. Proceedings of the American Society for Engineering Education 1999 Annual Conference, Washington, D.C.: ASEE.

Halloran, N.H. (2000). Freshman learning communities and their effectiveness on college student adjustment and adaptation. Doctoral dissertation, Georgia State University; Atlanta, GA.

Halpin, G., Haplin, G., Benefield, L.D., Walker, W.F., & MacGuire, S. (1999). An evaluation of an integrated pre-engineering program: Results from the freshman year and beyond. Proceedings of the American Society for Engineering Education 1999 Annual Conference, Washington, D.C.: ASEE.

Harms, P.C., Mickelson, S.K., & Brumm, T.J. (2001a). Using learning community course links to bring meaning to the first-year engineering curriculum. Proceedings of the American Society for Engineering Education 2001 Annual Conference & Exposition, Washington, D.C.: ASEE.

Harms, P.C., Mickelson, S.K., & Brumm, T.J. (2001b). Using a first-year learning community to help meet departmental program objectives in Agricultural and Biosystems Engineering. Proceedings of the American Society for Engineering Education 2001 Annual Conference & Exposition, Washington, D.C.: ASEE.

Heenan, W. & McLuauchlan, R.A. (1997). Development and implementation of an integrated engineering curriculum for the sophomore year. Proceedings of the 1997 Frontiers in Education Conference. Washington, D.C.: ASEE.

Hein, T.L. & Budny, D.D. (1999a). Teaching to students' learning styles: Approaches that work. Proceedings of the 1999 Frontiers in Education Conference. Washington, D.C.: ASEE.

Hein, T.L., & Budny, D.D. (1999b). Teaching with style: Strategies that work. Proceedings of the American Society for Engineering Education 1999 Annual Conference, Washington, D.C.: ASEE.

Hendricks, R.W., & Pappas, E.C.. (1996). Advanced engineering communications: An integrated writing and communication program for materials engineers. Journal of Engineering Education, 85(4), 343-352.

Hoit, M., & Ohland, M. (1996). Integrating the first two years of engineering education. Proceedings of American Society for Engineering Education 1996 Annual Conference, Washington, D.C.: ASEE.

Holm, S.K. (2000). Developmental students' perceptions of their learning community experiences in relation to their persistence in college. Doctoral dissertation, The University of Akron, Akron, OH.

Hundhausen, J.R., & Yeatts, R. (1995). An experiment in integration: Calculus and physics for freshman. Journal of Engineering Education, 84(4) 369-374.

Hunkeler, D., & Sharp, J.E. (1997). Assigning functional groups: The influence of group size, academic record, practical experience, and learning style. Journal of Engineering Education, 86(4), 321-332.

Jacobson, D., Davis, J., & Licklider, B. (1998a). See one, do one, teach one... Two faculty member's path through student-centered learning. Proceedings of the 1998 Frontiers in Education Conference. Washington, D.C.: ASEE.

Jacobson, D., Davis, J., & Licklider, B. (1998b). Ten myths of cooperative learning in engineering education. Proceedings of the 1998 Frontiers in Education Conference. Washington, D.C.: ASEE.

Jacobson, D., & Licklider, B. (1999). Project SUCCESS: Sustaining undergraduate careers: A computer engineering support system. Proceedings of the American Society for Engineering Education 1999 Annual Conference, Washington, D.C.: ASEE.

Jahanian, S. (1999). Multidisciplinary project: A tool for learning the subject. Journal of Engineering Education, 88(2), 153-158.

Johnson, D., Johnson, R., & Smith, K. (1991). Active learning: Cooperation in the college classroom. Edina, MN: Interaction Book Company.

Jones, J.D, & Brickner, D. (1996). Implementation of cooperative learning in a large-enrollment basic mechanics course. Proceedings of the American Society for Engineering Education 1996 Annual Conference, Washington, D.C.: ASEE.

Karp. M. (1998). Cooperative and collaborative learning in university aviation education. Proceedings of the 1998 Frontiers in Education Conference. Washington, D.C.: ASEE.

King, R.H., Parker, T.E., Grover, T.P., Gosink, J.P., & Middleton, N.T. (1999). A multidisciplinary engineering laboratory course. Journal of Engineering Education, 88(3) 311-316.

Lamancusa, J.S., Jorgensen, J.E, & Zayas-Castro, J.L. (1997). The learning factory- A new approach to integrating design and manufacturing into the engineering curriculum. Journal of Engineering Education, 86(2), 103-112.

Landis, R. (1990). Building collaborative learning communities. Proceedings of the American Society for Engineering Education 1990 Annual Conference, Washington, D.C.: ASEE.

Larson, D., Gruber, S., Scott, D., & Neville, M. (1998). A holistic assessment of writing in design. Proceedings of the 1998 Frontiers in Education Conference. Washington, D.C.: ASEE.

Lenning, Oscar T., & Ebbers, L.H. (1999). The powerful potential of learning communities: Improving education for the future. ASHE-ERIC Higher Education Report Volume 26, No. 6. Washington, D.C.: The George Washington University Graduate School of Education and Human Development.

Lent, R.W, Brown, S.D., & Larkin, K.C. (1984). Relation of self-efficacy expectations to academic achievement and persistence. Journal of Counseling Psychology 31, 356-362.

Lent, R.W, Brown, S.D., & Larkin, K.C. (1986). Self-efficacy in the prediction of academic performance and perceived career options. Journal of Counseling Psychology, 33 265-269.

Lent, R.W., Lopez, F.G., & Bieschke, K.J. (1993). Predicting mathematics-related choice and success behaviors: Test of an expanded social cognitive model. Journal of Vocational Behavior, 42 223-236.

Levine, J.H. (Ed.) (1999). Learning communities: New structures, new partnerships for learning. (Monograph No. 26). Columbia SC: University of South Carolina, National Resource Center for the First-Year Experience and Students in Transition.

Lopez, F.G., & Lent, R.W. (1992). Sources of mathematics self-efficacy in high school students. The Career Development Quarterly ,41, 3-12.

Martin, D.C., & Arendale, D.R. (eds.) (1994). Supplemental instruction: Increasing achievement and retention. New Directions for Teaching and Learning, 60. San Francisco, CA: Jossey-Bass.

Martinazzi, R., & Samples, J. (1997). Using active learning to teach technical and non-technical skills in the same course. Proceedings of the 1997 Frontiers in Education Conference. Washington, D.C.: ASEE.

Matsumoto, E., Masters, C., Akyurtlu, A., Hill, D., Ivory, M., Regan, A., Tutumluer, E., Coppock, K., Courter, S., Luker, K., & Pfatteicher, S. (1998). The Engineering Education Scholars Program - Preparing a new generation of faculty. Proceedings of the American Society for Engineering Education 1998 Annual Conference, Washington, D.C.: ASEE.

McDowell, J. & Yost, S. A. (1998). A low-cost approach to the retention of undergraduate women engineering and science students. Proceedings of the American Society for Engineering Education 1998 Annual Conference, Washington, D.C.: ASEE.

Mehta, S. (1998). Cooperative learning strategies for large classes. Proceedings of the American Society for Engineering Education 1998 Annual Conference, Washington, D.C.: ASEE.

Meier, R. D. (1999). Active learning in large lectures. Proceedings of the American Society for Engineering Education 1999 Annual Conference, Washington, D.C.: ASEE.

Mickelson, S.K., Harms, P.C., & Brumm, T.J. (2001). Building community for first- and second-year students in the Agricultural and Biosystems Engineering Department at Iowa State University. Proceedings of the American Society for Engineering Education 2001 Annual Conference & Exposition, Washington, D.C.: ASEE.

Millan, H.L. (1996). Poetry in engineering education. Journal of Engineering Education, 85(2), 157-162.

Miller, R., & Olds, B. (1995). Connections: Integrated first-year engineering education at the Colorado School of Mines. Proceedings of the 1995 Frontiers in Education Conference. Washington, D.C.: ASEE.

Moller-Wong, C.L. (1995). Development of a longitudinal data base for tracking and analysis of attrition data. Doctoral dissertation. Iowa State University. Ames, IA.

Moody, L., & Burtner, J. (1998). Using collaborative learning techniques to integrate economics and engineering economy at the freshman level. Proceedings of the American Society for Engineering Education 1998 Annual Conference, Washington, D.C.: ASEE.

Mourtos, N.J. (1997). The nuts and bolts of cooperative learning in engineering education. Journal of Engineering Education, 86(1), 35-38.

National Science Board (2002). Science and Engineering Indicators, National Science Foundation, Washington, D.C.: www.nsf.gov/sbe/srs/seind02.

Nelson, J., & Napper, S. (1999). Ramping up an integrated engineering curriculum to full implementation. Proceedings of the 1999 Frontiers in Education Conference. Washington, D.C.: ASEE.

Office of Institutional Research (2000). Interpretation of entering student test scores. Ames, IA: Iowa State University.

Olds, B. (1998). Technical writing across the curriculum: Process, problems, and progress. Proceedings of the 1998 Frontiers in Education Conference. Washington, D.C.: ASEE.

Parker, J., Cordes, D, Laurie, C., Hoppenwasser, A., Izzat, J., & Nickles, D. (1995). Curriculum integration in the freshman year at The University of Alabama. Proceedings of the 1995 Frontiers in Education Conference. Washington, D.C.: ASEE.

Pascarella, E.T., Edison, M., Whitt, E.J., Hagedorn, L.S., Nora, A., & Terenzini, P.T. (1996). What have we learned from the first year of the National Study of Student Learning? Journal of College Student Development, 37(2) 182-192.

Pauschke, J., Felver, J. Jr., & Marcellus, R. (1996). An academic residential program for engineering and technology students. Proceedings of the

American Society for Engineering Education 1996 Annual Conference, Washington, D.C.: ASEE.

Pike, G.R. (1999). The effects of residential learning communities and traditional residential living arrangements on educational gains during the first year of college. Journal of College Student Development, 40(3) 269-283.

Quinn, R. (1995). Implementing large scale curriculum changes - the Drexel experience. Proceedings of the 1995 Frontiers in Education Conference. Washington, D.C.: ASEE.

Quinn, R.G. (1993). Drexel's E4 Program: A professional experience for engineering students and faculty. Journal of Engineering Education, 82(4).

Rochefort, W.E. (1998). Leadership and mentoring in undergraduate engineering programs. Proceedings of the American Society for Engineering Education 1998 Annual Conference, Washington, D.C.: ASEE.

Rogers, G., & Winkel, B.J. (1993). Integrated first-year curriculum in science, engineering and mathematics: Nature, evolution, and evaluation. Proceedings of American Society for Engineering Education 1993 Annual Conference. Washington, D.C.:ASEE.

Rosati, P. (1999). Specific differences and similarities in the learning preferences of engineering students. Proceedings of the 1999 Frontiers in Education Conference. Washington, D.C.: ASEE.

Schaub, D.A., Legg, S.M., Svoronos, S.A., Koopman, B.L., & Bau, S.X. (1999). Applying total quality management in an interdisciplinary engineering course. Journal of Engineering Education, 88(1), 107-118.

Schaefers, K.G. (1993). Women in engineering: Factors affecting persistence and attrition in college majors. Doctoral dissertation, Iowa State University, Ames, IA.

Schroeder, C.C., & Hurst, J.C. (1996). Designing learning environments that integrate curricular and cocurricular experiences. Journal of College Student Development, 41(2) 174-181.

Schulz, K.H., & Ludlow, D.K. (1996). Incorporating group writing instruction in engineering courses. Journal of Engineering Education, 85(3), 227-232.

Sehitoglu, H., & Saint, P.K. (1998). Retraining laid-off engineers using an integrated curriculum: The project INTENT experience. Journal of Engineering Education, 87(5), 549-554.

Seymour, R.M., McKeage, K., Donahue, D.W., Skinner, D., & Christensen, T. (1999). Interdisciplinary team projects with marketing students to improve engineering capstone design experience. Proceedings of the American Society for Engineering Education 1999 Annual Conference, Washington, D.C.: ASEE.

Sharp, J.E., Harb, J.N., & Terry, R.E. (1997). Combining Kolb learning styles and writing in engineering classes. Journal of Engineering Education, 86(2), 93-102.

Sharp, J.E., Olds, B.M., Miller, R.L., & Dyrud, M. (1999). Four effective writing strategies for engineering classes. Journal of Engineering Education, 88(1), 53-58.

Shuman, L. J., Delany, C., Wolfe, H., Scalise, A., & Besterfield-Sacre, M. (1999). Engineering attrition: Student characteristics and educational initiatives. Proceedings of the American Society for Engineering Education 1999 Annual Conference, Washington, D.C.: ASEE.

Shuman, L.J., Atman, C. J., & Wolfe, H. (1996). Applying TQM in the IE classroom: The switch to active learning. Proceedings of the American Society for Engineering Education 1996 Annual Conference, Washington, D.C.: ASEE.

Smith, K.A. (1995). Cooperative learning: effective teamwork for engineering classrooms. Proceedings of the 1995 Frontiers in Education Conference. Washington, D.C.: ASEE.

Smith, K.A. (1998). Cooperative learning. Proceedings of the American Society for Engineering Education 1998 Annual Conference, Washington, D.C.: ASEE.

Steadman, S., & Whitman, D. (1999). Residential innovations for engineering students. Proceedings of the American Society for Engineering Education 1999 Annual Conference, Washington, D.C.: ASEE.

Terenzini, P.T., Pascarella, E.T., & Blimling, G.S. (1996). Students' out-of-class experiences and their influence on learning and cognitive development: A literature review. Journal of College Student Development, 37(2) 149-162.

Terenzini, P.T., Springer, L., Pascarella, E.T., & Nora, A. (1995). Academic and out-of-class influences on students' intellectual orientations. The Review of Higher Education, 19(2) 23-44.

Tharp, H. (1998). Improving writing skills through an upper-division course. Proceedings of the 1998 Frontiers in Education Conference. Washington, D.C.: ASEE.

Tinto, V. (1993) Leaving College: Rethinking the causes and cures of student attrition (2nd Ed.) Chicago,IL:The University of Chicago Press.

Tinto, V. (1997) Classrooms as communities. Journal of Higher Education, 68(6). 599-623.

Tinto, V., & Goodsell, A. (1994). Freshman interest groups and the first year experience: Constructing student communities at a large university. Journal of the Freshman Year Experience, 6(1), 7-28.

Tinto, V., Goodsell, A., & Russo, P. (1993). Building community among new college students. Liberal Education, 79(4), 16-21.

Tonso, K.L. (1996). Student learning and gender. Journal of Engineering Education, 85(2), 143-150.

Tooley, M.S. (1997). The WIN Program - A mentoring program for women in engineering at the University of Arkansas. Proceedings of the American Society for Engineering Education 1997 Annual Conference, Washington, D.C.: ASEE.

Treisman, P.U. (1985). A study of the mathematics performance of black students at the University of California-Berkeley. Doctoral dissertation. Berkeley, CA.

Waitz, I.A., & Barrett, E.C. (1997). Integrated teaching of experimental and communication skills to undergraduate aerospace engineering students. Journal of Engineering Education, 86(3), 255-262.

Walker, A.A. (2001). The impact of general education clusters on first-year university students. Doctoral dissertation, University of California, Los Angeles; Los Angeles, CA.

Wheeler, E. & McDonald, R. (1998). Using writing to enhance collaborative learning in engineering courses. Proceedings of the 1998 Frontiers in Education Conference. Washington, D.C.: ASEE.

Whitt, E.J., Nora, A., Edison, M., Terenzini, P.T., & Pascarella, E.T. (1999). Interactions with peers and objective and self-reported cognitive outcomes across 3 years of college. Journal of College Student Development, 40(1) 61-78.

Wilke, R.R. (2000). The effect of active learning on college students' achievement, motivation, and self-efficacy in a human physiology course for non-majors. Doctoral dissertation, The University of Texas at Austin; Austin, TX.

Wooten, E. (1998). Cooperative learning: introduced in three different levels of electrical engineering courses at a military institution. Proceedings of the 1998 Frontiers in Education Conference. Washington, D.C.: ASEE.

Zunkel, K. (2000a). Learning communities in engineering education, Presentation at the ASEE North Midwest Section Meeting, Minneapolis, MN.

Zunkel, K. (2000b). Impact of learning communities on undeclared engineering students. Presentation at the ASEE North Midwest Section Meeting, Minneapolis, MN.

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