CircLES: A Comprehensive First-Year Program for Entering Engineering and Science Students

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Abstract

The current paper describes a comprehensive first-year program for all entering engineering and science students that has been implemented at The University of Texas at El Paso. Designed to meet the educational and developmental needs of entering students attending an urban commuter campus, *CircLES* links a mandatory summer orientation and advising with a required first year engineering or science oriented learning community for the purpose of increasing student success and persistence toward graduation. Emphasis is placed on developing an environment in the first year in which students learn to be successful college students and begin the development of lifelong learning habits. This paper describes the rational, goals, and the structure of the program, results of the pilot and institutional scale-up, lessons learned, and challenges facing the movement of students from an entering students program to departmental programs. Retention rates and student feedback indicate that the program is accomplishing the short-term outcomes of increasing retention rates and providing students with experiences designed to increase their success and progress into the major.

I. Introduction

Increasing the retention rates and the success of students in engineering and science have become growing concerns for engineering and science programs across the nation. Historically, students in the Colleges of Engineering and Science at The University of Texas at El Paso (UTEP) have returned after one year at a rate slightly above the institutional one-year retention rate (~66% regular admissions university-wide 1997 Student Cohort). However, the six-year graduation rate for students in the sciences and engineering is generally lower than the rest of the institution. In the past, pre-engineering and pre-science students, many who are not calculus-ready, have been over-looked by engineering and science programs. During their first year at UTEP, they have relied on university-wide advising and taken general education courses with no interaction with faculty and staff in the Colleges of Science and Engineering. In an effort to address these issues, the Colleges of Engineering and Science with the support of the National Science Foundation Model Institutions for Excellence Program have instituted an innovative

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comprehensive first-year program for entering students in engineering and science called *CircLES* (Circles of Learning for Entering Students). The uniqueness of the *CircLES* program lies in the collaborative relationship developed between the Colleges of Engineering and Science and the creation of an administrative unit headed by an Associate Dean for Engineering and Science who holds an administrative appointment in both Colleges.

CircLES provides an academic "home" for entering students in science, engineering and mathematics (SEM). The objectives of *CircLES* are to increase retention, improve academic performance and add value to a student's education through the creation of an environment in which students make connections with the University, the Colleges, SEM faculty and staff, and other students. A summer orientation begins the process of introducing new students into the academic and social communities of the university. The engineering or science oriented learning communities provide students with the knowledge and skills necessary for success at the university and facilitates students' progress into the major. Throughout the first year students participate in advising activities conducted by student development professionals whose expertise is in advising students in science and engineering programs.

Since its inception in the spring of 1998, the *CircLES* Program has become recognized model on campus and elsewhere for creating a strong foundation for entering students to springboard them toward a successful college and (eventual) professional career. Two areas in the literature influenced the design of the program: (1) research on institutional departure and persistence[1 2] and (2) programmatic efforts focused on undergraduate curriculum innovation/reform, specifically, learning communities [3 4] and the first–year seminar.[5]

Research on students' departure and persistence in higher education reveals, that the decision to depart or persist, is a function of the interaction between the academic and social context of the campus and students' experiences and background. Tinto's (1993) model speaks to the longitudinal process of students' decisions to persist or depart from the university. It is a social psychological model focused on the multiple interactions in the social and intellectual context of the institution. The model focuses on elements that are relevant to institutional policy and to members of an institution asking and answering the question: How can the institution be altered to enhance retention on campus? The model of persistence and departure, in brief, starts with pre-entry attributes (family background, skills and abilities, and prior schooling). These attributes influence students' entering goals and commitments, specifically, intentions, academic goals, institutional commitments, and external commitments. These influence the kinds of institutional experiences the students have in the academic system (academic performance and faculty/staff interactions) and in the social system (extracurricular activities and peer group interaction). These academic and social experiences form students' levels of academic and social integration into the institution and in turn influence students' decisions to leave or persist. .

In their ethnographic study of "talking about leaving" science or engineering, Seymour and Hewitt (1997) found that students' reasons for staying or leaving the sciences and engineering are embedded in complex processes in which students become aware of their professional and personal goals and the ways in which the faculty and other representatives of the institution "create" the academic culture (i.e., ways of teaching, faculty interactions with students, students interactions with students, the lack of emphasis place on teaching and student learning in science and engineering-oriented courses). Students, both switchers and non-switchers, emphasized what Seymour and Hewitt (1997) labeled "structural or cultural sources" within the institution or concerns about future careers. Both groups of students reported the lack of teaching strategies supporting student learning and/or an academic culture withholding interactions with science and engineering faculty until after completion of fundamental courses. These findings support current and past recommendations for the reform of undergraduate education.[6]

One curricular innovation that has promise for increasing students' academic and social integration into the institution is the development and implementation of learning communities. In general, learning communities can be described as both curricular and organizational innovations that "purposefully restructure the curriculum to link together courses or coursework" that supports coherence of instruction, material and assignments and increased interaction between students and faculty.[7 8 9 10] The literature suggests the value of incorporating a first-year seminar into learning communities as a way to provide a needed linchpin for developing and maintaining a coherence of the experience[11]. The FIPSE Learning Communities Dissemination Project has defined five vital elements whose presence seem to be associated with learning community initiatives that "are being propelled forward, or whose absence makes the process much more challenging:" (1) Institutional readiness; (2) funding and other resources; (3) faculty involvement and faculty support; (4) collaborative leadership group and (5) assessment as a strategy for program development. Since these elements are defined as important to instituting and institutionalizing change in higher education, an effort continues to be made to sustain them in the *CircLES* Program.

This paper is divided into five sections. Section I has provided an introduction to the program. Section II provides a brief background of the program and Section III provides an overview of the program. Section IV presents the results of the on-going evaluation and assessment of the program. Finally, Section V provides a set of lessons learned and challenges that face programs involved in curricular and institutional change.

II. Background of the Program

Increasing the number and diversity of students who obtain undergraduate degrees in science, mathematics, engineering and technology and then pursue graduate degrees in those fields are crucial elements in this nation's effort to sustain economic stability and remain at the scientific and technological forefront.[12 13] In recent years, these efforts have sought to increase the number of students from traditionally under-represented groups in science, mathematics, engineering and technology (SMET) at all educational levels.

With funding from the National Science Foundation's Model Institutions for Excellence Program, the Model Institutions for Excellence (MIE) project at The University of Texas at El Paso (UTEP), an Hispanic-serving institution, has focused its efforts towards increasing the number and diversity of SMET professionals.

> The University of Texas at El Paso (UTEP) will serve as one of the models for successful recruitment, academic enrichment, early research experience, mentoring, counseling, orientation to graduate school, and undergraduate retention and production of quality SEM baccalaureate degree recipients who go on to earn doctoral degrees in SEM (Cooperative Agreement HRD-9550502).

UTEP's MIE is required to produce the following:

- A mandatory summer transition program for all entering SEM students and course integration and clustering for all entering students;
- An integrated problem solving course for all second year SEM students and the services of an academic center for engineers and scientists;
- Research, mentoring and professional internships, including expansion of undergraduate research experiences and industrial internships and enhancement of upper division SEM courses;
- An active learning center offering collaborative and computer-based learning opportunities;
- New rewards for innovative and outstanding teaching with student-learning as the key; and
- Enhancement of the institution's capacity for evaluation and assessment for improvement, accountability, and understanding of undergraduate education in SEM that leads to student success and institutionalization of best practice.

With funding for this comprehensive and systemic reform effort, UTEP's MIE was required to develop and institutionalize (1) a mandatory summer transition program for all entering science, engineering and mathematics (SEM) students and (2) course integration and clustering for all entering SEM students that included a Freshman Seminar, an introductory course in SEM (Physical Science and Engineering or Life Sciences), a first semester mathematics course, and a first semester English Composition course. In addition, the program was to incorporate an advising component for pre-engineering and pre-science students who, until MIE, did not have an "academic home," and relied on general university advising. To coordinate and administer these activities, the Deans of the Colleges of Engineering and Science created an Associate Dean for Engineering and Science who reports to both Deans and an administrative office to oversee the *CircLES* Program (Office of the Associate Dean for Engineering and Science).

III. Program Description

Circles of Learning for Entering Students (*CircLES*) is a comprehensive retention program targeting first-time freshmen and first-time transfer students in science, engineering, and mathematics. The goals of the program are threefold: 1) To provide pre-engineering and pre-science students with the skills and knowledge to become successful college students; 2) to develop leadership skills and self-awareness in entering and other students to foster their success; and 3) to connect entering students to the university, the college, engineering and science faculty and staff, and to each other. These goals are accomplished by designing the program and its activities to be consistent with curriculum and organizational change work dealing with the reform of undergraduate education describes in the higher education literature.

Prior to 1999, there were separate orientation programs for pre-science and pre-engineering students and for the general population of entering students. To better serve the entering SEM students, *CircLES* integrated the activities of the pre-science and pre-engineering programs, incorporating the best practices from each orientation. In addition, the program linked its activities with selected activities of the university-wide orientation so that SEM students benefited from information about the university in general, such as healthy life styles and university academic policies. Table 1 lists the types of activities in which entering SEM students participated during the 2000 Summer Orientation.

Table 1. Orientation Activities

Activities
• Math Refersher • Design Project/Science Laboratory Experience • Factors-Course Catalog • Math Anxiety Workshop • Tim Management; Cost of Tuition • Lunch with Professors • Taking Personal Responsibility Workshop • Academic Center for Engineers & Scientists • College Open Hours • Programs in Science and Engineering Session

The *CircLES* orientation contains two major activities in addition to the standard activities designed to connect students to the university and the colleges. The students are introduced to engineering and science through a weeklong design project or a science laboratory experience. At the end of the week, teams of students present the results of their project or experiment. Students also participated in a weeklong math refresher curriculum designed to help them improve their mathematics placement test scores. At this time students are registered as a learning community cohort based on “declared major.”

Clusters or Learning Communities are the hallmark of the *CircLES* Program. All first-time freshmen are required to participate in a three course Clustuer consisting of a mathematics course, and English course and a University core course, Seminar in Critical Inquiry. A unique feature of our learning communities is that students are placed in cluster groupings based on mathematics and English placement scores. The seminar proves to be an excellent curricular vehicle for providing science, engineering and mathematics students with the skills necessary to be successful in college. In addition, students interact with engineering and science faculty and staff, as well as upper division students and their peers. Include in the clustered courses are team building activities, self-awareness activities, and critical thinking activities along with problem solving activities designed for engineering and science students. In all section of the Seminar students learn cooperative learning strategies and apply group skills to complete assignments both in and out of class and are required to present one or more oral reports and complet multiple written assignments. In addition, the Seminar serves as the "glue" to connect faculty with each other and to integrate course topics and assignments across courses.

Strong developmental advising is an essential element of the *CircLES* Program. The program has been very successful in instituting a variety of approaches to "intrusive" advising and schedule building. Instead of having students register for courses on their on or with help from general advising, *CircLES* requires students to meet with student development professionals who specialize in engineering and science. In the fall of 1999, *CircLES* initiated a program in which first semester students were advised in their Seminar courses. The advising process brought together a team consisting of the course instructor and peer facilitator along with a student development professional from the *CircLES* Program. The process has been so successful that it has been extended into the second semester. Based on the advising and mentoring activities of *CircLES*, it has become the focal point or "home" for entering SEM students.

CircLES employs a number of students, as Orientation Leaders and Peer Facilitators for the clustered courses. These students undergo extensive training during the summer and the academic year. They become part of the instructional team for the orientation and learning communities and are involved in the planning of activities and teaching. For example, the Orientation Leaders are an integral part of the planning process for the Orientation. They develop the instructional modules, write the skits and oversee the engineering design project and the science laboratory experience.

Peer facilitators in the Seminar participate in teaching xourse material and are role models for the entering students. In addition, they are tutors and act as "translators" and mediators, helping students make sense of the university and university course expectations. Many of these students move onto research or other professional development opportunities. Of the 86 students who are participated as peer facilitators 50 of them are still in school, 16 have received their bachelors degrees and are pursuing masters degrees at UTEP, 12 students have graduated, and 8 students have stopped out.

IV. Success of the Program

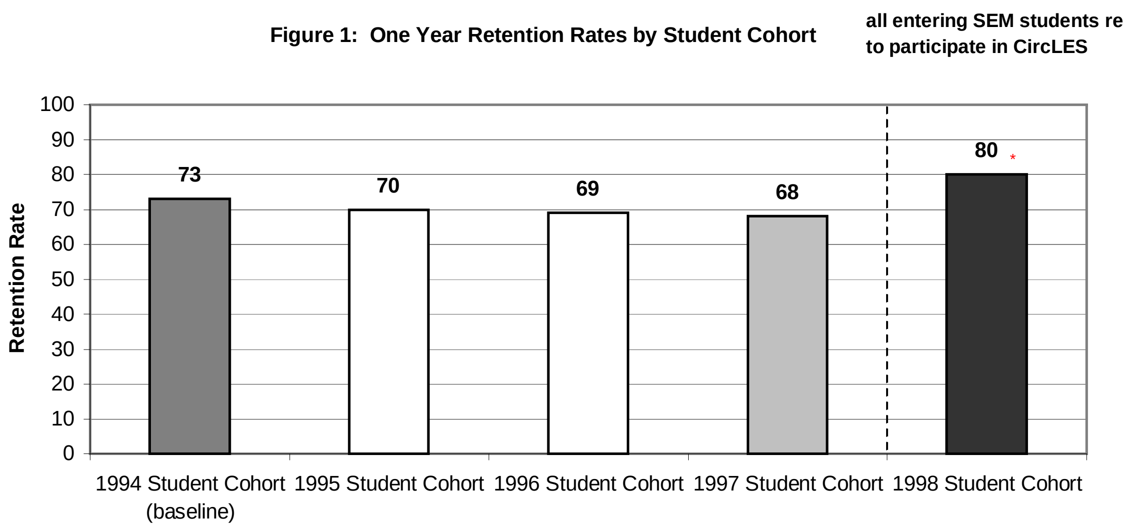
This integrated approach has proved to be highly effective in enhancing the retention and success of our pre-engineering and pre-science students. Retention rates were defined as the percent of students in a cohort who re-enrolled at UTEP in subsequent years. Success of the students was defined as the mean cumulative grade point average (GPA) for the cohort. GPA was selected as an indicator based on the types of decisions the institutions makes using individual grade point averages, such as probation, entry into a major and graduation. A secondary indicator of student success is the average number of completed hours in a semester in relation to the average number of attempted hours in a semester for the cohort. Number of complete hours is an indicator of student persistence in their courses and the degree to which the student is making progress in completing his/her degree program.

The 1997 cohort of entering SEM student included two groups that comprise the comparison groups for the longitudinal study of student cohorts: a group of students who self-selected to participate in the 1997 learning communities (the 1997 Pilot Cohort) and students who chose not to participate in the learning communities (the 1997 Comparison Cohort). The 1997 Comparison Cohort was selected as the primary comparison group for the longitudinal study. A second student cohort, the 1997 Pilot Cohort, was selected as the secondary comparison group. Subsequent cohorts will be compared to them. (The external evaluation group for the MIE project selected the 1994 student cohort retention rate as a baseline measure.) These comparison groups are label as follows: 1994 Student Cohort (baseline), 1997 Comparison Cohort, and 1997 Pilot Cohort.

The 1998 Cohort was the first entering SEM student cohort to participate in the scale-up of the *CircLES* learning communities, that is, all entering SEM students for fall 1998 who also participated in the summer orientation were enrolled in the learning communities. Figure 1 presents one-year retention data for the 1998 Cohort in relation to the 1997 Student Cohort and the one-year retention rates of student cohorts for the years 1994 to 1996. (Table 2 presents one-year retention data for the fall 1999 Cohort and two-year retention rates for the 1998 Cohort).

Based on a statistical analysis of enrollment data, the one-year retention rate for the 1998 Student Cohort was significantly higher than the one-year retention rate for the 1997 Student Cohort ($z = 3.32$; p-value = .001). “One Year Retention Rates by Student Cohort” is presented in Figure 1.

Figure 1: One Year Retention Rates by Student Cohort



To further test the statistically significant overall one-year retention rate for the 1998 CircLES Cohort, an analysis of gender and ethnicity was conducted using the Cochron-Matel-Haenszel statistical analysis controlling for gender and ethnicity. The significant overall retention rate is reinforced by significantly higher retention rates for Hispanic and males with the retention rate for females approaching statistical significance. Figure 2. "One-Year Retention Rates: Overall, Hispanic, Males, and Females" presents the overall retention rates for the 1997 Comparison Cohort and the 1998 CircLES Cohort along with the one-year retention rates disaggregated for Hispanics, males, and females for both cohorts.

Figure 2. One-year Retention Rates: Overall, Hispanic, Males and Females

Although a statistical analysis of enrollment data comparing the one-year retention rate for the 1997 Pilot Cohort with the 1998 CircLES Cohort was not performed, it is important to note that the one-year retention rate for the 1998 CircLES Cohort (representing the scale-up) was higher than the over-all one-year retention rate of students who self-selected into the 1997 Pilot Cohort. Figure 3. "One-Year Retention Rates: Overall, Hispanic, Male and Females for Three Groups" presents retention rates for the 1997 Comparison Cohort, the 1997 Pilot Cohort, and the 1998 CircLES Cohort. NOTE: The 1998 CircLES Cohort includes all entering science, engineering and mathematics students.

Figure3.
One-Year Retention Rates by Comparison, Pilot and CircLES Cohorts: Overall, Hispanic, Males and Females

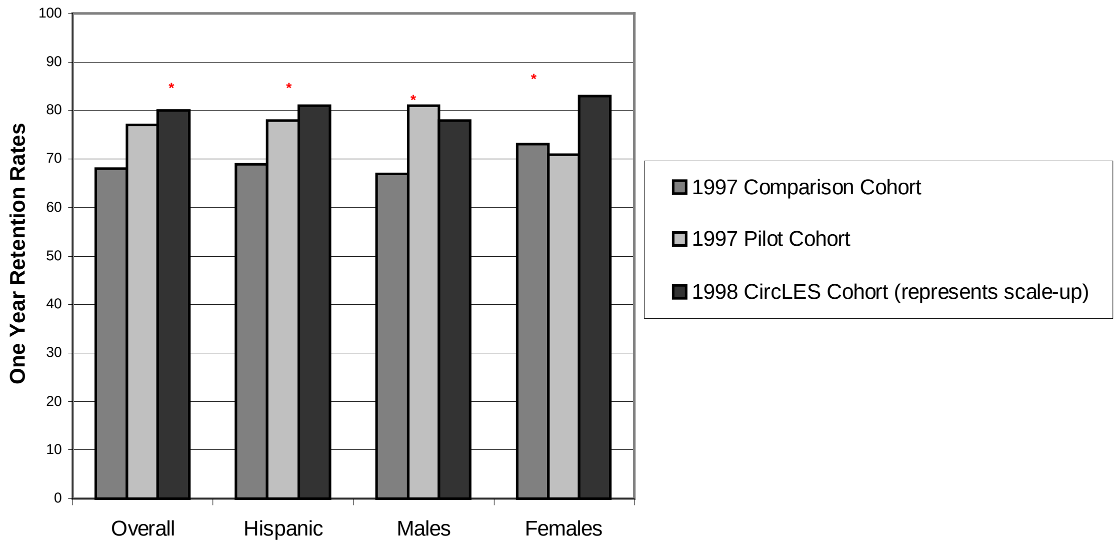


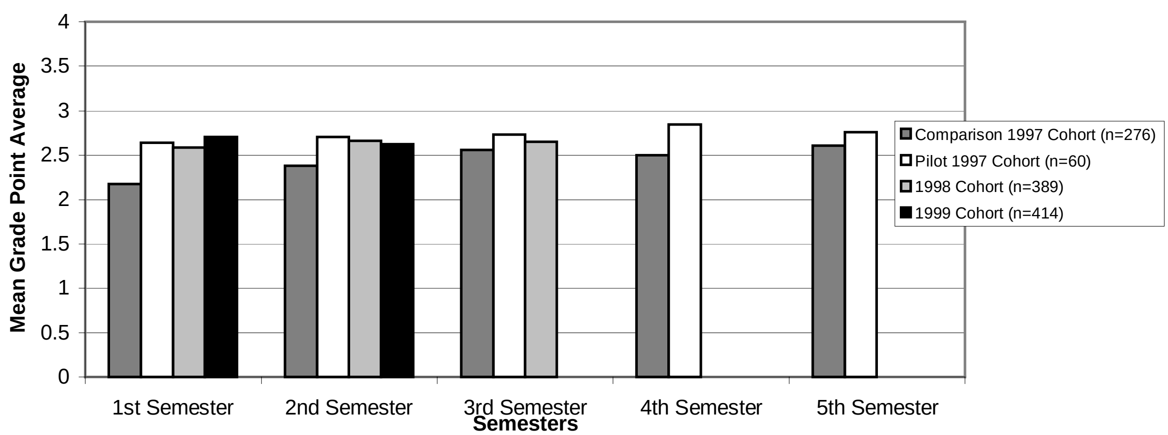
Table 2. "Retention Rates for 1998 Cohort and the 1999 Cohort" presents the one-year retention rates for the 1998 Cohort and the 1999 Cohort and the two-year retention rates for the 1998 Cohort compared to the University-wide retention rates. NOTE: The University-wide retention rates include entering SEM students.

Table 2. Retention Rates for the 1998 Student Cohort and the 1999 Student Cohort

Student Cohort	**One-year retention rate**	**Two-year retention rate**
1998 Student Cohort – University wide (1,811 students including SEM)	70%	57%
1998 Student Cohort SEM (approximately 400 students)	**80%**	**69%**
1999 Student Cohort – University wide (1,985 students including SEM)	70%	
1999 Student Cohort SEM (approximately 400 students)	**80%**	

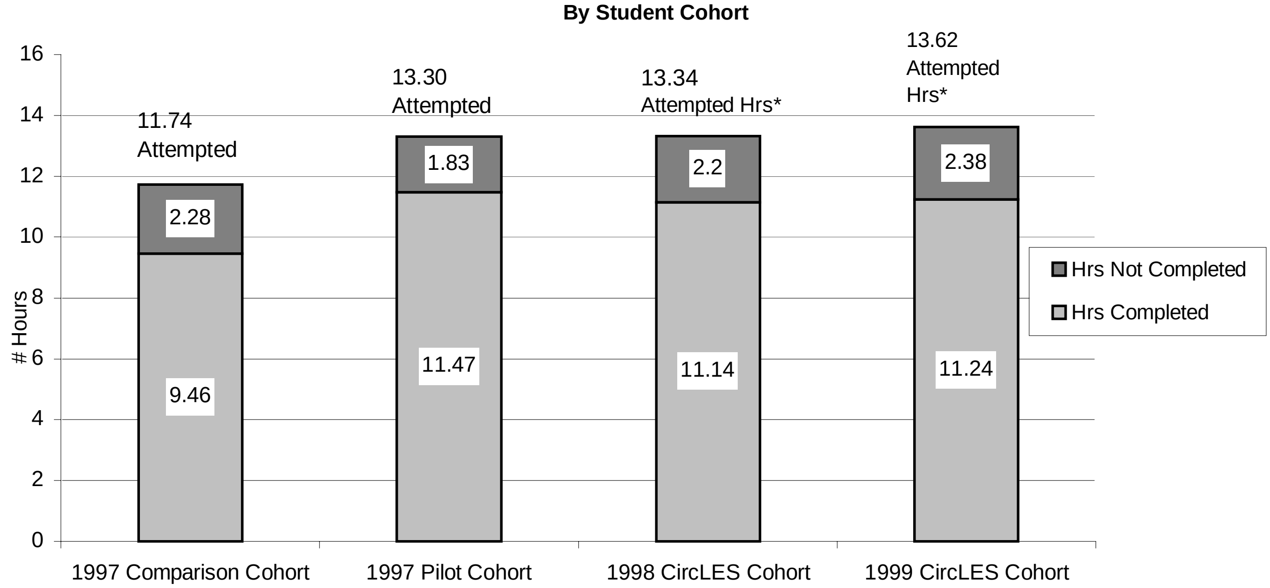
In addition, two indicators of student success were examined: Mean cumulative grade point average and hours completed/hours attempted. For the first semester, the mean cumulative grade point average for the 1997 Pilot Cohort, the 1998 CircLES Cohort, and the 1999 CircLES Cohort were higher than the mean cumulative grade point average for the 1997 Comparison Cohort. Furthermore, the mean cumulative grade point average for the 1997 Student Cohort is consistently lower as student cohorts complete more semesters of coursework. See Figure 4. Mean Cumulative Grade Point Average by Semester.

Figure 4.
Mean Cumulative Grade Point Average (GPA) by Semester



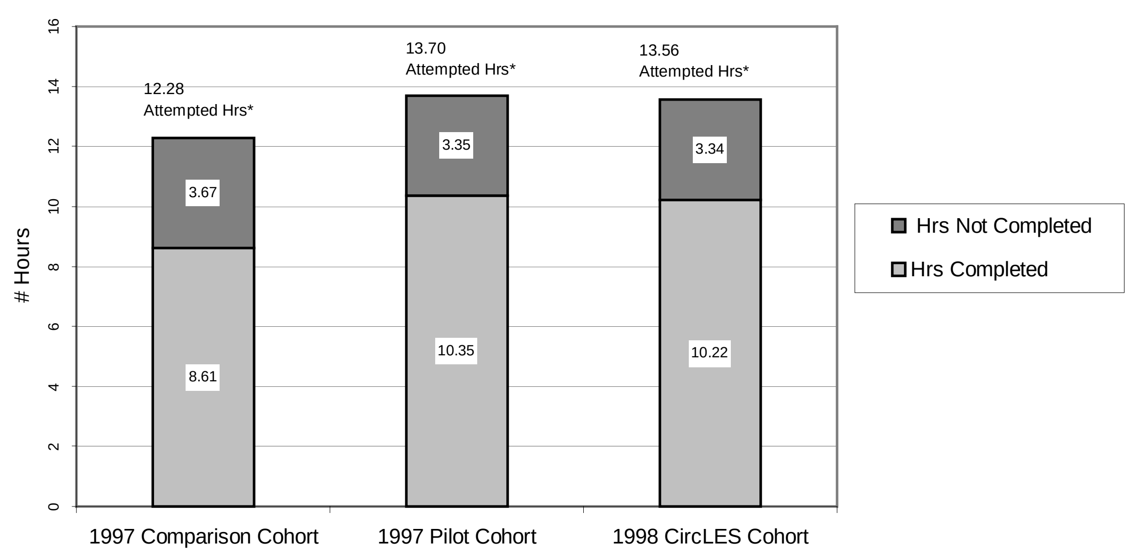
For the first semester of the first year, the mean hours attempted and the mean hours completed by the 1997 Pilot Cohort, the 1998 Cohort, and the 1999 Cohort are higher than the mean hours attempted and completed by the 1997 Comparison Cohort. See Figure 5. Mean hours Attempted and Mean Hours Completed For First Semester By Student Cohort.

Figure 5.
Mean Hours Attempted and Mean Hours Completed For First Semester
By Student Cohort



For the Fall semester of the second year, the mean hours attempted and the mean hours completed by the 1997 Pilot Cohort, and the 1998 CircLES Cohort are higher than the mean hours attempted and completed by the 1997 Comparison Cohort. See Figure 6. Mean Hours Attempted and Hours Completed For Fall Semester of the Second Year By Student Cohort.

Figure 6.
Mean Hours Attempted and Mean Hours Completed For Fall Semester of the Second Year
By Student Cohort



The retention data support the claim that the *CircLES* Program has been effective in increasing the retention rates of SEM students who participate in a learning community that includes a University Seminar, a mathematics course and an English course. In addition, data on mean cumulative grade point average suggests that the program has been effective in increasing the success of students during their first year at UTEP. Program administrators and the evaluator are aware of the issues associated with using grade point averages as a measure of success. Grade point averages were selected based on the institution's use of gpa to make decisions about individual, such as placing a student on probation, accepting students into their program/major and granting a student a bachelor's degree. Hours completed is an indirect indicator of progress to graduation. Additional analysis of the hours completed associated with courses taken will be undertaken to assess the type of courses in which students are enrolling. Although not reported in this paper, other methods and measures have been used to assess the effectiveness and impact of the program.

V. Lessons Learned and Challenges

Many of the lessons learned about change are not much different from those found in other organizations, such as business, industry and education. Change is hard. The curricular and institutional changes established under the *CircLES* Program have questioned the traditional ways undergraduate education in SEM has taken place. In this section, the paper describes the lessons learned and the challenges facing the program as it moves to sustain new ways of educating undergraduates in science, engineering and mathematics.

<u>Lesson and Challenge One</u>. The *CircLES* Program effort would not have come to fruition if it were not for a commitment to providing students in engineering, science and mathematics with gateways to obtaining an undergraduate degree in those disciplines. Personal and professional commitment to the development of students' intellectual and social development provide the motivation and time that is required to design and implement the program. The challenge is to build in institutional structures that support the commitment and facilitate the activities associated with that commitment. Implementation and sustainability is the responsibility of the institution and its members.

<u>Lesson and Challenge Two</u>. A common vision of and commitment to the mission of the program must provide the basis for change and sustainability. As the institution scales-up a program, communication, coordination and joint decision-making among administrators, faculty and staff become vital and essential. Sustaining the success and effectiveness of the effort is enhanced when all players have knowledge of what is happening in the program and have the time and the resources to work together and share information for continuous improvement.

<u>Lesson and Challenge Three.</u> It takes time and resources to mobilize and sustain the process, maintain the activities and commitment of people, and establish institutional units and the authority to maintain innovation. Essential activities and components must be funded by and institutionalized in the university. Institutionalization sends a message to institutional members that the activities and components are important to the mission of the whole institution.

Lesson and Challenge Four. Long-standing institutional values and institutionally embedded conflicts and animosities will surface. Supporters must be aware of what they are and be prepared with arguments and evidence that support institutionalization of the innovative programs. The politics of the institution can and will come into play.

Lesson and Challenge Five. The key players in implementing and institutionalizing change are the chairs and key faculty, who may or may not support the innovation. Department chairs are the formal linkages between faculty and the administration and are key in the implementation of institutional policy and procedures. Both chairs and key faculty serve as conduits, interpreters of information and advisors to faculty and administrators. Their endorsement, lack of endorsement, indifference, or attack of the innovation make a difference in the support and maintenance of the program.
In summary, commitment to students, a passion for increasing the academic and social integration of students into the university community, a commitment to on-going data collection are key elements in the creation and longevity of curricular and institutional innovation. The *CircLES* Program has combined these elements to increase the retention rates and success for students who attend an urban computer campus. The challenge is to develop institutional mechanisms to sustain the program and its activities.

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