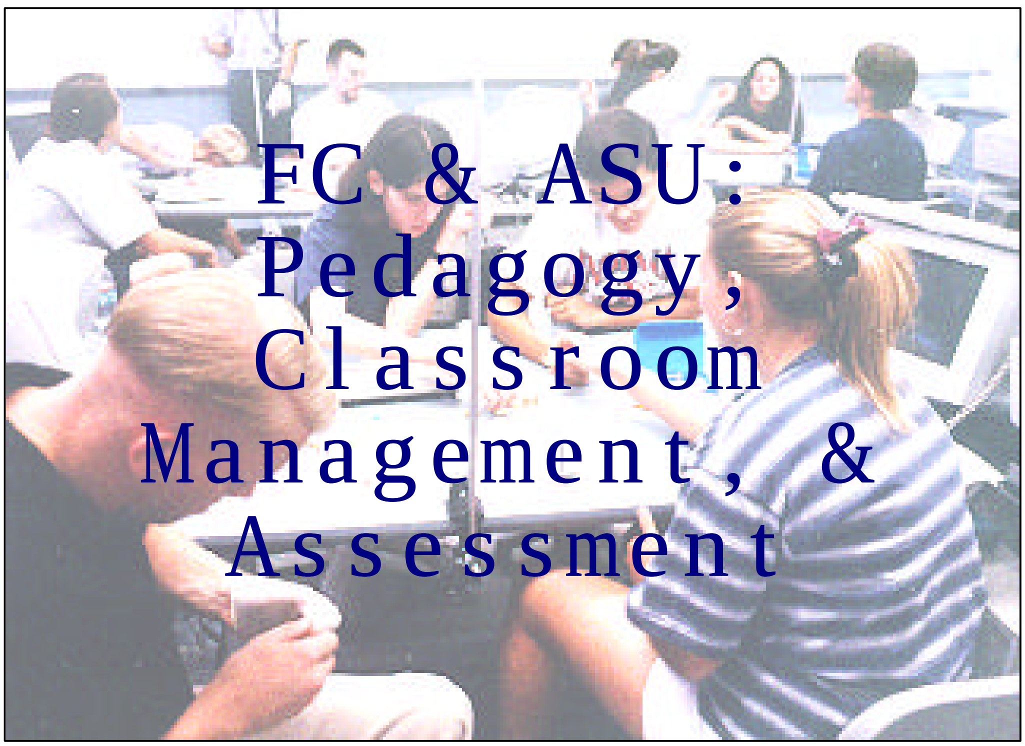
Report on Years 1 through 5

of the

Foundation Coalition

College of Engineering and Applied Sciences
Arizona State University



Center for Innovation in Engineering Education
Tempe, Arizona

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Acknowledgements

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The bulk of this report was written by Dr. Susan Haag and Ms. Teri Reed-Rhoads, both of whom serve as assessment coordinators for the Foundation Coalition program at Arizona State University. Their work is hereby gratefully acknowledged. The help and participation of other faculty, both those who have participated in the Foundation Coalition programs and those who have taught classes other than those designed or affected by the Foundation Coalition, is also appreciated.

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Overview

This bulleted *Overview* is intended to provide a summary of the Foundation Coalition (FC) activities at Arizona State University during the first 5 years of its operation. The *Overview* covers the Freshman, Sophomore, and Upper Division work at ASU, along with the beginnings of the work on Responsive Curricula, an objective in years 6 though 10 of the FC's future. This *Overview* is followed by the Years 1-5 Summative Assessment Report which contains much more detail on many of the items briefly highlighted here.

Freshman Curriculum

There are many aspects to the engineering freshman program at ASU due to the readiness of the incoming students for Calculus and English, the course load the students take, and the amount of employment they maintain while attending the University.

General Changes

Below is a listing of some of the offerings at the freshman level (only the first of the bulleted items has not had FC funding in its development and implementation):

- The College has already institutionalized a 4 hour course Introduction to Engineering Design that teaches teaming and technology. This course was initiated immediately before the FC was funded and first taught during the first year of FC funding.
- The College has institutionalized a 13 hour Freshman Integrated Program in Engineering (FIPE), which contains the following courses:
  - Calculus;
  - Physics;
  - Introduction to Engineering Design; and
  - English,

  This course is taken by 80 students each fall – which is all but about 30 of the students who take a load of 13 hours which include Calculus, Introduction to Engineering Design, and English. Generally, these 30 students take Chemistry instead of Physics. The group of 30 form the comparison group for the FIPE students.
- The College has begun cohorts in English and Introduction to Engineering Design *with* coordination – one of the lessons learned from the FIPE is that this can be a very good combination. The combination has shown that students attain a much earlier realization of what their chosen profession (engineering) is all about when taking this integrated English along with their Freshman Engineering course.
- The College runs cohorts in math (calculus or pre-calculus), chemistry, and engineering design *without* coordination.
- The College has addressed the problem of bridging transfer students who do not have teaming and technology experience (more details can be found in the *Sophomore Changes* of this *Overview*). This spring the College will offer a new course that separates new freshmen from transfer students, and gives the transfer students more technologically challenging problems. Students are already registered for this course.
- Calculus and physics integration – the College has not tried this integration since its survivability is doubtful. Mathematics faculty have no appreciation for the practical

use of mathematics, and they, in general, shun the calculus reform movement. Physics probably could not sustain such an integration. Thus, there seems to be no chance for institutionalization.

- Several mathematics improvements are currently being discusses or acted upon:
  - The Engineering Dean has met with the mathematics department chair and there has been progress made, albeit slow progress. It appears that the Mathematics department may abandon reform calculus. Engineering is now determining what it wants and Mathematics seems somewhat willing to give it.
  - CIEE is cosponsoring a *Technology in the Classroom* seminar series with the Mathematics Department for the purpose of increasing the awareness of the math administration and faculty to the plight of Engineering and its needs, if not the plights and needs of all students.
- The FC has developed an interactive CD-ROM on Diversity, aimed at solving some chronic problems that have been observed each year in the FIPE (this is the only program in which such problems are being assessed, but they doubtlessly occur in other parts of the program). The CD was developed using focus groups to design the modules that are included and to assess their apparent value and effectiveness. The modules that make up the CD pose commonly encountered "situations" and ask students to choose which of several alternative "best practices" they would consider using to ameliorate each "situation." The appropriateness of each possible solution is then examined in detail to finish the module. The CD has just reached the state where it can be tried in beta testing. Copies will be provided to the visitation team.

Freshman Integrated Program in Engineering (FIPE)

This special freshman curriculum is the flagship program for the FC. Unfortunately, due to the criticism of earlier review teams who did not like that it was referred to as the "Campus Match" program (to fit it into a growing program for new students that is recognized throughout the University), it has taken on the moniker of the Foundation Coalition. This has made it difficult to identify any other reform work that the Foundation Coalition undertakes at ASU.

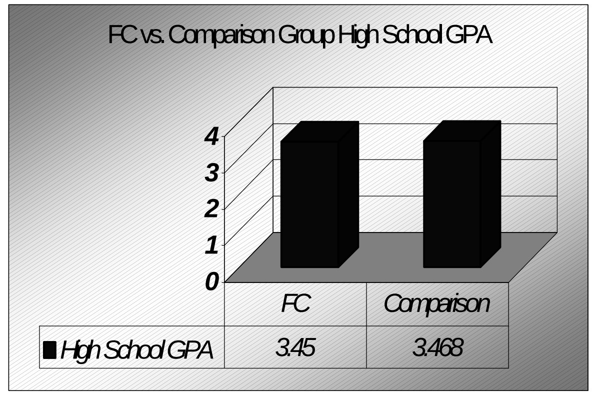
	Mon	Tues	Wed	Thur	Fri
7:40	ENG 101 1st. Comp.		ENG 101 1st. Comp.		ENG 101 1st. Comp.
8:40	MAT 270 Calculus	PHY 122 Physics	MAT 270 Calculus	MAT 270 Calculus	MAT 270 Calculus
9:40	ECE 194 Intro to Engrg Des	PHY 122 Physics	ECE 194 Intro to Engrg Des	PHY 121 Physics	PHY 121 Physics
10:40	PHY 121 Physics	ECE 194 Intro to Engrg Des	PHY 121 Physics	ECE 194 Intro to Engrg Des	PHY 121 Physics
11:40					

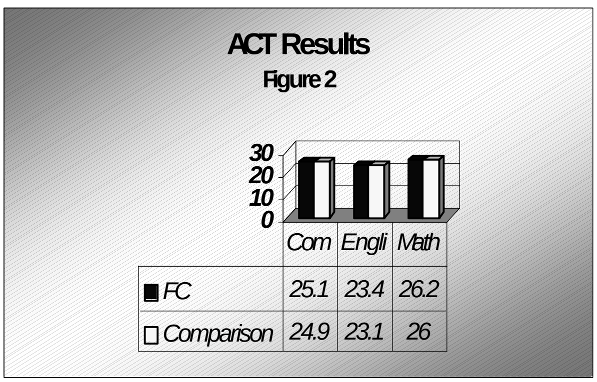
Freshman Integrated Program in Engineering: Weekly Schedule (for the Registrar)

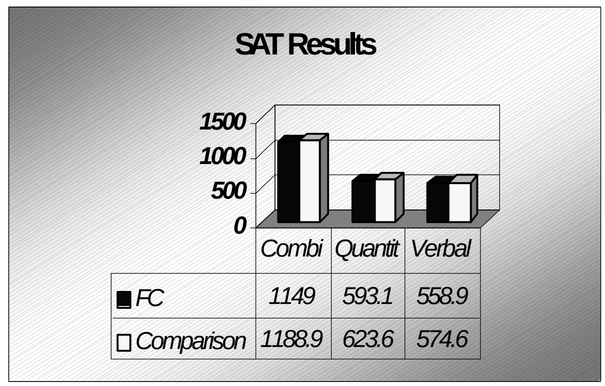
The FIPE is characterized by:

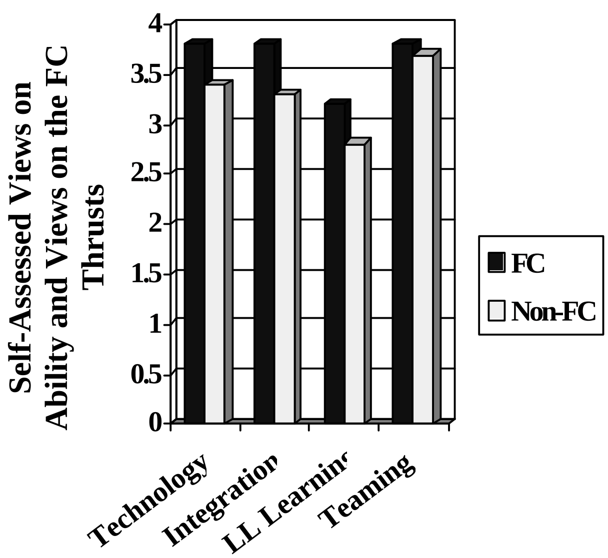
- **Integrated curriculum** in calculus, physics, engineering design, and English - 13 hr package fall and spring semesters.
- **Collaborative learning** environments utilize cooperative learning, team training, team projects, and active learning.

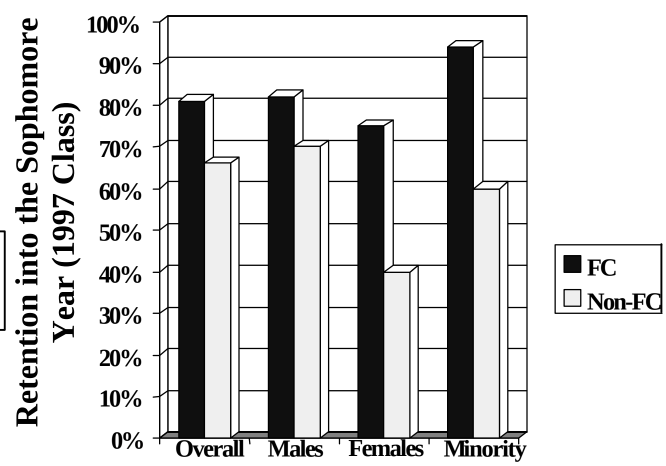
- **Computer-based learning** environments emphasize multi-step and open-ended problems, provides students with enhanced design and problem solving tools; helps students discover connection between course work & their careers.
- **Assessment and Evaluation** results are used to improve the instruction, classroom climate, learning activities and projects. The FIPE students are also compared to a very similar "comparison group" of students.











The FIPE is now in its fifth year of operation and has shown improved outcomes for students who take it compared to the comparison group (see the sidebars above for predictor data on both the FIPE students and their comparison group for the 1997-98 class). Improvements include better self-evaluations in their understanding, use, and attitudes toward technology, integration, life-long learning, and teaming, and in their retention into the sophomore year (see the sidebars above). More detail can be found in the section on *Years 1-5 Summative Assessment Report*.

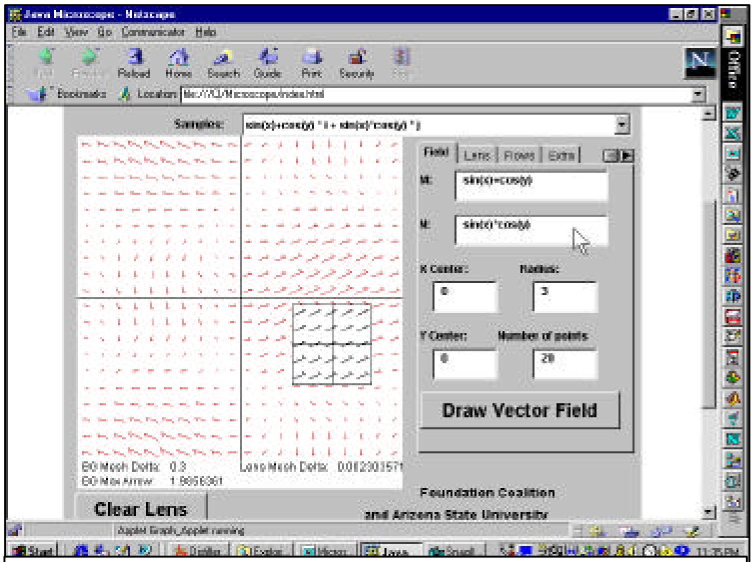
Sophomore Changes

Many changes have occurred in Sophomore-level courses as a result of the FC. These include:

- A revamped circuits and instrumentation course (4 hrs) with new computerized instrumentation labs, cooperative learning, and set up for vertical integration. The struggle is to now institutionalize it. A start on this has been inhibited in the past due to the unavailability of seat time in high tech classrooms. However, a Hewlett-Packard gift of about $210,000 will outfit a new high tech classroom in which these changes of this course and its integrated follow-ons will be taught.
- The College has instituted a new Newtonian mechanics course (4 hrs) that uses conservation principles as the central theme and statics as a special case of dynamics, with technology and active learning. This course is required of all EE's and is on the curriculum check sheet for majors in the Industrial and Management Systems Engineering Department.
- Several attempts have been made at mathematics integration – either with technical subjects such as the two courses mentioned above or among Calculus, differential equations, and linear algebra. This problem is just now beginning to be understood by the mathematics department. Among the positive things happening is:
  - The Mathematics Department will offer a modern differential equations course (strong on technology) for Engineering, while keeping their own traditional course.
  - A Java "software microscope" for viewing 2D vector fields has been constructed and is being used in the sophomore math courses (Calculus III and Differential Equation). It operates in any Java-enabled browser and can be downloaded from the web (see http://www.eas.asu.edu/~asufc/). It has been presented at several national and international meetings and is now being used throughout the world.

An Engineering Project in the Sophomore Mathematics Class

A sophomore course in engineering (with teaming and technology introductions) for bridging transfer students has been designed and is being offered in the spring. Students are already signed up for this course. Through the Fall '98 semester, transfer students, except for transfers from Maricopa Community College District schools (MCCD was a member of the FC in years 1-5), have always had to take the freshman Introduction to Engineering Design course where teaming and technology was taught, thus mixing students of different mental and technical maturity. This sophomore course has been needed for some time, but it took the urging and the financing by the FC to bring it to fruition.



A "Software Microscope" for Viewing Vector Fields
See http://www.eas.asu.edu/~asufc/

Upper Division Changes

Upper Division Changes: EE

- The Electrical Engineering Department has integrated and taught material from two courses and found improved student outcomes. The two courses integrated are:
  - An introduction to the properties of electronic materials; and
  - The first course for EE majors in electromagnetic engineering integrated waves and materials course.
- The department has made progress on a vertically integrated set of circuit analysis courses.

Upper Division Changes: IMSE

- With FC support, the Industrial & Management Systems Engineering Department is assessing the "responsiveness" of the UD IMSE curricula.
- The department has addressed integration of the following courses and is beginning to teach:
  - Facilities Analysis and Design;
  - Work Analysis and Design; and
  - Senior Design Project.

Upper Division Changes: MAE & CE

- Two faculty are designing an integrated statics and strength of materials course that would make heavy use of technology. This set of courses is taken by AE's, CE's, and ME's.
- Some members of the fluids faculty are beginning to study the adoption of a CD-ROM-based fluid mechanics "text" for the ME required course in fluid mechanics.

Curriculum and Assessment: Responsive Curricula

College Work on EC 2000 and Responsive Curricula

- The College has established a Subcommittee of the Dean's Advisory Council (DAC, our IAB) for work on ABET EC 2000:
  - This committee has now met three times;
  - The committee has brought definition to the following College and University objectives.:
    - Metropolitanism;

- Professionalism;
- Technical Competence;
- Design and Manufacturing; and
- Life-Long Learning.

The First Meeting of the DAC Subcommittee on EC 2000

<u>Curriculum and Assessment Workshop Outcomes</u>

- The FC held a one week workshop in May 1998 for:
  - CEAS administration (including Deans and Department Chairs);
  - One faculty member per department;
  - FC management (including the assessment staff).
- The workshop got all departments off to a common start.
- The workshop established common terminology.
- The workshop developed a common template for objectives (see Appendix E)
- The workshop established versions 1.0 of objectives:
  - Metropolitanism;
  - Professionalism; and
  - Communication skills (see Appendix E).
- This workshop has put degree programs on their way to completing these templates.

Years 1-5 Summative Assessment Report Introduction

Reform across subject areas through curricular integration has overarching goals of achieving high academic success for all students and better preparing students for the engineering workplace. The Foundation Coalition at Arizona State University (ASU) has offered an integrated freshman program and embedded four core reform competencies in its strategic plan and across all subject areas. A sophomore program has also been tried in many forms with less success, as fully integrated packages, but success, none-the-less. Upper division courses have been successfully implemented in Electrical and Industrial Engineering Departments.

This report contains outcomes from diverse assessment methods conducted over a four-year period (1994 through 1998) at ASU reflecting student progress, perceptions, and retention; faculty perceptions; and program strengths, successes, and weaknesses.

The Foundation Coalition (FC) at ASU is continuing to meet its curricular strategies and promote institutional change. According to exiting engineering freshmen, the FC program was more effective in the utilization of technology, curricular integration, and the promotion of life long learning than the comparison program and the differences were statistically significant. Additionally, the FC was successful in the retention of all students and more specifically under-represented minority students in the field of engineering. Another strength of the FC program was faculty responsiveness. FC freshmen felt that their instructors were more available to help them with coursework and provide encouragement than a comparison group of students (i.e., the non-FC students). Additionally, the FC student course GPS's have continued to improve over the past three years.

Overall, three curricular strategies (core competencies) were strengths of the FC program: technology, curricular integration, and life long learning. However, there was little difference between FC and non-FC groups regarding teaming. One explanation is that teaming has been implemented and emphasized in the non-FC course, ECE 100: Introduction to Engineering Design. It is likely that the College of Engineering and Applied Sciences (CEAS) has begun to institutionalize this FC strategy as a result of curricular and pedagogical changes begun before the existence of the FC program.

After offering a large block, integrated sophomore program in years 3 and 4 of the first five years of funding, it has been decided that this approach will not succeed at this institution. The enrollment of these large block offerings was very small due to many reasons: the sophomore year is the first year in which the curriculum becomes major dependent and not all majors are required to take all of the courses; the student body consists of many part-time students who do not carry the size of load in the packages tried; an integrated sophomore curriculum is in place in Chemical Engineering (the original TAMU/NSF integrated engineering sciences curriculum has been in place for about 6 years), but it is viewed as a Chemical Engineering curriculum and it would be difficult to get other departments to buy-in at this point; even students who take the size of load involved in the integrated block, seldom take this selection of courses at the same time-they expect and get more freedom outside the program.

The Foundation Coalition has been offering as separate courses an integrated *Calculus with Analytic Geometry III* and *Elementary Differential Equations*, but like the sophomore integrated block courses, this package has not been attractive to students and advisors. Mathematics has been complaining of the low enrollments, and for the last year has opened up these courses to anyone desiring the courses, making integration of subject matter questionable. Engineering has been working with the math department chair over the last six months in order to get them to understand the problems faced by reform of the engineering programs and the concomitant need for a modern, technology-based set of courses. This situation is being addressed, albeit slowly. We expect that by next fall we will have such a set of courses on board – at least a differential equations course, and being taught in one of the high tech classrooms.

Electrical Networks (ECE 301) has been in development since the first semester it was taught under the auspices of the Foundation Coalition in year 3 of funding. There have been computerization of the laboratory, the development of new experiments in the laboratory, the use of technology (mainly, PSPICE and Matlab), and the inclusion of cooperative learning. These have been done in at least one section of the course each semester – doing more sections involves finding the seat time in a high tech classroom. This will be solved as soon as the Hewlett-Packard classroom is finished sometime in the spring semester. This new room, equipped through the generosity of the Hewlett-Packard Company, will have team tables that seat four students, with each student having access to a laptop computer. The instructor will have available through a remote control, VCR, laser disc, pad camera, lighting control, screen control, and interactive white board.

Engineering Mechanics (ECE 301) is an course developed under the auspices of the Foundation Coalition for the purpose of breaking the mold of the typical mechanics sequence of statics and dynamics without technology. Currently, electrical engineering requires this course for their students and Industrial Engineering will apparently require it in the near future. The course follows the conservation equation approach used in the TAMU integrated sophomore engineering sciences but stops at the application to mechanics. Another unique part of this course is the concentration on dynamics first and foremost, introducing statics (steady state cases for dynamics) as a special case. Kinematics is taught on an as-needed basis, not as a detached topic that must be mastered first before any other topics in dynamics/mechanics can be taken up.
A new bridge course for transfer students has been designed during year 5 of the Foundation Coalition. This course will allow bridging of sophomores and juniors arriving with transfer credit to be introduced to teaming and technology without putting them in with the freshman students as is now being done. The difference in both mental maturity and technical maturity makes the inclusion of both new freshmen and transfer students in the same class, undesirable. The new course will be offered as ECE 294 in the spring of 1999, and later given its own permanent and unique number of ECE 200.

FC Effects on Gender and Under-represented Minorities

Gender and minority differences were revealed as a result of data analysis. First, the FC program positively impacted gender and minority retention rates. Second, we detected attitudinal discrepancies between female and male students. Finally, cognitive performance measures revealed some statistically significant differences among the males and females and the males and under-represented minority groups favoring the non-minority students.

The FC program retained more students in engineering than the non-FC program. More specifically, the FC retained more females and under-represented minorities in engineering during the 1997-98 Academic Year than the comparison program.

Although not statistically significant, gender differences were evident in the Freshmen Exit Survey. On average, male responses were more positive than female responses regarding teaming, the utilization of technology as a learning tool, integration of concepts, and professional development.

Similarly, two cognitive measures, the Force Concept Inventory (FCI) and the Mechanics Baseline Test (MBT), revealed gender differences favoring the males. However, unlike the attitudinal measures, these cognitive differences were statistically significant. Both the pre- and post-FCI analysis indicated significant gender differences favoring the males. Additionally, the post-FCI showed significant discrepancies between the under-represented minorities and non-minority groups favoring the non-minorities.

Analysis of the pre-MBT revealed significant gender differences favoring the males as well as ethnic differences favoring the non-minority groups. However, on the post-MBT only gender differences were evident. In summary, although all groups exhibited similar gains from pre- to post-test, the males always outscored all other groups of interest.

Effects of Assessment on Curricular and Culture Change: Evaluation Feedback Loop

The formative feedback from FC assessment activities has provided impetus for program modification. The FC Assessment and Evaluation (A&E) team provided the faculty with student data and attitudinal differences. Faculty planning sessions were conducted during the summer where there was opportunity to disseminate student assessment outcomes and to discuss findings. FC faculty and A&E staff are working collaboratively, examining student differences, and determining strategic curricular and non-curricular actions to correct learning and attitudinal discrepancies. FC instructors are working with female students to strengthen their cognitive, technological, and teaming skills and to improve female attitudes about curricular methods and professional development.

Faculty

It is important not only to assess the attitudes, academic performance, and technical abilities of students, but also to evaluate the FC's educational impact on the CEAS faculty at ASU. The FC attempted to collect faculty information via a survey administered on the web at the end of April, 1998. Although the response was not high this year (35), it almost tripled last year's response (12).

Consistent with last year's national FC faculty results, a discrepancy between the FC and non-FC faculty existed on some issues. The group opinions differ in the following areas: 1) FC faculty workload; 2) the FC experience for FC students, faculty, the department, CEAS, and the institution; and 3) FC implementation challenge. It was noteworthy to find that the FC faculty believed that Coalition strategies were difficult to implement (i.e., integration of topics/courses, cooperative learning, and formal monitoring and assessment techniques). One explanation is that FC faculty actually had to implement these curricular changes and knew empirically how difficult it can be to reform the traditional engineering program.

However, the FC and non-FC faculty agreed on five of seven FC strategies that impact student learning. Most faculty felt that: 1) Cooperative learning enhances student learning, 2) team training prepares students for the future, 3) technological skills give students an advantage in engineering courses, 4) the FC program improves educational outcomes for engineering students, and 5) FC students are better prepared to meet employers' needs. These are critical FC strategies that all faculty feel are important. However, about one half of all faculty failed to believe that assessment activities provided them with useful information. This year, a College-wide effort will address this by further developing the faculty feedback loop and continuing to educate faculty as to the benefits of formative and summative assessment. A&E will continue to provide the faculty with current feedback from assessment and will collaborate with instructors in order to improve educational outcomes.

Meta-analysis of all surveys revealed that both the FC faculty and students held similar views regarding implementation of the FC strategies. Although the majority of faculty and students agreed that teaming, technology, and curricular integration were implemented and required in the coursework, most felt formal monitoring and assessment of these core competencies were lacking. Faculty survey data were consistent with faculty meeting data (i.e., opinions voiced during the summer planning sessions). Faculty expressed that effective and appropriate assessment of, for example, teaming and technology was difficult to do. This same opinion was evident in the faculty survey results.

In response to this issue, the FC faculty are continuing to work toward improvement of the teaming strategy. Feedback has been provided to the FC faculty in order to implement adequate and effective monitoring and assessment techniques. Two program improvements were adopted: Faculty members implemented the FC special team time twice a week for students and refined and disseminated a prior "team process check" document in order for students and faculty to monitor team effectiveness and dynamics. Students will administer a self-evaluation and then meet with faculty for council approximately three times during the year to improve team dynamics and to overcome team dysfunction before a crisis occurs.

Additionally, students must implement "team rotation" whereby all students must rotate to a new team role for each class project. The students are required to document this process and record each member's role. This process facilitates many strategies and should improve overall student performance and outcomes. The rotation may force team members to rotate to different roles in which they are less competent or comfortable therefore strengthening students' weaker areas. For example, the process may aid students who lack technological competence; additionally, it will allow passive students to take more active roles.

Web Site Information

The ASU Foundation Coalition A&E Team maintains a web site at:

http://www.eas.asu.edu/~asufc/AEDteam/AEteam.html,

which is also accessible through the ASU Foundation Coalition web site:

http://www.eas.asu.edu/~asufc/.

Freshmen

The Foundation Coalition Program at Arizona State University continued to provide an integrated curricular program to engineering freshmen during the 1997/98 academic year. The Foundation Coalition program is a self-selection program. It is publicized through Freshman Orientation and in a mailing to entering freshmen who have indicated engineering as their chosen major. This letter is sent from CEAS under the Dean's signature. The Foundation Coalition personnel work with the ASU advisors to recruit students who are calculus ready into this program. One limitation of the program is the number of entering freshmen who already have some type of English, Math, or Physics credit. Some of these students do not wish to repeat courses for which they already have credit. A second limitation is the number of calculus ready students entering engineering. There is a requirement that all students must take all courses as a package with no exceptions.

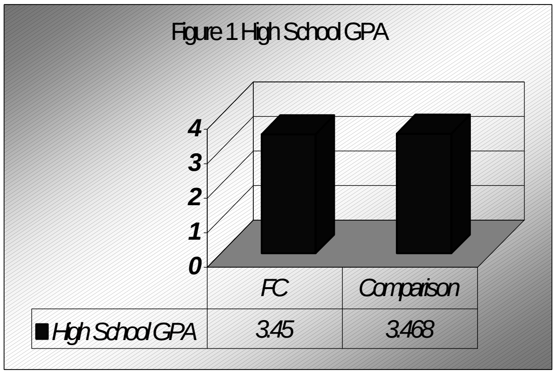
Rationale

The ASU A&E Team was charged to assess FC student outcomes and perceptions about engineering. The team had three purposes: 1) to gather information for the assessment of student learning, recruitment, and retention of under-represented populations under the Coalition's programs, 2) to gather information to provide faculty and administration an evaluation of the successes of instructional and curricular strategies related to the FC program, and 3) to facilitate program institutionalization. The FC program implemented a plan that included formative and summative measures.

The FC Assessment and Evaluation team focused on:

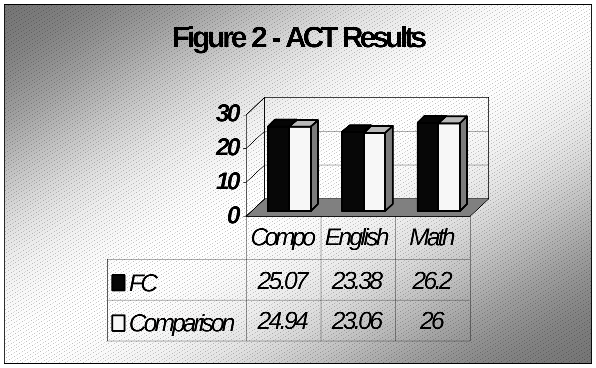
- ♦ student cognitive performance
- ♦ student attitudes
- ♦ faculty attitudes and campus climate

Part of the research design included the assessment of a comparison group of students with similar demographics. The comparison group of freshman students was defined by: 1) sorting through the list of incoming freshman students and picking those who were enrolled as professional engineering students in one of the degree programs in the College (i.e., students were not described as pre-professional students); 2) taking at least the same course load as the Foundation Coalition students (i.e., 13 hours or more); 3) and enrolled in at least three of the same courses in which FC students were enrolled. The students meeting these requirements for fall '97 were designated as the comparison group (non-FC group) for the fall '97 Foundation Coalition student cohort.



The following three figures indicate that the comparison group chosen using this method is comparable to the Foundation Coalition students with respect to high school GPA, SAT scores, and ACT scores. Table 1 reveals the similarities among 1) the Foundation Coalition students, 2) the comparison group students, and 3) the CEAS student population overall with respect to ethnicity, gender, GPA, and SAT or ACT averages. Based on these statistical comparisons, we are confident that the conclusions made using these two groups of students are valid.

Seventy-eight students enrolled in the FC in academic year 97-98 (Year 5 of the Foundation Coalition funding). Twenty three percent of the FC students were under-represented minorities and fifteen percent were female. The demographics of the Foundation Coalition class are comparable to the CEAS demographics (presented in Table 1). The four integrated courses for the fall semester were: ECE 194 Introduction to Engineering Design; MAT 270 Calculus with Analytic Geometry I; PHY 121 University Physics I Mechanics; PHY 122 University Physics Laboratory I; and ENG 101 First-Year Composition I. The four integrated courses for the spring semester were: ECE 194 Introduction to Engineering Design II; MAT 271 Calculus II; PHY 131University Physics II; PHY 132 University Physics Laboratory II; and ENG 102 First-Year Composition II.



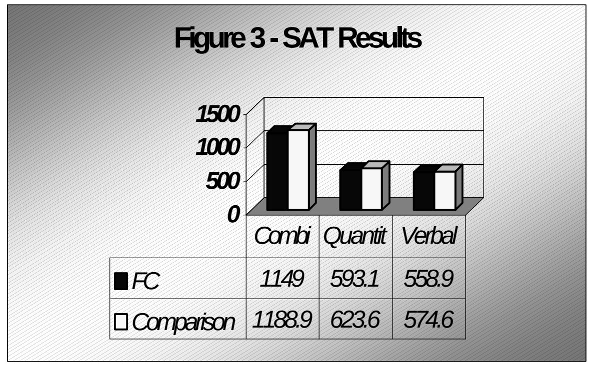


Table 1
ASU FC Freshman, Comparison Group, and Overall College Demographics
Fall 1997

	FC Class	Comparison Group	College of Engineering
Total Students	78	32	
Males	66 (85%)	27 (84%)	80.7%
Females	12 (15%)	5 (16%)	19.3%
Hispanic	13 (17%)	7 (22%)	10.3%
African-American	4 (5%)	1 (3%)	2.8%
Native American	1 (1%)	1 (3%)	2.8%
ACT Average	25.07	24.94	24
SAT Average	1149	1188.9	1157
High School GPA Average	3.45	3.468	

This portion of the FC report is divided into three sections: 1) attitudinal analysis, 2) cognitive analysis, and 3) retention and progress toward degree. First, we discuss the attitudinal component, which includes the results of the Freshmen Exit Survey and the Views about Writing Survey (VAWS). Additional attitudinal assessments (i.e., the Felder Learning Styles, the Pittsburgh Freshman Engineering Survey, and the Student Assessment Journal) are found in Appendix B. Second, we present the cognitive component, which includes ASU course GPA analysis; Force Concept Inventory (FCI) and Mechanics Baseline Test (MBT) results. Finally, freshmen engineering retention and progress toward degree information is presented.

Attitudinal Data Results

Freshmen Exit Survey

Consistent with the Foundation Coalition Strategic Plan, assessment and evaluation of student outcomes is a primary thrust on which learning environments and curriculum models will be based. Retention of all students continues to be a dominant goal of the Coalition with special attention on females and under-represented minorities. Additionally, the FC focuses on four strategic curricular objectives that drive the program: 1) Improvement of human interactions through cooperative education and teaming, 2) Utilization of technology-enabled education, 3) Integration of subject matter within the curriculum, and 4) the promotion of life long learning.

This report contains outcomes from a standardized FC survey that the Coalition requires participating campuses to administer to exiting FC freshmen each year. This year, a similar survey was given to the comparison group of exiting engineering students (called the non-FC group) to examine differences between the two groups. The non-FC survey was adapted from the FC survey by the ASU A&E Team and was approved by the CEAS.

The Freshman Exit Survey was administered to exiting FC freshmen in 1998 and the results were then presented to the FC faculty and staff during the 1998 summer planning sessions. The purpose of one of the planning sessions was to review the FC freshmen assessment results, discuss perceived program weaknesses identified in the results, and recommend strategies to correct deficiencies. FC strategies were modified and implemented at the beginning of the FC 1998/99 academic year. For example, FC team training, monitoring, and assessment were improved this year. Additionally, “team time,” was added to the schedule and one of its purposes was to help improve team dynamics.

Brief Summary of Results

Overall, the FC is continuing to meet its strategic curricular objectives. According to exiting freshman engineering students, the FC program was more effective in the utilization of technology in education, curricular integration, and the promotion of life long learning than the comparison program and the differences were statistically significant. Additionally, the FC has proven to be successful in the retention of students in the field of engineering. Another strength of the FC program was faculty responsiveness. Exiting FC students felt that their instructors were more available to help them with course work and provide more encouragement than non-FC students. (See Appendix A for Freshman Exit survey results for years 3, 4, and 5.)

However, there were no statistical differences between the Coalition and the comparison group for teaming. One explanation is that teaming, a critical goal of the Coalition, has been institutionalized in the CEAS. Teaming has been emphasized in the non-FC course, ECE 100, which may have affected this outcome. One issue, was common in both programs. Although all students felt that they were assigned to work in groups, some believed that the teams were not monitored adequately throughout the year.

Methodology

Of the 78 students enrolled in the Foundation Coalition Program, 50 responded to the exit survey. We attempted to contact every exiting freshman by phone; however, if we were directed by parents or roommates to mail the student survey to another address, we complied. Some students simply failed to respond to the survey and eight students could not be contacted due to bad addresses and phone numbers. The FC Exit Survey sample was 82 percent Anglo, 12 percent Hispanic, 4 percent African American, and 2 percent Native American. Eighty percent of the respondents were male and 20 percent were female. Over one half of the FC students had a high school grade point average of 3.51 or higher and studied 11 to 20 hours per week. While enrolled in the FC, half of the FC students were not employed and over one fourth worked only five to ten hours a week.

We were able to survey 25 of the 32 students in the comparison group. The non-FC Exit Survey comparison group was 68 percent Anglo; 24 percent Hispanic; and 4 percent each of African American, and Native Americans. Eighty four percent (21) were male and 16 percent were female. The majority of non-FC students (60%) had a high school grade point average of 3.51 or higher, which was consistent with the FC Exit Survey sample group.

Two differences were noted between the comparison and the FC groups. The non-FC students studied less and worked more than the FC group. While 52 percent of the non-FC students studied between 11-15 hours, over one third (36%) studied less than 10 hours a week. Additionally, almost half of the non-FC group worked 20 or more hours a week compared to 25 percent of the FC sample.

Four Core Competencies:Technology, Curricular Integration, Life Long Learning, and Teaming

Technology, curricular integration, and life long learning were strong components of the FC program. We created special groupings of the questions in the Exit Survey for the four FC core competencies: teaming, technology, integration, and life long learning to examine differences between the FC and the non-FC groups. Statistical differences between the groups existed favoring the FC in three of the four major areas. See Table 2 for means and statistical significance.

Overall, the FC means in the 4 core areas, although significantly higher than the comparison group, were not as robust as they could be. Ideally, we would expect the means to be between 4 and 5. Therefore, student attitudes in these areas could be improved. This phenomenon can be partially explained by gender differences in all 4 areas. In general, female responses were neutral or more negative in all areas, which brought the means down. Additionally, females failed to agree that faculty formally monitored and assessed their competence in the four strategic areas.

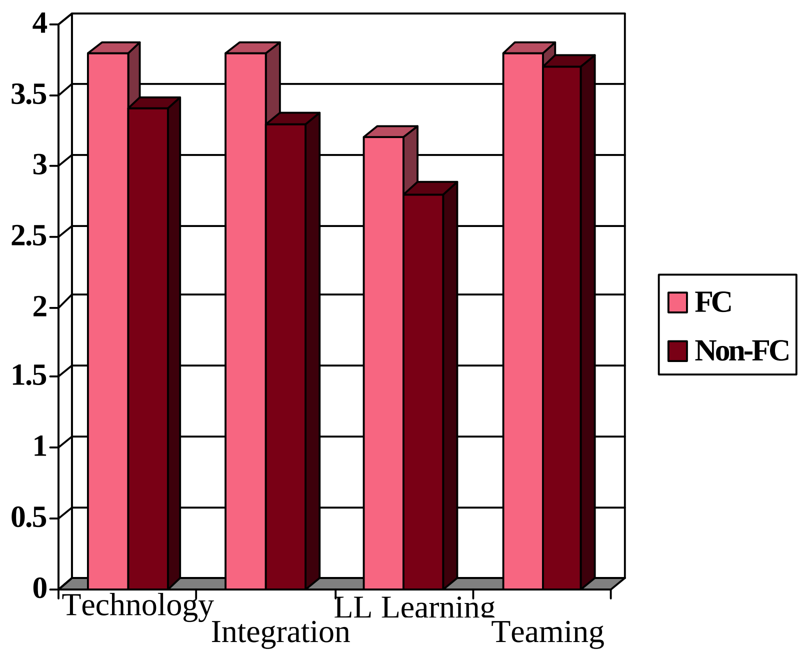
Table 2 Four Core Competencies: Year 5 FC and non-FC Comparison

Special Groupings: FC Four Core Competencies	FC Mean SD N=50	Non-FC Mean SC N=25	Significance P value
Technology	3.80 .3639	3.40 .6441	* .0088
Integration	3.81 .4020	3.33 .5538	* .0001
Life long learning	3.15 .3884	2.77 .2926	* .0000
Teaming	3.82 .4737	3.69 .6661	

As mentioned above, we combined relevant survey questions statistically to develop the "special grouping" categories. More specifically, for "Technology" we combined questions: 4, 29, 30, 31, and 37. For "Curricular Integration" we used questions: 13, 18, 32, 33, 34, 39. For Life Long Learning we combined questions: 19, 20, 21, 22, 23. And finally, for "Teaming" we combined questions: 3, 5, 26, 27, 28, and 35. See Appendix A for specific questions and results. Figure 4 is a graphical presentation of this data.

Figure 4

Four Core



Competencies: Technology, Curricular Integration, Life Long Learning, and Teaming

We ran non-parametric tests for special groups to examine differences between groups (i.e., gender and ethnicity) within the FC due to the small sample sizes. However, we only found statistically significant differences between FC males and females regarding curricular integration favoring the FC males.

Utilization of Technology

The FC program aspires to produce students who demonstrate an increased flexibility and competence in using modern technology effectively for communication, analysis, and design. When given a problem, students should be able to solve it with appropriate technological tools. Additionally, students should be incorporating technology into all presentations and reports.

A statistically significant difference existed between the FC and the non-FC group regarding the use of technology. Most FC students felt they received formal instruction on the use of technology and were asked to use technology on a regular basis for course work. However, few FC students felt that faculty formally monitored and assessed their computer competence.

A question that revealed weaknesses in this area concerned using technology as a learning tool for the females. Although 95 percent of the males agreed that computer technology helped them understand material presented in class, one-third (30%) of the females disagreed. Additionally, although one half of the males believed their technological competence was monitored or assessed, all females disagreed.

Curricular Integration

One of the FC objectives is to produce students who demonstrate an increased capability to integrate knowledge from different disciplines to define problems, develop and evaluate alternative solutions, and specify appropriate solutions. Another outcome espoused by the FC is that students will demonstrate an understanding of the interrelationships among math, science, and engineering and will integrate concepts from these disciplines with other knowledge. In an effort to implement curricular integration, the FC staff and faculty members meet once a week to coordinate instructional materials, assignments, tests, and important deadlines; to exchange syllabi; and to coordinate curriculum activities and projects. Additionally, faculty members use email to discuss weekly events and the FC web page to coordinate assignments and projects.

The majority of FC students felt that the faculty emphasized and demonstrated how concepts covered in their courses were related to concepts in other math, science, or engineering courses. Similarly, most FC students agreed or strongly agreed that they were assigned activities that required them to integrate ideas from math, science, or engineering. The majority expressed that as a result of the freshman FC program, they could integrate knowledge from different disciplines. However, only 37 percent of the FC respondents agreed that faculty formally monitored and assessed their ability to integrate ideas.

Curricular integration discrepancies were highlighted in gender analysis. Males were more likely to agree that instructors integrate concepts (100%) and assess student competence (46%) in this area. Females, in contrast, were more neutral in their responses and 60 percent disagreed that their competence in this area was formally monitored and assessed.

Life Long Learning

According to the FC, the hallmark of academic excellence is intellectual vitality, which is characterized by the free exchange of ideas and creativity. The FC believes that institutions, faculty, and students should strive for excellence in all endeavors, which will result in organizational, professional, and personal development. Another student outcome espoused by the FC is to instill a sense of value in life long learning. Exiting students felt that the FC program was more effective in the promotion of life long learning than the comparison program and the differences were significant. The majority of students felt that their participation in the FC gave them more confidence in their ability to learn on their own. Additionally, FC students frequently participated in experiences that contributed to their personal development.

Although not statistically significant, gender differences were evident in the life long learning area. Males were more likely to pursue activities and experiences that related to their professional development. For example, although all males said they pursued activities that pertained to their future profession, only 40 percent of the females concurred.

Teaming

Another goal of the FC is to produce individuals who demonstrate the ability to be effective team members. To accomplish this goal, the program offers team training and requires students to work in teams in several learning situations including projects. Several questions on the survey were devoted to team training, student productivity, and learning in a team environment.

Although the FC mean for teaming appears to be higher than the non-FC mean, the difference between the two groups in not statistically significant. As mentioned above, ECE 100 (Introduction to Engineering Design), a course required of all non-FC students, offers formal team training and requires students to work in teams. Therefore, teaming has been institutionalized at the freshman level at ASU

Overall, FC participants felt that teaming was a valuable aspect of the Foundation Coalition. The majority of respondents stated that the FC program offered them the opportunity to work in teams on a regular basis, felt that working in teams helped them learn, and that teams enabled them to better understand the material presented in class. Additionally, most believed that they were offered adequate team training in the FC program. However, FC students perceived that one aspect of teaming could be improved. One fourth felt that instructors were not monitoring and assessing their teaming skills effectively throughout the course. Students requested that instructors work with teams more closely and offer constructive advice when problems occur.

Student comments in the open-ended section highlighted issues common to both groups. FC and non-FC students stated that at times, one or two team members failed to show up for meetings, submitted inadequate or incomplete assignments, or failed to turn in any work which significantly impacted the rest of the team's performance. In essence, team members' attitudes and level of participation became barriers to effective teaming and learning for some. Students were also concerned because a portion of their grade depended upon total student participation. Students recommended that teachers meet with teams regularly to assess skill level, monitor performance throughout the course, and provide instant feedback to teams in crisis rather than waiting until the end of the semester.

Although gender differences were identified in the teaming component, they were not statistically significant. However, because differences were evident in most of the core competency survey responses, they were noteworthy. On average, males felt stronger than females regarding their actual learning experience in teams. Although all the males agreed or strongly agreed that working in assigned teams with peers helped them understand material presented in class, 40 percent of the females disagreed. Additionally, female respondents believed that instructors failed to monitor and assess their skills in teams.

Although we heard some positive teaming comments, the following represent the majority of responses by non-FC students:
"Teaming was problematic and affected my grade; only 2 members showed up instead of 4."
"Faculty did not assess teaming. They just looked at the stuff at the end."

The following statements represent the essence of the FC teaming comments:
"I like teaming in ¾ of the team groups. I would not have survived without team help."
"Teachers did not help if we had a teaming problem."
"Teachers did not monitor teams throughout the year. We need feedback during the semester."
"I loved the program and the use of teaming. I developed friendships."

Views about Writing Survey

The development and initial administration results of a new attitudinal instrument, the Views about Writing Survey (VAWS), are presented here. This is a discipline specific instrument that is being refined and validated by ASU. The goal of the VAWS is to measure the attitudes, beliefs, values, and perceptions that students have about writing at the beginning of the composition course and again at the end of the semester to show if and how their attitudes change. To this end, the instrument is used as a pre- and post-semester tool to compare students taught in a traditional English composition course with those taught in an English composition course that has been integrated with the engineering, physics, and calculus courses. For a full report on the development and initial administration of this instrument see Duerden and Garland (1998) and Rhoads, Duerden, and Garland (1998).

The VAWS was administered to 50 freshmen engineering students within the Foundation Coalition program and to 155 freshmen students within regular sections of English in the first week and again in the last week of classes in the fall semester of 1997. This is a brief discussion of the development of the instrument including the course objectives addressed by the survey. Further, initial validation results of this new instrument and statistical results from comparisons of the engineering students within the Foundation Coalition and students in regular English courses will be presented.

Background

Attitudes (affective domain) have been linked to knowledge (cognitive domain) as being an integral part of the overall university learning experience. Therefore, attitudinal surveys are becoming more common place in the assessment of various educational programs. Several instruments exist that investigate students' attitudes toward subjects such as mathematics, science, statistics, and engineering in general. The Foundation Coalition has already conducted attitudinal surveys in the other components of the program, engineering, physics, and calculus. But, after a literature search for existing surveys in Composition, the instructors determined that they needed to create a new instrument focusing on the goals and objectives of the Composition class that would reflect and evaluate the students' attitudes, beliefs and perceptions about writing. Therefore, we developed the Views about Writing Survey (VAWS) to assess English 101 and 102, the first and second semesters of Freshman Composition. This is the first of two instruments being developed by ASU directed at specific course objectives. The second instrument is in the area of Electrical Engineering in the Upper Division focus of the FC.

Assessing student progress in writing, and therefore assessing the value of writing programs, is notoriously difficult [1]. Unlike teachers of some subjects, composition teachers are not imparting a body of knowledge that can be objectively scored. Instead, Composition is a skills course, and sometimes the changes that students make during the freshman year are barely perceptible. Thus, measuring and then evaluating those changes are difficult tasks. National exams such as the SAT and ACT may tell us about a student's critical thinking abilities or vocabulary, but these do not necessarily indicate good writing.

To evaluate our students' writing and to compare our students to students outside of the Foundation Coalition, several assessment tools are being developed and instituted. One of these tools is an attitudinal survey that attempts to survey more than apprehension. There already exists an attitudinal survey developed by Daly and Miller [2]. This survey of 26 items examines writing apprehension. Daly concludes that high writing-apprehensive students "not only write differently and with lower quality than low apprehensives, but, in addition, fail to demonstrate as strong a working knowledge of writing skills as low apprehensives" [3]. And although Lynn Bloom has found that some anxious writers are good writers [4], most researchers agree that the Daly and Miller's Writing Apprehension Test is an accurate tool in surveying writing apprehension [5]. However our instrument, the Views about Writing Survey, attempts to measure the students' attitudes to writing in general and how they see writing in the larger context of the university and their careers. The need for such measurement has been emphasized with the new ABET EC2000 criteria [6]. Table 3 lists the goals of the English course and how they correspond with the specific questions from the VAWS and Table 4 lists the differences between the FC English and traditional English courses.

Table 3 Listing of the Goals of the Integrated English Course with the corresponding question(s) from the VAWS instrument.

Goals for English 101	VAWS Question Number
Value rhetorical situation	
Feel there is a connection between writing and other subjects	2, 3, 4, 11
Believe there are common strategies between writing and other subjects	14, 16, 17

Believe there are organizational strategies in writing that make writing better and that can be taught	1, 7, 9, 10, 12, 13, 15, 25
Believe they can assess their own writing	5, 6, 18, 19, 20, 21, 22
Value collaborative writing and believe it can be taught	

The instrument was fashioned after the *Views about Science Survey* written by Halloun and Hestenes [7]. A copy of the original instrument is on the web [8].

Table 4. Comparison of Engineering Specific English Course versus Traditional English Course

Foundation Coalition English Course	Traditional English Course
75 students	25 students
3 instructors	1 instructor
Collaborative writing taught with individual writing	Individual writing solely
Heavy emphasis on rhetorical situation	Less consistent emphasis
Integration of engineering as the profession	No specific integration
Students are all engineering majors	Students are varied majors
Computer-integrated	Limited computer access
Instructors coordinate problem solving strategies from other subjects (mainly engineering) with the English problem solving strategies	No coordination

Results

Paired t-tests were utilized to determine a change from the beginning to the end of the semester within each type of course, traditional and integrated. Two questions (i.e., 6 and 9) were found to exhibit significant change from the beginning to the end of the semester in the traditional English sections. Both of these questions had the goal of teaching students to assess their own writing. In both cases the students exhibited a positive trend. Interestingly, the only significant change for the Foundation Coalition students from the beginning to the end of the semester was question 19. Again, the change was a positive trend in that the students' attitudes are considered more positive at the end of the semester by the English instructors.

Table 5 reveals the questions that showed a significant difference between the two types of courses for the pre- and post-semester surveys. As for the differences between the traditional English class and the Foundation Coalition English class at the beginning of the semester, the students in the two classes were quite similar. In fact, only one question exhibited a significant difference. This was Question 24, which is a question directed at the student's perception of their ability to learn to write. In this question, the FC students were significantly different from the traditional English students in that the FC students felt that English could be mastered with effort. By the end of the semester, there was no significant difference between the two sets of students with respect to this question.

At the end of the semester, there were more differences between the two groups of students. These differences were found in Questions 7, 16, 19, and 23 and are shown in Table 5. FC students felt that doing well in Composition depends on how much time they put into writing. This question was directed at the organizational skills required by writing. On a question aimed at the belief that there are common strategies for writing, traditional students felt that they needed to know how to write papers in general. On Question 19, the FC students had the stronger belief that revising means rewriting parts of a paper. Finally, on a question aimed at the students' general attitude toward writing, the FC students felt that writing was a way to find out what you understand versus a way for teachers to grade.

Table 5. Differences between the traditional English class and the Foundation Coalition English class from the pre-semester survey to the post-semester survey. (The sample size answering each question is in parenthesis.)

Questions	Foundation Coalition		Traditional		Significant Difference p-value ≤ 0.05	
	Pre	Post	Pre	Post	Pre	Post
7. For me, doing well in Composition depends on: (a) how much time I put into writing. (b) how well the teacher explains what I have to do.	2.9 (49)	***2.7 (46)***	3.2 (153)	***3.2 (150)***		**
16. In order to write a paper, I need to: (a) have written a paper like this before. (b) know how to write papers in general.	5.4 (49)	***4.8 (46)***	5.5 (152)	***5.2 (150)***		**
19. For me, revising means: (a) rewriting parts of a paper. (b) changing words and correcting spelling and punctuation.	3.8 (49)	***3.1 (45)***	4.1 (152)	***3.7 (149)***		**
23. To me, writing is: (a) a way to find out what you understand. (b) a way for teachers to grade us.	3.5 (49)	***3.0 (46)***	3.6 (152)	***3.6 (150)***		**
24. Grammar, Punctuation, and Mechanics: (a) are impossible to master after the age of 11. (b) can always be mastered with effort.	***6.0 (49)***	5.7 (45)	***5.4 (151)***	5.7 (148)	**	

The next steps in validating this questionnaire include using focus groups to confirm the questions are being interpreted in a consistent manner with the intended goals. Also, "expert" groups will be surveyed in order to form the expert opinion, which we will ultimately use as our basis of comparison. These experts will come from the field of English Composition and from Engineering. This step by itself should provide some interesting results. These two steps are to be completed in the fall of 1998 so that a revised version of the instrument will be ready for administration in the fall of 1999. This instrument will then become an expert-novice comparison instrument and graphical tools will be added to illustrate differences. Two questions were added in the fall of 1998 administration. The questions covered each of the goals in table 5 that were not assessed with the original instrument. After presentation of this instrument at the 1998 Frontiers in Education Conference, ASU has begun receiving solicitations from other universities who wish to use the instrument with the understanding that they will help with the validation in return for statistical analysis of their data.

References

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2) Daly, J. A., and Miller, M. D., "The empirical development of an instrument to measure writing apprehension", *Research in the Teaching of English*, 9, 1975, pp. 272-289.
3) Daly, J. A., "Writing Apprehension and Writing Competency", *The Journal of Educational Research*, 2, 1978, pp. 10-14.
4) Bloom, L., "The Fear of Writing", *William and Mary Quarterly*, Winter, 1980, pp. 25-29.
5) Reed, M. W., Burton, J. K., and Vandett, N. M., "Daly and Miller's Writing Apprehension Test and Hunt's T-Unit Analyses: Two measurement precautions in writing research", *Journal of Research and Development in Education*, 21(2), Winter, 1988, pp. 1-8.
6) Accreditation Board for Engineering and Technology (ABET), "ABET Engineering Criteria 2000", third edition, 1988, p. 2.
7) Halloun and Dave Hestenes, "Views about Science Survey", *Science & Education*, October, 1966.
8) *http://www.eas.asu.edu/~asufc/*

Cognitive Data Results

Freshman GPA Analysis

An analysis of the students' freshman year grades was conducted to compare the Foundation Coalition and the non-FC comparison groups. There were no statistically significant differences found between the two groups in Physics, Calculus, Engineering, and English. However, a significant difference in grades was found between the two groups in Chemistry, a class that is not a part of the FC integrated package. Therefore, the Foundation Coalition students outperformed the comparison group in a common class taken outside of the FC package. It should be noted that the comparison group students typically take this class their first semester of their freshman year and the FC students typically take this class their second semester. Maturity may partially explain the grade differentials at this point of their academic careers.

We also examined gender and under-represented minority differences within each of the two groups. As a result, we found that males outperformed females in only one course, FC Physics, and the differences were statistically significant. There were no statistically significant differences between the under-represented minorities and non-minorities in the FC group. However, the non-minorities performed significantly better than the under-represented minorities within the comparison group in Engineering. (See Appendix C for a complete depiction.)

The last area examined was the number of hours enrolled in the first semester. There was a statistically significant difference between the two groups for hours enrolled the first semester. The non-FC group's average 14.7 hours was significantly different from the FC's 13.3 hours (.0001).

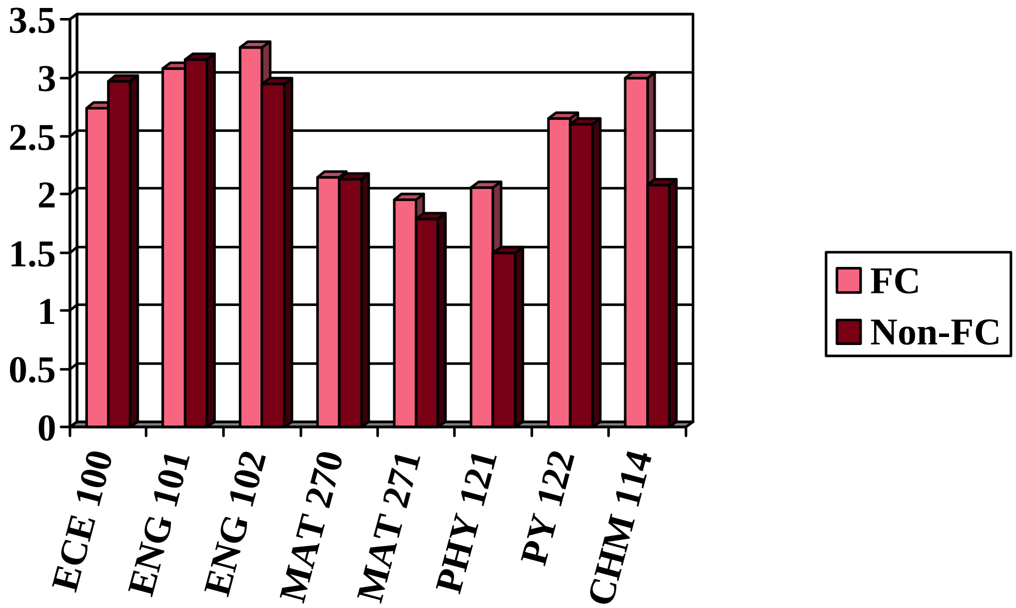

Figure 5
Year 5 Course GPA analysis: FC and Non-FC Comparison

The yearly course GPA's have been followed over the past three years. The results show an increasing upward trend for the FC students over the past three years. (See Figures 6, 7, 8)

Additional GPA analysis for the following courses can be found in Appendix C: MAT 272, Calculus III, MAT 274, Differential Equations, and ECE 300, Intermediate Engineering Design.

<u>Force Concept Inventory and Mechanics Baseline Test</u>

The Force Concept Inventory (FCI) and the Mechanics Baseline Test (MBT) were given in the Foundation Coalition freshman class by the Physics instructor. Both tests are multiple choice and are scored on a percent correct basis. Both instruments are now available on an ASU program called Quizzer. The post-FCI and both administrations of the MBT were done on the computers in the classroom. Only the pre-FCI was done on paper. The attached tables are summaries of the overall data and the data broken down by groups of interest. These groups at ASU are males/females, under-represented minorities/non-minorities, and students staying in engineering after the freshman year/students leaving engineering after the freshman year. There are three different data presentations, pre data, post data and the change from pre to post data.

The pre-FCI was given in August of 1997 in the Physics class as extra homework credit in Physics and the post-FCI was given in December 1997 as the final exam in Physics. The results were analyzed overall and by the groups of interest. The increase in test scores from pre to post-FCI tests was significantly greater than zero for every group of interest using a paired t-test as the means of analysis (level of significance .05). The p-values for this analysis were never higher than 0.01. The average gain from the pre to the post-test was 18 percent. The Kruskal-Wallis Test on the medians was used to test for significant differences between groups due to the fact that the groups of interest had small sample sizes (4 to 17) and these data found to not be normal using the Anderson Darling test for normality.

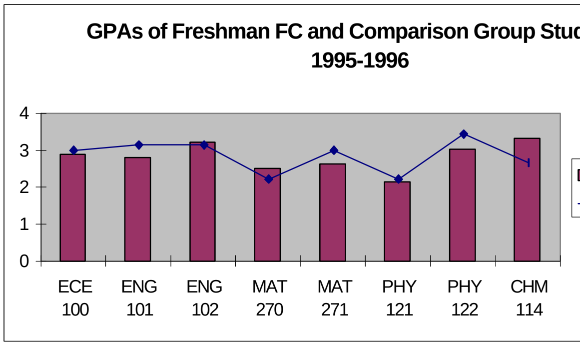

Figure 6

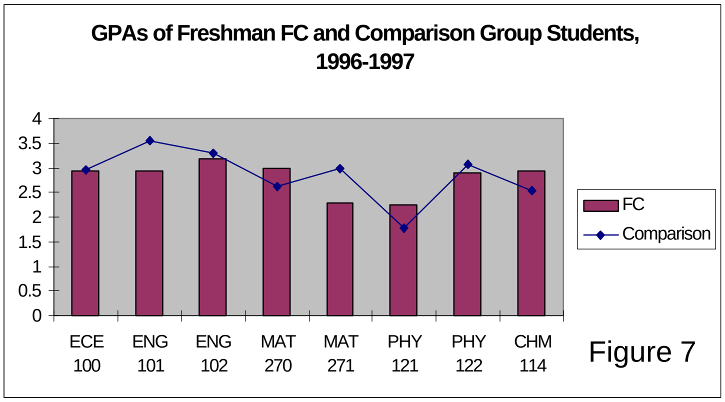

Figure 7

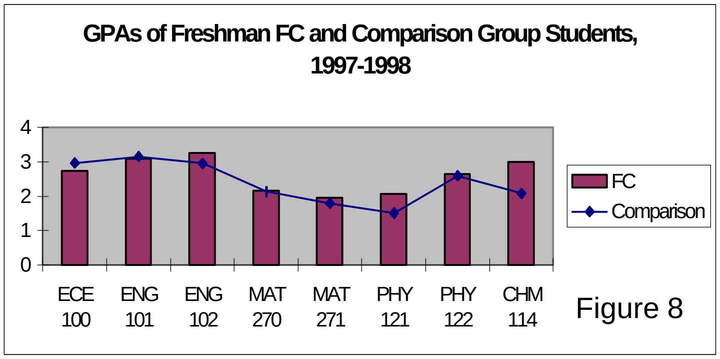

Figure 8

The analysis on the gains from the pre- to the post-FCI administration found no significant differences. Therefore, all groups had similar gains from the beginning to the end of the semester. The pre-FCI analysis indicated significant gender differences favoring the males (p-value = 0.004). The differences between the under-represented minorities and the non-minorities as well as the differences between the students staying and leaving engineering after the freshman year were not significant in the pre-FCI administration. The post-FCI analysis again indicated significant gender differences favoring the males (p-value = 0.0001), but also between the under-represented minorities and non-minorities (p-value = 0.053). Similar to the pre-FCI, there were no differences between those students staying or leaving engineering after the freshman year.

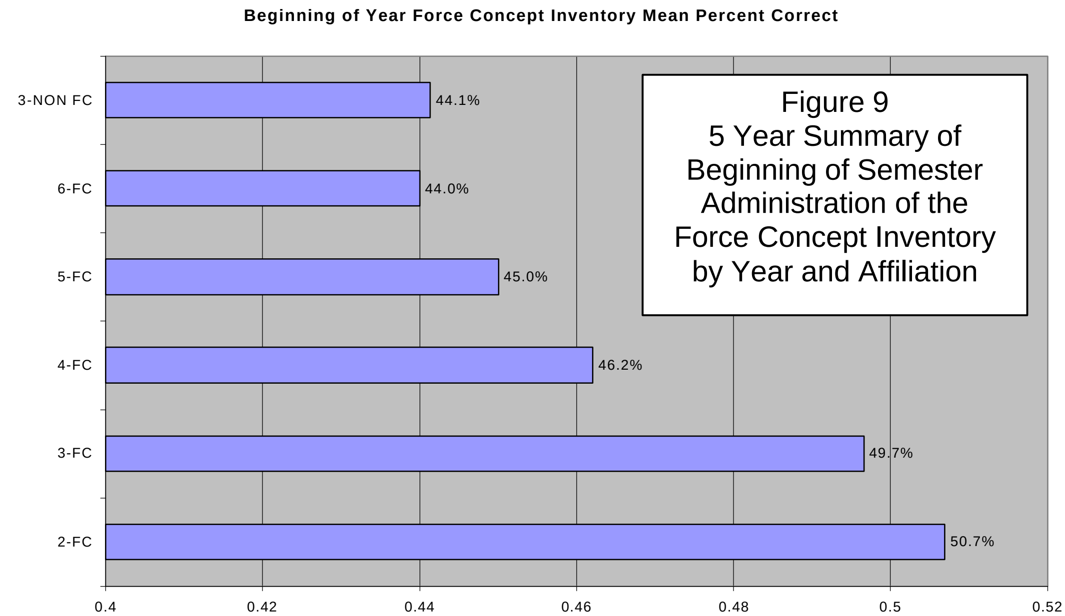

Figure 9
5 Year Summary of Beginning of Semester Administration of the Force Concept Inventory by Year and Affiliation

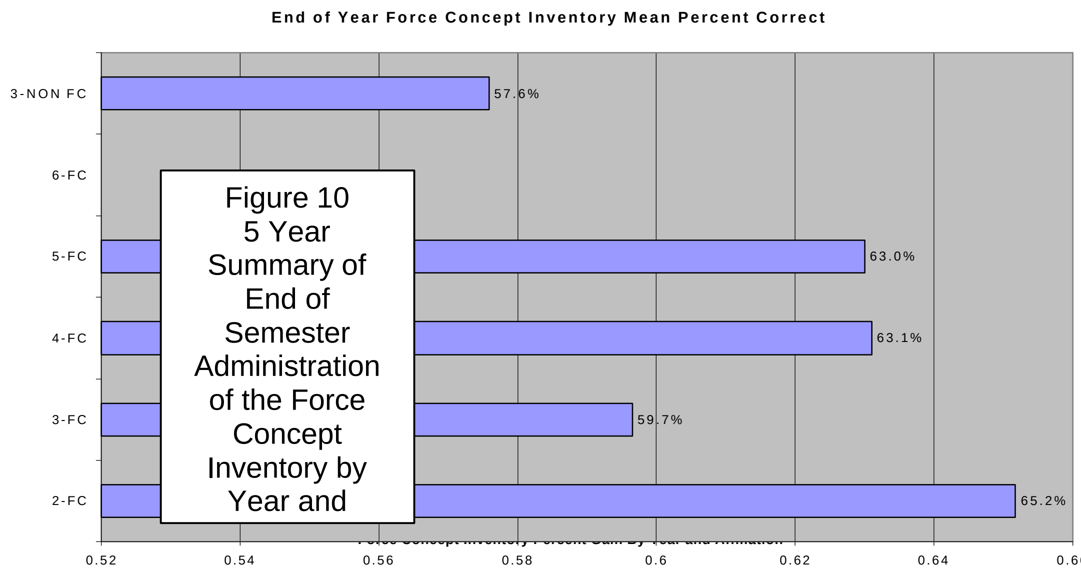

Figure 10
5 Year Summary of End of Semester Administration of the Force Concept Inventory by Year and

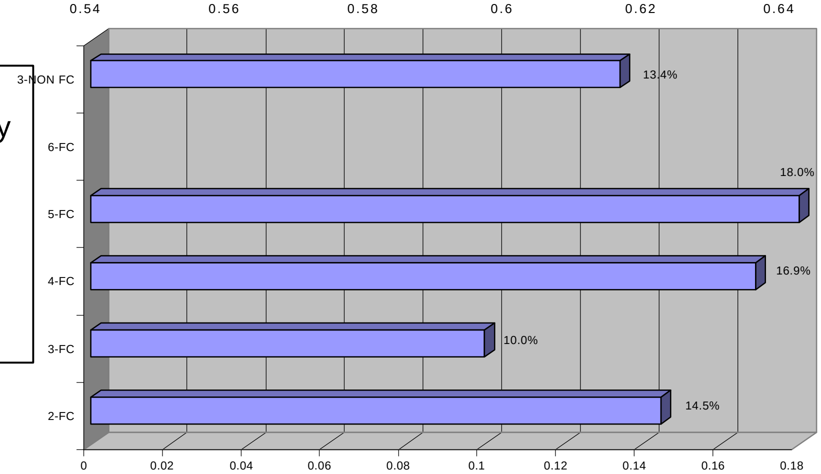

Figure 11
5 Year Summary of Gains in the Force Concept Inventory by Year and Affiliation

The Hestenes' Mechanics Baseline Test can be used to assess the students' ability to apply the fundamentals of mathematics and science to solve problems in engineering. The MBT assesses the learners' understanding of the most basic concepts in mechanics, which are taught in introductory Physics. The pre-MBT was administered as the final exam in December of 1997. The post-MBT was the final exam in May 1998. Analysis of the paired differences from pre to post-MBT administrations revealed no significant changes. Though not significant from zero, the changes trended negatively for the overall students, non-minorities, and male students staying and leaving engineering and positively for the under-represented minorities and females. Therefore, there was no significant decay in memory from the fall semester when mechanics was taught to the spring semester when the assessment occurred.

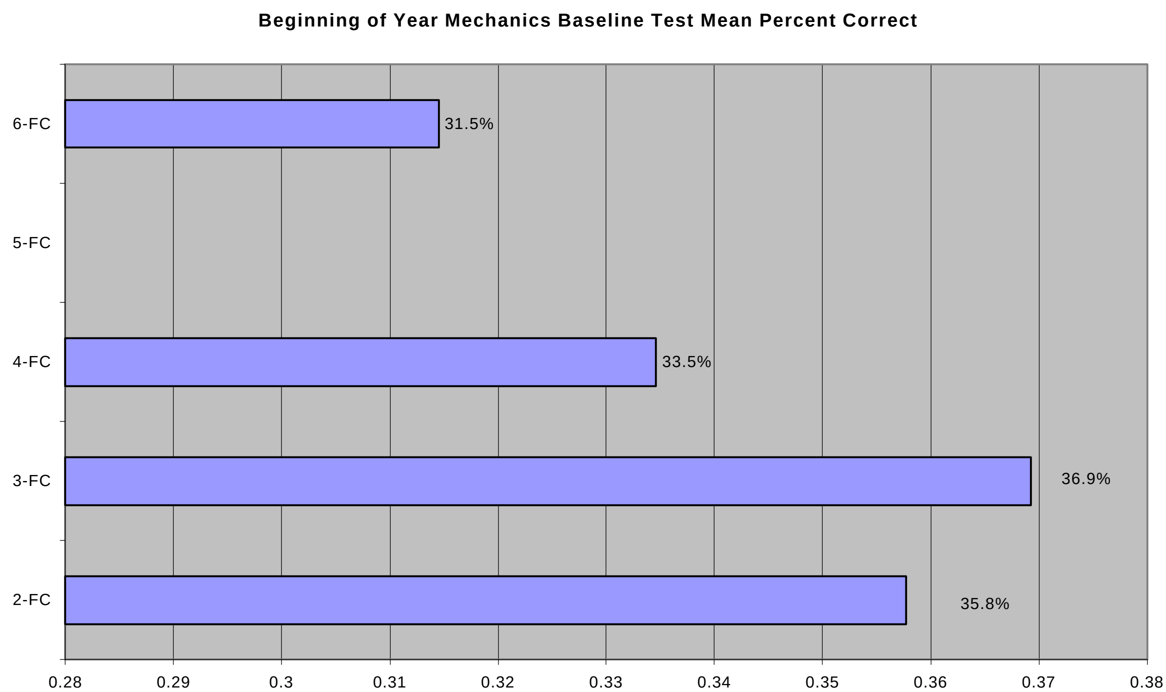

Figure 12
5 Year Summary of Beginning of Semester Administration of the Mechanics Baseline Test by Year

All groups experienced similar changes from the pre to the post-MBT administration, though as previously stated, none of these changes were different from zero. The analysis of the pre-MBT found significant gender differences favoring the males (p-value = 0.014) as well as ethnic differences favoring the non under-represented minority groups (p-value = 0.025). There was no statistically significant difference found between those students staying and leaving engineering after the freshman year. In the analysis of the post-MBT, significant gender differences favoring the males was found once again (p-value = 0.034). Unlike the pre-MBT, there were no statistically significant differences between the under-represented minority and the non-minority groups. Again, there were no statistically significant differences between the students staying or leaving engineering after the freshman year.

These results in the MBT pose an interesting situation. The MBT was written by Hestenes to be a post exam (Hestenes, 1992). The Physics instructor agreed to take the time this semester to administer this instrument at the end of the first semester and again at the end of the second semester. This arose out of the Foundation Coalition Assessment and Evaluation Team requirement to administer the MBT at the end of the second semester of the freshman physics sequence. Mechanics is taught in Arizona State University's first semester of Physics and our instructor was concerned about the memory loss that would occur from the semester the information was taught to the semester the actual evaluation took place. The results of these two administrations indicate that no significant information loss occurs in this time period. Therefore, waiting to give the MBT in the second semester of Physics, despite the fact that the actual content is taught the first semester of Physics, has no effect.

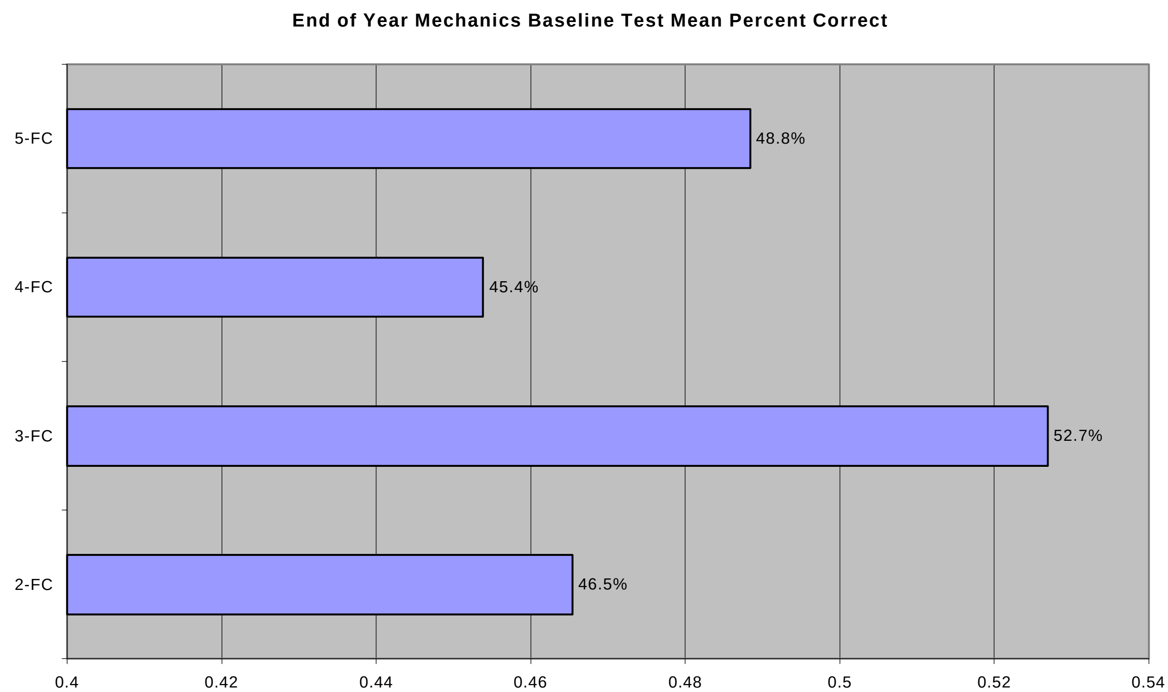

Figure 13
5 Year Summary of End of Semester Administration of the Mechanics Baseline Test by Year

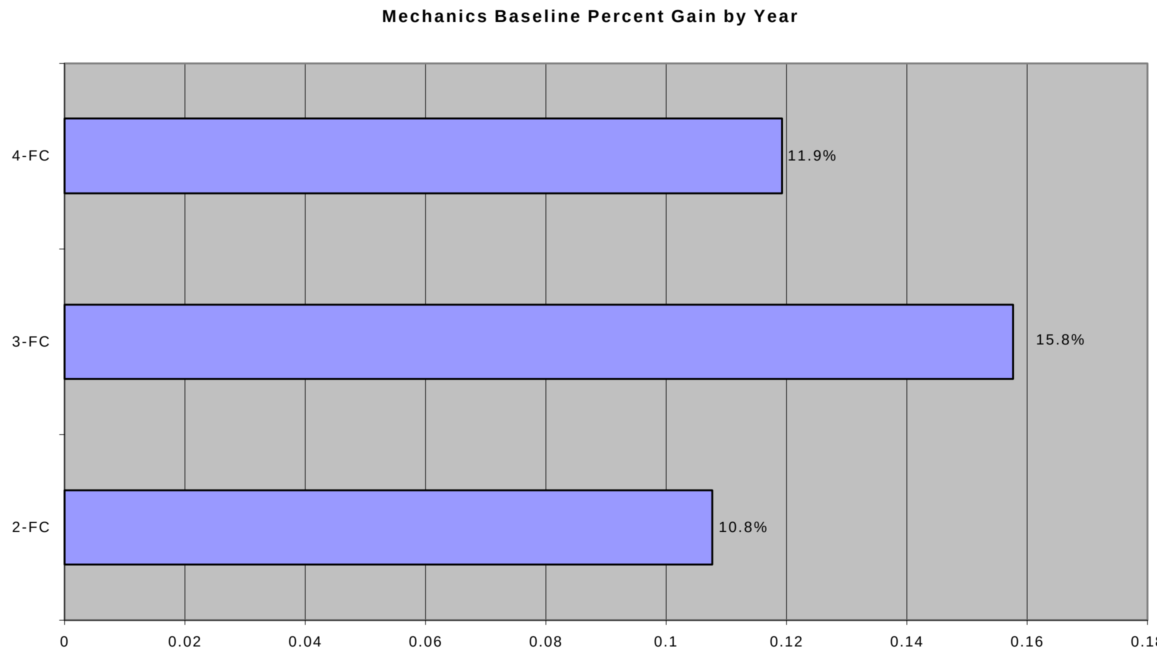

Figure 14
5 Year Summary of Gains Experienced on the Mechanics Baseline Test by Year

In conclusion, the following observations can be stated about the 1997-98 Freshman Foundation Coalition Class. The changes in students' pre- to post-test scores, based on the groups of interest, are not significantly different for either the FCI or the MBT. Although all groups exhibited similar gains, the males always outscored all other groups of interest. The gender differences in every test administration, both FCI and MBT, significantly favors the males. Also, the pre-MBT indicates a difference between the under-represented minorities and the non-minorities while the post-MBT has no significant differences. There are no significant differences exhibited by those students staying in engineering and those who have left engineering after the freshman year.

As for the Years 2 through 5 administrations of the two cognitive instruments, no significant difference results from year to year. However, there is a noted dropping trend in the beginning semester administration of the Force Concept Inventory and the differences from Years 2 and 3 to Years 5 and 6 are significant. However, the class size has changed in those periods from approximately 40 to approximately 80. Also, our FC recruiting efforts have become more wide-spread in that all entering freshmen indicating an interest in engineering are solicited for participation. Further studies would have to be initiated to determine if the overall quality of entering freshmen has actually decreased. It is interesting to note that the gains exhibited on the FCI (with the exception of Year 3) have been continually increasing, perhaps somewhat compensating for the lower incoming scores.

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Retention in Engineering and Progress Toward Degree

The purpose of this section is to compare retention in the College of Engineering for students in the Foundation Coalition curriculum to students of the same year comparison group, who were enrolled in the traditional curriculum. Retention data were collected by examining transcript data on each student semester by semester, for the freshman entering classes of the fall semesters of 1994 (Year 2), 1995 (Year 3), 1996 (Year 4), and 1997 (Year 5).

We define students as "retained" if they successfully complete their freshman year and return to the College of Engineering within any engineering major after the 21st day of enrollment of the following year. We define students who either leave the University or change to a different college as "exiters." Retention in the Foundation Coalition is defined differently and is depicted in Table 7 below.

Year 5 Retention

The FC program was more successful in the retention of females and under-represented minorities than the comparison group in year 5 (1997-1998). In fact, the FC program retained more of all students in year 5 than in any other year since its inception. We believe that this upward trend will continue in years 6 though 10. The following figure and table illustrate that the Foundation Coalition is continuing to retain a higher percentage of starters in the College of Engineering than the comparison group.

FC and Non-FC Comparison

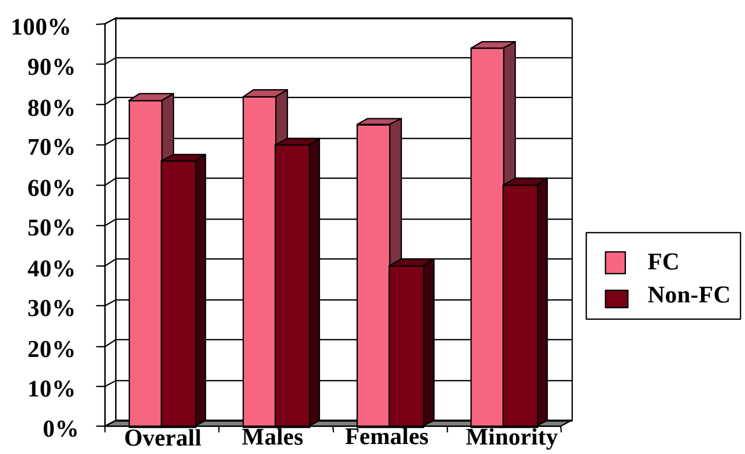

Figure 15

Year 5 Retention

Table 6
FC Year 5 Freshmen Retention Within the College of Engineering (1997-98)

	Fall Enrollment 1997			End of Spring 1998		
	Enrollment	% Women	% Underrepresented Minority	Enrollment At the End of Spring 1988	% Women	% Underrepresented Minority
FC	78	15% (12)	23% (18)	82% (64)	92% (11)	77% (14)
Comparison	32	16% (5)	31% (10)	66% (21)	80% (4)	40% (4)

Actual numbers are presented in parenthesis.

The ASU FC program was more successful retaining students in engineering in all categories than the comparison group. More specifically, the FC program was more successful in retaining females and underrepresented minorities than the non-FC in year 5. This definition of retention is different from the official FC retention definition. The official definition is retention within the FC program. Those data are seen in the following table:

Table 7
Year 5 FC Retention within the FC program

	Fall Enrollment 1997			End of Spring 1998		
	Enrollment	% Women	% Underrepresented Minority	Enrollment At the End of Spring 1988	% Women	% Underrepresented Minority
FC	78	15% (12)	23% (18)	69% (54)	50% (6)	72% (13)

<u>Four- Year Retention: 1994 – 1998</u>

The FC program retained more students, on average, over a four-year period (63%) than the non-FC group (56%). Although the FC program retained 82 percent of its students during Year 5 of the program, retention rates for years 3 and 4 (45.2%; 45.6%) brought the four-year overall average down. Additionally, the FC program retained more under-represented minorities (61%) than the non-FC group (58%) over the four-year period. Note: *Native American numbers are too small to draw any conclusions. See Appendix D for the four-year FC and non-FC retention analysis. However, the female retention rate was not as noteworthy. The overall female retention rate for the four-year period was 61 percent for the FC program, which was lower than for the non-FC program (68%). Although the FC program retained 92 percent of the females in year 5 (the best female retention rate in the four year period),again, years three and four brought the overall female retention rate down (i.e., 36%; 43%). Table 8 and Figure 15 are summaries of this data.

Table 8
4 Year Retention
FC and Non-FC (1994-1998)

Program	Total (n)	Fall 1998 Total	Male	Female	White Asian	African American	Hispanic	Native American
FC	219	137 63%	111 63%	26 61%	110 63%	6 60%	18 62%	3 60%
Non-FC	183	103 56%	82 54%	21 68%	84 56%	2 50%	12 57%	4 67%

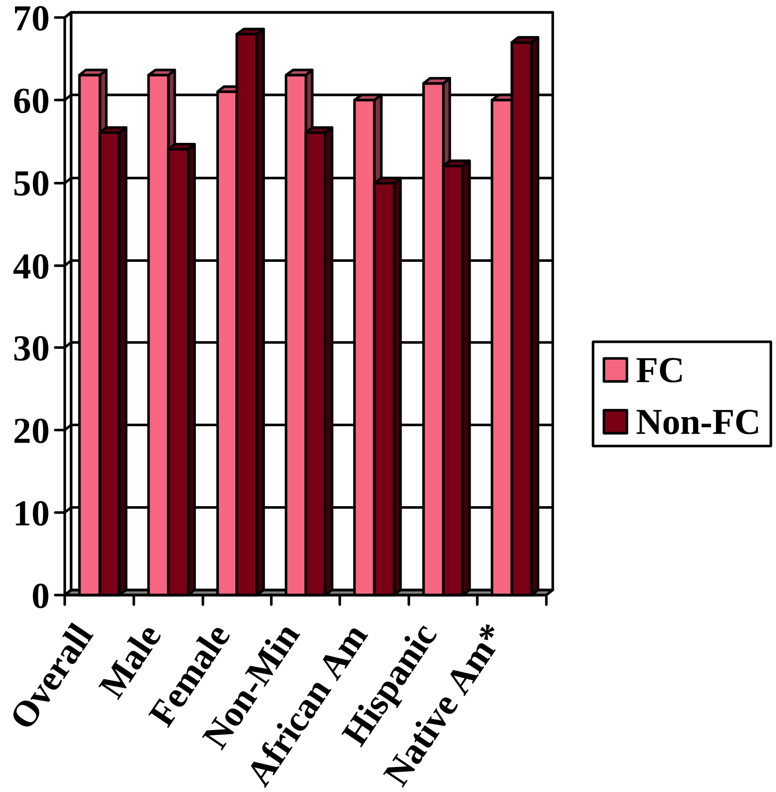

Figure 16
Four Year Retention: FC and Non-FC 1994-1998

Sophomore

Assessment and Evaluation

As previously explained on page 7 of this report, ASU does not offer a large block, integrated FC sophomore program. The Coalition does offer separate courses in Calculus with Analytic Geometry III, Elementary Differential Equations, Electrical Networks and Engineering Mechanics during the sophomore year. For an in-depth description of each of these courses and their status see page 8. These courses are open to all engineering students despite their involvement or lack thereof in the FC freshman year. The following table illustrates that the FC retained a high percentage (96%) of sophomore students enrolled in these courses in the fall of 1997. Furthermore, the program successfully retained women and under-represented minorities.

Table 9
Sophomore Retention Year 5

ASU	Fall Enrollment1997			End of Fall1997		
	FC Enrollment	% Women	% Underrepresented Minority-	FC Enrollment	% Women	% Underrepresented Minority
	137	11% (15)	15% (20)	96% (130)	93% (14)	90% (18)

Actual numbers are presented in parenthesis.

The Mechanics Baseline Test (MBT) was administered to our Foundation Coalition sophomore class at the end of the semester. The results are represented in the following table and are given in terms of number of questions correct. There are 26 possible correct questions.

Table 10
Sophomore Mechanics Baseline Test Results - Years 4 and 5

	Number of students	Mean	Median	Standard Deviation
Post - Fall 1997 (Year 5)	42	13	12	5.4
Post - Fall 1996 (Year 4)		13.1		
Pre – Fall 1995 (Year 3)	12	13		

When compared to the freshman Foundation Coalition results from the MBT given at the end of the year, there are no statistically significant differences in scores. However, this comparison is questionable due to the fact that the students are now mixed in that some participated in the freshman year experience and some did not. Also, there was no pre-semester administration of the instrument in the same year that it was used as a post-semester instrument in order to calculate the gains in the course. This is an assessment problem that the A&E Team needs to address at the Sophomore level.

A second assessment instrument was administered in Year 5 at the Sophomore level, this was the FC Calculus Exam. A summary of these results were not available at the time of this report.

An Integrated Mechanics Curriculum

I. Summer of 1998

The initial planning stages of the project identified the courses that will be targeted for this approach as well as an overall targeting timeline. It was decided that *Statics*, ECE-210 would be the foundation course, and that we would target pre-requisites of Statics as well as those course for which Statics is a pre-requisite in succeeding semesters. As a starting point, it was decided that *Engineering Mechanics*, ECE 314, in the Fall of 1998 would be used as a test course for implementing the finite element method as a fundamental tool for all engineers. This would be followed by further implementation during the Spring of 1999 in a test section of *Statics*, ECE-210.

In addition, it was decided that the software to be used in the beginning courses should be MATLAB and/or MathCAD, since those are both commonly used in the pre-requisite courses for Statics. During the Fall of 1999, we plan to evaluate Finite Element (FE) software that will be used in the upper division courses for which *Statics* and *Strength of Materials* are prerequisites.

A. Year One Target Courses

The target course for year one are *Statics*, ECE 210 and *Engineering Mechanics*, ECE-314, primarily because we are teaching sections of these courses. The main goals were to:
Develop a set of notes which introduces students to the Finite Element Method (FEM) at a very fundamental level. These notes are attached as Appendix I.
Develop one or two computer based projects to demonstrate the concepts introduced in part
Assess the notes and projects at the end of the semester.

B. Year Two Target Courses

- During the second year, the important target courses would be:
- Strength of Materials, ECE-313
- Mechanics of Materials, MAE-422
- Aerospace Structures, MAE-425

C. Year Three Target courses

- Engineering Design, MAE-443
- Aerospace Design, MAE-444
- Aerospace Systems Design, MAE-468

D. Year Four Target Courses

- Linear Algebra, MAT-242
- Differential Equations, MAT-274
- Numerical Methods, ECE-384
- Partial Differential Equations, ECE-386

Year Five Target Courses

During year five, the target courses will be 400 level MAE electives and, hopefully, some 300 and 400 level courses in other departments.

Faculty Buy-in

During the Fall semester of 1998 and Spring semester of 1999, we plan to meet with other faculty members in the mechanics area to discuss this project and to begin the efforts necessary to make this a mainstream curriculum.

II. Fall of 1998

A short description of the progress (through October 15, 1998) follows.

A. Development of Class Notes

A set of class notes for implementing the finite element method for two dimensional trusses was developed and is included as Appendix I. These notes were used in *Engineering Mechanics*, ECE-314 during the Fall semester and were used to extend the text material. Every effort was made to make the notes compatible with the textural materials and the material was presented over six class periods (4 credit hour course, hence this corresponds to 1.5 weeks).

B. Project Development

A single project, based on the class notes was also developed and is included as Appendix II. Since this course is a service course for electrical engineers, the project was given an electrical engineering flavor (power pole design) and had a design component to it. Students worked in groups both in class and outside of class, however students turned in individual reports, based on the group's work. Two full class periods (in addition to those used to introduce the FEM) were devoted to the project in a computer classroom (ECG-224).

C. Software Selection

The software used for the FEM project described above was MathCAD, primarily due to the fact the it has the shortest learning curve and the students, for the most part, have no programming or software tools experience. A MathCAD worksheet was developed that implemented the FEM method for a 2-D truss as discussed in class. It has a basic geometry input section and includes both numerical (tables of results) and graphical (plots of the undeformed and deformed truss) output. An identical MATLAB version of the truss FEM software was developed in parallel with the MathCAD version. (available upon request).

One of the goals of this project is to get the students to a level where they can use FE software packages for design. In order to solve more complex design problems, we must have a FE software tool that is available to all students at the IT computing sites as well as in the CEAS computer classrooms. It is important to use one of the well know FE tools and we are evaluating both ANSYS and MSC NASTRAN. The final decision will be made at the end of the fall semester, 1998. The steps to obtain a site license will be pursued in the Spring semester of 1999.

Faculty Buy-in

The first meeting with the mechanics group: scheduled for late Fall, 1998.

III. Spring of 1999

A section of Statics, ECE-210 will be targeted for this semester, using the notes and projects developed in the Fall of 1998. The notes will be extended to cover topics other than trusses and additional projects will be developed. The FE software package chosen during the Fall semester will be purchased and placed on the appropriate network servers, but will not be used during this semester. Plans for targeting one section of *Strength of Materials*, ECE-313 will be made.

IV. Summer of 1999

The FE software installed in the spring semester will be tested and, with the help of a graduate assistant, an additional project will be developed for use in the Strength of Materials course in the Fall of 1999.

Upper Division

Electrical Engineering

Assessment - Wave Concepts Inventory

The Foundation Coalition at Arizona State University offered for the first time a novel upper division integrated course in Electrical Engineering in the fall '97 semester. The courses involved were (1) an introduction to the properties of electronic materials and (2) the first course for EE majors in electromagnetic engineering. The main thread that integrated the two courses was "wave phenomena." To determine whether this integration successfully teaches the students in wave phenomena, we developed an assessment tool, which we have called the Wave Concepts Inventory. This is a description of the organization of the Waves Concepts Inventory and its use in assessing upper division students in their understanding of wave concepts. For further details and information see Roedel, El-Ghazaly, and Aberle (1998) and Roedel, El-Ghazaly, Rhoads, and El-Sharawy (1998).

Introduction

The Department of Electrical Engineering at Arizona State University has started the process of developing an upper division curriculum that would be a natural extension of the Foundation Coalition lower division classes that are presently in place. During the fall 1997 semester, we offered through the Electrical Engineering Department at ASU a new upper level Foundation Coalition course, which combines and integrates two other courses – introduction to the properties of electronic materials (ECE352) and the first course in electromagnetic engineering (EEE340) [5]. The main thread that integrates the two courses is "wave phenomena." In the electronic materials portion of the class, the students are introduced to quantum mechanics and Schrödinger's wave equation. Here they discover that the objects that dominate solid state physics, such as the electron, the photon, the phonon, and so on, have wave character. And of course, in the electromagnetic portion, the students learn Maxwell's wave equations and their application to the propagation of EM waves.

What strengthens this integrated offering is that students see at one time several analytical models that describe waves, their propagation, and their interactions. But to determine whether this integration successfully teaches the students in wave phenomena, we developed an assessment tool, which we have called the Wave Concepts Inventory (WCI). This WCI survey is based on the model developed by Dave Hestenes and co-workers at ASU known as the Force Concept Inventory [6]. The FCI has been assembled and refined over several years to test freshman students on their intuition concerning kinematics concepts, Newton's Laws, and conservation principles.

The WCI is a multiple-choice examination, but allows for more than one correct choice in most of the questions. In fact, choosing more than one answer correlates with increasing understanding of the material. The test was administered before and after the new course - and to a group of similar electrical engineering students taking the traditional E&M course as a comparison group. This paper will describe in detail the organization of the Wave Concepts

Inventory and its use in assessing all upper division students in their understanding of wave phenomena.

The Wave Concepts Inventory

The WCI consists of 20 multiple choice questions with possible 34 correct answers. The survey asks a variety of questions that probe several areas of knowledge, including visualization of waves, mathematical depiction of waves, and wave definitions. Though the WCI is a multiple-choice examination, it allows for more than one correct choice in most of the questions. In fact, choosing more than one answer correlates with increasing understanding of the material. For example, in question 4, many students will quickly recognize (a) as the obvious answer since it is Maxwell's Equation, but students with more experience will also notice that (c) is a correct answer too since it is a version of Schrödinger's wave equation. Similarly, in question 7, answer (d) is normally the first choice, but the added choice of answer (a) shows deeper understanding of the phenomenon.

Analysis of the results

There are multiple correct answers to individual questions and credit was given to individuals who chose more than one correct answer. No penalty was imposed for incorrect answers, and therefore, guessing was not discouraged. The test was administered to two classes of electrical engineering students. The first class was the traditional class that had 58 students completing the semester. There were 11 juniors (19%), 40 seniors (69%), 6 graduate students (10%), and 1 unclassified undergraduate (2%) in this class. The comparison class was what we refer to as the integrated class. This class was composed of 22 students. There were 8 juniors (36%), 13 seniors (59%), and 1 graduate student (5%). The scoring of the two classes was a comparison of the number of total correct answers from the test being taken at the beginning of the semester (Pre-test) and the same test being taken at the end of the semester (Post-test). Perhaps more importantly is the change that was affected in the individual students. This statistic is reflected in the "Change" variable which represents the post-test score minus the pre-test score for those students who took both tests. Table 11 summarizes the descriptive statistics.

Tests on the changes in each student from the pre- to the post-semester tests were performed on the means and standard deviations. Each class was used to test the null hypothesis that the mean change (post-test minus pre-test) was equal to zero versus the alternative that the mean change is greater than zero. By formulating the hypothesis in this manner, we are hoping to make the strong conclusion and reject the null hypothesis, in favor of seeing a larger increase in the post-test scores. For the traditional class, we failed to reject this hypothesis (p-value = 0.077). That is, on the average, there is not a significantly positive change in test scores from the beginning to the end of the semester.

Table 11 – Descriptive Statistics for Each Course

	Pre-Test	Post-test	Change
Traditional Course			
Average	10.4	11.9	0.9
Median	10	12	1
Standard Deviation	2.8	3.3	3.4
Sample Size	54	51	39

Integrated Course			
Average	11.8	15.2	3.4
Median	12	15	3
Standard Deviation	2.8	2.9	1.5
Sample Size	21	20	19

For the integrated class, the hypothesis was rejected with a p-value of 0.0001 indicating that there was a significant increase in the post-test score. A test of the null hypothesis that the changes between the traditional and integrated courses were equal versus the alternative that the changes were unequal was performed. This null hypothesis was also rejected (p-value = 0.0004). Figure 16 is a dotplot of the changes from post to pre-test scores within each course. Another interesting note is that only positive changes resulted in the integrated course. Normality was confirmed for the integrated course due to its small sample size using the Anderson Darling test statistic. [7]

```
         .               :
         :           .   :       :   :   :
 .       :   .   :   :   :   :   :   :   :       .   .   :
  ---+---------+---------+---------+---------+---------+---
Traditional
   -5.0      -2.5       0.0       2.5       5.0       7.5
                                 .       .
                                 :   :   :   .
                             .   :   :   :   :       .
  ---+---------+---------+---------+---------+---------+---
Integrated
   -5.0      -2.5       0.0       2.5       5.0       7.5
                    Points Changed
```

Figure 17 - Character Dotplot of the Net Changes in Test Scores from Pre to Post-test Administration for the Traditional and Integrated Courses.

An analysis of the correlations between the pre-test, post-test, changes, and grade received in the course was performed and the results are included in Table 12. In both courses, the pre-test scores were negatively correlated with the changes. Therefore, the higher the pre-test score, the lower the change from the pre to the post-test. The grade received in the course was not found to be significantly correlated with any of the other variables. The correlation for the grade received in the course with the post-test score was highest, though not significant

In the engineering world, correlations in the range of 0.5 are not typically considered significant. In general, correlation coefficients greater than or equal to 0.8 indicate strong linear relationships, while correlation coefficients less than 0.6 indicate weaker relationships. Therefore, only the integrated course pre-test to post-test correlation is in the range of significance for engineers. This correlation is so high due to the fact that only positive changes resulted in the integrated course.

Table 12 – Correlations Between Variables for Each Course

Correlations (p-value)	Grade Received in Course		Pre-test Score		Post-test Score	
	Traditional	Integrated	Traditional	Integrated	Traditional	Integrated
Post-test Score	0.28483 (0.0831)	0.38974 (0.0894)	0.49708 (.0020)	.87386 (.0001)		
Change			-0.45015 (0.0059)		0.551057 (.0015)	

There are many possible factors that could have created the above differences. Two faculty members, functioning as a team, teach the integrated course. These faculty members are the authors of the instrument used to evaluate the two courses. Though the instrument was written a full semester before its application, the authors will tend to write questions on the concepts that they feel to be most important. These views may or may not be shared with other instructors. Also, teaching to the test may have been a factor. The test was administered and graded by a disinterested third party. In fact, this third party did not know which class the instrument authors taught and which was not. All grading and reporting of results took place after the completion of the semester. Additional factors that could have had an effect on the data are the small class size for the integrated course, the small class had 2 instructors, and these students had potentially twice as many lectures since students in the comparison class were not required to take the second course.

Future plans for the continued validation of this instrument include the evaluations of personal interviews that were conducted in the spring of 1998 with students who took the test in the fall of 1997. We are currently interviewing instructors who teach the subject matter for their input. Both of these activities are a part of our question by question analysis that is currently underway with the goal of differentiating between good and bad questions as well as good and bad possible solutions to each question. We are interested in having individuals use this instrument in other institutions and situations. More details about the structure of the Wave Phenomena course can be found on the same web page:

http://www.eas.asu.edu/~roedel/ece352

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2) R.J.Roedel, D.Evans, M.Kawski, B.Doak, M.Politano, S.Duerden, M.Green, and J.Kelly, "An integrated, project-based, introductory course in calculus, physics, English, and engineering," Frontiers In Education (FIE) conference, November 5, 1996, Salt Lake City, UT.
3) R.J.Roedel, D.Evans, R.B.Doak, J.McCarter, S.Duerden, M.Green, and J.Garland "Projects that integrate engineering, physics, calculus, and English in the Foundation

Coalition freshman program," Frontiers In Education (FIE) conference, November 5, 1997, Pittsburgh, PA.

4) S.Duerden, R.B.Doak, M.Green, J.Garland, R.J.Roedel, P.Williams & D.L.Evans, "Scaling Up the Foundation Coalition First-Year Integrated Program in Engineering: Problems and Solutions," Frontiers In Education (FIE) conference, November 5, 1997, Pittsburgh, PA.
5) R.J.Roedel, S.El-Ghazaly, and J.T.Aberle, "An integrated upper division course in electronic materials and electromagnetic engineering - "wave phenomena" for EEs," Frontiers In Education (FIE) conference, November, 1998, Tempe, AZ.
6) D.Hestenes, M.Wells, and G.Swackhamer, "Force Concept Inventory," The Physics Teacher, 30, 141 (1992).
7) Montgomery, Douglas C., George Runger, and Norma Faris Hubele, Engineering Statistics, Wiley, 1998.

Industrial Engineering

Sophomore Curricula

- The integrated Statics/Dynamics course has been adopted as part of the IE curriculum

Note: This activity is reflected in the current IE curriculum check sheets.

- Working with EE faculty in developing an integrated Introduction to EE course to serve both (IE and EE) curricula

Note: This is under discussion; as yet, there is no course outline.

Upper Division

DELPHI analysis of the IE curriculum

- All courses listed in the 1997 ABET review
- Outline of DESIGN as articulated by ABET
- Panel of five experienced IE faculty
- Overwhelming emphasis on analysis in IE courses
- Results being used in redesign of courses

Note: The DELPHI study is available in a separate folder Redevelopment of Operations Research/Production Systems

- Included all graduate as well as all undergraduate courses in the emphasis area
- All courses integrated in order that common knowledge areas could be emphasized
- Undergraduate courses emphasizing design elements

Note: New (and old) course outlines are available in a separate folder

Implementation of Foundation Coalition approaches into upper division IE course

- Trial basis, one course (IEE 476 Operations Research), Fall 1998
- Utilizing Felder, Levels of Learning and other approaches

Note: Report on techniques being implemented available in a separate folder (J. Cochran summer development)

IEE 394 Facilities Analysis and Design ready to be put in the curriculum and ASU catalog

- Integrated with IEE 394 Work Analysis and Design
- Integrated with IEE 490 Senior Design Project
- Taught in Undergraduate Design Laboratory
- Application of cooperative learning (team and Felder "5 minute" questions)
- Design emphasis drawn from results of DELPHI study

Note: Course syllabus and structure (design project) available in separate folder

IEE 394 Work Analysis and Design will be taught in Spring 1998 and then be ready to be put in the curriculum and ASU catalog

- Integrated with IEE 394 Work Facilities and Design
- Integrated with IEE 490 Senior Design Project
- Taught in Undergraduate Design Laboratory
- Application of cooperative learning (team and Felder "5 minute" questions)
- Design emphasis drawn from results of DELPHI study

Note: Course syllabus and structure (design project) available in separate folder

Integrated senior design project course (IEE 490) currently used by all faculty teaching the course

- Course structure maintained in computer data base for faculty sharing
- Course emphasizes team work and cooperative learning
- Course under continued redesign to promote added interdisciplinary focus

Note: Complete course description maintained in a separate folder

Articulation of the goal statements for ASU, CEAS, IE and FC is partially completed

Note: Goal statements and preliminary articulation available in separate folder

Assessment

Assessment library completed and available for faculty use

- Developed using ENDNOTES application package
- Instructions and download for ENDNOTES viewer made available on FC web pages
- Documents available for checkout
- Continued development of document data base (e.g. documents from 1998
- Best Practices Symposium being accessed)

Note: Instructions and description for use of the data base available in a separate folder and on the web

Senior exit interviews being redesigned

Note: Exit interview format available in a separate folder

Alumni questionnaire on curriculum (used for ABET and Decennial reviews) being redesigned

Note: Questionnaire available in a separate folder

Active faculty involvement in developing methods of assessment

- Faculty service on the Dean's Advisory Committee on ABET and Assessment (W. C. Moor)
- Faculty involvement in FC Symposium on Assessment and Evaluation (Chair, G. L. Hogg; Ass't Chair for U/G, J. E. Bailey; and W. C. Moor attendees)

Note: Committee rosters and attendee lists available in a separate folder

- Internal meta-assessment model developed
- Graduate student help in data collection and statistical analysis being performed

Women in Science and Engineering (WISE) Program

Funds were used by the WISE program but no formal report has been forthcoming. These funds were used to develop a CD ROM on diversity which is to be used in classes to help all students understand and appreciate the diversity. Funds were also used to subsidize a summer recruiting program for young women. More details will be available at the site visit review, including a copy of the CD ROM to all site visitors.

Papers published by this group include:

Blaisdell, Stephanie, Constantine Andreyev, and Russell Jones. "An Interactive CD ROM to Sensitize Engineering Students to Diversity Issues". Frontiers in Education Conference, November, 1998.

Blaisdell, Stephanie, Constantine Andreyev, and Russell Jones. "Diversity In Engineering Work Teams: An Interactive CD-ROM Based Diversity Training Program for Freshman Engineering Students". ASEE, July, 1998.

Blaisdell, Stephanie, Constantine Andreyev, and Russell Jones. "An Interactive CD ROM to Sensitize Engineering Students to Diversity Issues". WEPAN National Conference, June, 1998.

Minority Engineering Program (MEP)

Academic Excellence Program:

- Program includes courses that FC Campus Match students take such as: ECE 100, MAT 270, and PHY 121
- Successfully enhanced engineering and math concepts*
- Employed 3 undergraduate engineering students to serve as role models
- Expanding program next semester to include two dedicated classes to ASE 194 students in MAT 270 and MAT 271 with faculty partner and math department collaboration.

* see paper from FIE 98 – highlighted section included in Appendix F.

MEP Summer Bridge Program:

- Two week residential program (July 6-16, 1998) prior to classes commencing in fall for Foundation Coalition Campus Match incoming minority freshman students
- Eight minority engineering freshman students participated and received a total of $6,800 in scholarship support
- Overall, the program is showing a first year retention rate of 88% within the university and 77% within the CEAS.
- A study of the participants in last year's program showed that those students who participated in the Bridge program and the FC Campus Match program had an average GPA of 2.57 while those who were in the Bridge program and not in the FC Campus Match program had an average GPA of 2.34.*

* see paper from FIE 98 – highlighted section included in Appendix F.

MEP/MESA Fall/Spring Recruitment:

- Bring high school students on campus in October and April
- Recruit potential Campus Match Students
- Transportation Costs
- Materials and Supplies

Student Liaisons to high schools:

- Constant interaction with undergraduate students in local high schools
- Students interface with the high schools on a weekly basis
- Undergraduate student salaries

Over sixty high school students attended the MESA Sr. Engineering Day in Fall '97 and Spring '98 participating in ECE 100, an introductory engineering assembly design class and the FC classes. Worked with the Engineering students and faculty on the FC curriculum. In addition, attended a panel session consisting of FC faculty and students on the benefits of taking FC classes and pursuing engineering. Lunch hosted by FC.

Sponsored Engineering students to serve as MESA Liaisons to Sr. and Jr. High schools within the Phoenix area. Liaisons twice a week traveled to schools to recruit and mentor MESA students. Tutored in math and science and assisted the MESA Advisors with classroom activities. Liaisons provide a direct link between the MESA teachers, students and College of Engineering.

Funded the ASU MESA Center Recognition and Award Ceremony for students. Annual program brings together MESA Jr. and Sr. students, family, industry supporters, ASU Administrators, Engineering faculty, staff and students to acknowledge graduating high school seniors, academically outstanding students, induction of seniors into the ASU College of Engineering for the upcoming semester, disseminate scholarships, thank teachers and liaisons. Over 350 MESA participates in attendance.

Other papers published dealing with the MEP program include:

Anderson-Rowland, Mary R., Reyes, Maria A., and McCartney, Mary Ann. "Engineering Recruitment and Retention: A Successful Bridge", 1997 FIE Annual Conference Proceedings, Session 1171.

Anderson-Rowland, Mary R., Reyes, Maria A., and McCartney, Mary Ann. "MEP Summer Bridge Program: Mathematics Assessment Strategies", 1998 ASEE Annual Conference Proceedings, Session 2670.

Faculty

Background

Assessment and evaluation of student cognitive and technical skills are critical components of the Foundation Coalition. Assessment of the FC's educational impact on CEAS faculty at ASU is equally important. Therefore, FC and non-FC faculty were asked to participate in completing the faculty survey. Faculty were asked to participate via email and complete the web-based survey at the end of April, 1998. The response was better in 1998 (n=34) in comparison to last year (n=12), yet not overwhelming. Responses were automatically recorded in a database at the Rose Hulman Institute of Technology (RHIT) site. Data analysis for the ASU site was completed by the ASU Assessment and Evaluation team. Results from the survey are presented here and on the ASU Assessment and Evaluation web site; http://www.eas.asu.edu/~asufc/AEDteam/Aeteam.html.

Approximately 164 tenured and tenure track College of Engineering and Applied Sciences faculty and additional faculty outside of engineering (English, Mathematics, and Physics) were asked to participate in the faculty survey. Unfortunately, only 34 responded to the survey. The faculty survey sample was 76 percent (26) Anglo, 12 percent American Indian (4), 6 percent Asian (2), and 6 percent failed to indicate ethnicity. Eighty eight percent were male and 12 percent were female. The sample was consistent with the overall CEAS faculty which is 90 percent male and 10 percent female. Half of the survey respondents were over 50 years of age while 21 percent were between 31 and 40, and 21 percent were between 41 and 49 years of age. Only 9 percent of the respondents were 30 or younger.

The composition of the ASU faculty response was as follows:

Involvement	Percent (Count)	
"Teach/taught FC course(s)	20% (7)	
"Formal Involvement in the FC"	18% (6)	
		FC: 38%
"No involvement in the FC"	62% (21)	
		Non-FC:62%

Focus of Survey

Survey questions addressed multiple aspects of a faculty member's experience within the Foundation Coalition. Aside from specific involvement information and key demographic characteristics (i.e., gender, ethnicity, age, years teaching, department appointment, tenure status and teaching vs research interests), the Faculty Survey measures:

Use of Foundation Coalition strategies
Attitudes toward Foundation Coalition strategies
Perceptions of personal & professional rewards of participation in the FC
Perceptions of degree of difficulty for implementation of FC strategies

Perceptions of campus culture for change
Perceptions of likelihood for campus to institutionalize FC programs
Comparison of attitudes and perceptions of FC faculty with Non-FC faculty

Preliminary Findings

Preliminary findings shown below represent a summary of ASU faculty responses.

Impact of FC Strategies on Student Learning

	Agree With Statement FC % (n=13)	Agree With Statement Non-FC % (n=21)
1. Cooperative learning enhances student learning	100% (13)	76% (16)
2. Students trained in team skills will be better prepared for future.	92% (12)	86% (18)
3. Students who use technology will have advantage in engineering courses.	92% (12)	86% (18)
4. FC assessment activities provide faculty with useful information.	54% (7)	48% (10)
5. FC program will improve educational outcomes for engineering students.	77% (10)	71% (15)
6. I believe FC students are better prepared to meet employers' needs	69% (9)	62% (13)
7. FC program is more academically rigorous than the traditional program.	31% (4)	38% (8)

	Agree With Statement FC % (N)	Agree With Statement Non-FC % (N)
Should FC Strategies be Widely Used:		
1. Cooperative learning techniques should be used by engineering faculty	69% (9)	76% (16)
2. Faculty should help students integrate knowledge from 2 or more disciplines	85% (11)	90% (19)
Perception of FC Faculty Workload:		
1. Teach w/FC approach for 1st time requires no more effort than other courses	38% (5)	19% (4)
2. Teaching FC courses requires more effort from faculty than traditional course	85% (11)	42% (9)
Perception of Impact of FC Strategies on Campus Populations:		
1. Overall, FC has been a positive experience for FC students	85% (11)	52% (11)
2. Overall, FC has been a positive experience for FC faculty	85% (11)	43% (9)
3. Overall, FC has been a positive experience for my department	69% (9)	29% (6)
4. Overall, FC has been a positive experience for my college	62% (8)	38% (8)
5. Overall, FC has been a positive experience for my institution	77% (10)	24% (5)
Perception of Degree of Difficulty for Implementation of FC Strategies:		
"My perception is that the following aspects of the Foundation Coalition are difficult to implement:"		
1. The integration of topics/courses	85% (11)	38% (8)
2. Use of technology to improve student learning	31% (4)	33% (7)I
3. Incorporation of cooperative learning	62% (8)	24% (5)
4. In-class use of formal monitoring and assessment techniques	69% (9)	38% (8)
5. Coordination with other faculty	62% (8)	52% (11)
6. Overall workload	85% (11)	43% (9)

Rewards of Participating in the FC:	FC Faculty Only
1. My involvement in the FC has been professionally rewarding	77% (10)
2. My involvement in the FC has been personally rewarding	92% (12)

Written Comments By Faculty Members:

What have been the greatest benefits to you as a result of your participation in the Foundation Coalition?

FC Faculty:
"Working with other faculty at our weekly coordination meetings"
"It sensitized me to the possible benefits of cooperative learning and technology-based teaching"
"I have learned a lot about teaching my subject because I was encouraged to experiment"

Non-FC Faculty:
"I became exposed to cooperative learning"
"I have grown personally and professionally by learning innovative educational approaches"
"The experience has helped broaden my perspective of engineering as a profession"
"The FC is a sheltered home for bringing innovations to the market"
"The infusion of technology into the classroom"

Summary

Consistent with last year's FC overall responses, a discrepancy between FC and non-FC faculty is evident. The two groups differ in their perceptions about the Program in several areas: 1) perception of FC faculty workload; 2) the FC experience for FC students, faculty, the department, CEAS, and the institution; and 3) and the degree of difficulty for implementation of FC strategies. It was somewhat surprising that the FC faculty felt that some FC strategies were difficult to implement in comparison to the non-FC group (i.e., integration of topics/courses, cooperative learning, and formal monitoring and assessment techniques). One explanation is that because FC faculty actually attempted to institutionalize these concepts, they empirically knew how difficult it was to adopt and implement changes to the traditional program.

The FC and non-FC faculty agreed on five of the seven FC strategies that impact student learning. The majority of both groups agreed that: 1) cooperative learning enhances student learning, 2) team training prepares students for the future, 3) technological skills give students an advantage in engineering courses, 4) the FC program improves educational outcomes for engineering students, and 5) FC students are better prepared to meet employers' needs. However, about one half of all the faculty failed to believe that FC assessment activities provided them with useful information. This year, the Assessment and Evaluation team are addressing this issue by providing the faculty with informative feedback from assessment whenever possible to help faculty improve educational outcomes.

Effects of Assessment on Curricular and Campus Culture

The FC program is supported by the Dean of the CEAS, Peter Crouch, who is committed to FC activities at this institution. Specifically with respect to Assessment and Evaluation, ASU has employed a full time Director of Assessment and Evaluation with a Ph.D. in educational research. Additionally, an ASU FC employee was nominated and chosen this year to be the National Strategic Director of Assessment and Evaluation. She will continue to work on this campus with the Director of A&E. Moreover, an instructor in Industrial Engineering continues as the FC Faculty Liaison. These four key people who represent overlapping constituent groups are dedicated to reform, assessment, and evaluation to affect curricular and cultural change at ASU.

CEAS, department, and FC meetings, seminars, and retreats have been ongoing to improve faculty awareness, development, and instruction toward educational reform. Additionally, CEAS faculty members have been exposed to FC strategies through a general 100 level engineering course (ECE 100) taught predominantly by non-FC faculty who adopted the teaming component and have made it an integral part of the curriculum. FC is associated with innovation on this campus as reflected in the following statement from a non-FC faculty member, "The FC is a sheltered home for bringing innovations to the market."

An assessment workshop, held in January, 1998, was attended by both FC and Non-FC faculty and assessment staff. At this workshop, Richard Felder of North Carolina State University conducted a follow-up seminar to a prior workshop held in 1996.

The FC Assessment team is an instrumental part of the CEAS preparation for ABET EC2000 which will take place at ASU in 2003. Multiple faculty workshops have been held this year focusing on student outcomes as well as university, college, and departmental goals. A new set of assessment definitions and a template for EC2000 usage have been two outcomes of these meetings. The FC A&E team also works with ASU's Industrial Advisory subcommittee on EC2000 which meets quarterly.

The FC A&E Team has been asked to participate in grant writing, instrument development, and program evaluation by multiple areas or departments within the College. One NSF CRCD grant was awarded this year with the help of the FC A&E Team expertise. The NSF stated that the assessment development was a strong component of the successful proposal. The A&E team is working with the college advisors to develop a new advising survey with the goal of better advising to all ASU CEAS students. Continued work in these areas will help develop a sense of comfort and need for the assessment and evaluation efforts on the ASU campus. The FC A&E Team is also working with the Office of University Evaluation to reduce the duplication of effort and promote the use of university assessment efforts. All of the above are efforts currently being utilized to establish faculty buy in to the Assessment and Evaluation efforts.

Responsive Curricula

ASU conducted a workshop the week of May 18, 1998, which featured the responsive curricula. The workshop served multiple purposes. First, it was an integral component in an ongoing effort to improve faculty awareness, curriculum development, and instruction toward educational reform. Second, it attempted to discuss and link student outcomes to university, college, and departmental goals. Third, it was instrumental in the ABET EC2000 preparation. Furthermore, the workshop showed the effectiveness of quality assessment methods and instruments. Ultimately, we hope that it will facilitate institutionalization and faculty buy-in in the areas of responsive curricula and assessment and evaluation. The attendees included the Dean and Associate Dean of Engineering, Department Chairs, faculty members from each of the College departments, FC faculty and A&E team, and Dr. Jack McGourty from the Gateway Coalition. Dr. McGourty conducted the workshop for two days. The workshop was then continued for three additional days by the FC staff.

Several products were developed as a result of the workshop: a glossary of common assessment terms and an ASU template for college outcomes drawing from the Rose-Hulman and Gateway Coalition examples. The template will be used by all College Departments to state their program objectives. During the workshop, attendees completed a communication template, which served as an example to the CEAS. During follow-up workshops, held throughout the year, the A&E team and the departmental representatives completed two additional templates (i.e., see templates on Metropolitanism and Professionalism, and Communication in Appendix D).

The workbook provided to all workshop participants included the following topics: Assessment slides on Institutionalizing Assessment & Continuous Improvement; Preparing for ABET 2000, Defining objectives, strategies, outcomes, and assessment methods; Student Outcomes Inventory; ABET Engineering Criteria 2000; Arizona State University and CEAS Goals; Dean's Advisory Council Subcommittee Meeting (DAC) Minutes; Assessment Guide, Stepping Ahead*: An Assessment Plan Development Guide* by Gloria Rogers and Jean Sando, Rose-Hulman Institute of Technology; Sample Assessments from CEAS and the Office of University Evaluation at Arizona State University.

During the workshop, Dr. Jack McGourty presented slides titled, *Institutionalizing Assessment & Continuous Improvement* and attendees worked in groups on program objectives and discussed ABET objectives and outcomes (a through k). Additionally, groups discussed linkage among program objectives, assessment, and ABET Program Outcomes. Dr. McGourty also discussed Assessment in the Classroom which featured: effective assessment programs, formative and summative evaluation definitions, measurement strategies, competency based surveys, self assessment methods, peer assessment methods, portfolio methods, embedded work samples, and levels of analysis (i.e., institutional, departmental, program, course, and individual/team levels). Group activity included defining course objectives, strategies and actions, outcomes, ABET 2000 criterion 3 (a-k).

ASU completed the workshop by asking participants to divide into teams to discuss program outcomes and objectives derived from: ASU and CEAS mission and vision statements;

Deans Advisory Council outcomes (DAC) which included Metropolitanism and Professionalism; and examples of other college mission and vision statements.

Lessons Learned

The following represent successes during Year 5 of the Foundation Coalition at ASU:

- The employment of a full time Director of Assessment & Evaluation.
- The selection of an ASU A&E person to National Strategic Director of Assessment & Evaluation.
- Continued development of the A&E team faculty feedback loop by active participation in all faculty meetings and correspondence.
- The FC continued to meet its strategic curricular objectives. The FC Program was more effective in the utilization of technology in education, curricular integration, and the promotion of life long learning than the comparison group and the differences were statistically significant.
- The FC was more successful than its comparison group in the retention of all students, but more critically, the retention of underrepresented minorities.
- Analysis of Freshman FC and non-FC course GPAs revealed an upward trend in FC course GPAs over the past three years.
- Exiting Freshman FC students felt that their instructors were more available to help them with course work and provide encouragement than non-FC students.

The following represent opportunities for improvement during Year 6 of the Foundation Coalition at ASU:

- The teaming environment, assessment, and monitoring needed to be improved. Teaming policies and check lists have been refined and implemented in Year 6. A special team time has been allotted where instructors are able to function as facilitators to the teams.
- Gender differences in the field of Physics needed to be monitored. The Physics instructors have been made aware of the situation. This year will be interesting in this aspect since the lead Physics instructor is, for the first time in the FC history, a female.
- There is a discrepancy between the grades received by FC students in FC courses and non-FC courses. The FC students continue to have lower grades in FC courses, yet they outperform non-FC students in non-FC courses. Attitudinally, FC professors feel that the FC courses have a higher overall workload (85% of the FC faculty agree with this statement). However, there is not a grade reward for this situation.
- The A&E team needs to work with more FC and non-FC faculty to better demonstrate the value of assessment activities. Non-FC attitudes were less positive towards these activities on the 1998 Faculty Survey; however, the sample size was too small to draw any significant conclusions or implications. This academic year, the A&E Team is pursuing multiple avenues of exposing the benefits of assessment and evaluation activities. We are seeking a high profile approach and plan to be active in multiple college developments, such as grant writing, ABET EC 2000 activities, and classroom and program support.
- The value of assessment and evaluation activities needs to be better demonstrated to the FC students.

Recommendations

Team Monitoring and Assessment

The FC program needs to continue to improve the monitoring and assessment component of teaming, one of the four FC core competencies. The ASU A&E team and faculty are already aware of the issues associated with teaming and have already taken steps to ensure its success in years 6 through 10.

As reflected in both the faculty survey and the FC freshman exit survey, both groups agreed that teaming enhances student learning, that formal training was provided by the FC, and that students were given the opportunity to work in teams. However, the two groups felt that formal team monitoring and assessment were less obvious. In fact, faculty expressed that effective and appropriate assessment of teams was difficult to implement.

Several quotes from students represent the essence of student opinion on the survey:
"Teachers did not help if we had a team problem"
"Teachers did not monitor teams throughout the year. We need feedback during the semester"
"Teaming was difficult if one member did not participate"

The FC A&E team disseminated attitudinal results, met with faculty during the summer planning sessions, and determined a strategic action plan in order to address these issues. Based upon the qualitative student comments, the Coalition developed several important actions:
Faculty refined a team process check document in order for students and faculty to monitor team effectiveness and dynamics. Students will complete an individual self-evaluation and then a team evaluation to be submitted to faculty several times during the year. Then, each team will meet with a faculty member for council to improve team dynamics and to overcome team dysfunction before a crisis occurs.

FC staff and faculty scheduled a special "team time" in the FC program twice a week. During this time, students may work in their teams on projects; meet with teams to discuss course issues or team dysfunction; collaborate with faculty on projects; and meet formally with faculty to enable and assist with monitoring and assessment. This process has been implemented in year 6.

Gender Differences

Attitudinal and cognitive differences were evident in student data.
Cognitive differences- *As indicated in the previous cognitive section of this report the outcomes of the two assessment measures, the FCI and the MBT, revealed a gender discrepancy favoring the male students. Although all groups exhibited similar gains, the males consistently outscored the females on both the pre- and post-tests of the MBT and the FCI and the differences were statistically significant. Data revealed that females entering the FC program were already lagging behind the males.*

Attitudinal differences – In general, FC mean averages on the exit survey concerning the 4 FC thrusts (i.e., teaming, technology, curricular integration, and life long learning) were not as robust as expected. Although males typically felt stronger about their experiences (responding more often with "Agree" or "Strongly agree" to questions regarding the 4 thrusts) females were not as positive, responding more often with a "Neutral" response which brought the mean down for each item. For example, males were more positive about their actual learning experiences in teams. Instructors need to continue working with females in the teaming environment in order to making females an integral part of the learning community.

Females were also less positive about their technological competence and quest for activities associated with life long learning. Females were less likely to pursue experiences related to their professional development and future profession. Although the gender differences were not statistically significant, they were noteworthy and shed light on an overall discrepancy between the male and female students both attitudinally and cognitively. However, the recently implemented action strategies mentioned above under teaming are starting to address this challenging gender issue.

National Data on Gender Differences- These results are consistent with national data on high school achievement tests which reveal gender differences on multiple choice tests (Hamilton, 1998). The literature reveals a complex relationship between test format and gender differences, a relationship that is sensitive to specific features of the items used.
This current research adds to the less studied realm of higher education and gender performance on tests and draws upon prior, traditional K-12 research which reveals striking similarities to our data and can partially explain gender differences on some FC assessments. Hedges and Nowell (1995) presented a summary of gender differences on total test scores for several national, large-scale assessments. They found that, on average, males performed slightly better than females in science and math. The variability of scores was greater for males and more males received scores that fell in the highest 10 percent of the distribution.

However, the results do not tell the whole story: both the format and content of test items have been found to influence gender differences. Gender differences are sometimes attributed to the multiple-choice format that is typically used on large-scale achievement tests. Many developers of large-scale assessments are beginning to include constructed-response items in addition to, or instead of, multiple choice items. Constructed-response (CR) items require students to produce rather than select a response and are often presumed to measure reasoning in a way that is difficult or impossible with multiple-choice (MC) items alone (Resnick & Resnick, 1992).

In other studies, test items whose content was aligned to the school curriculum have been found to favor females (Hanna, 1989) and items that closely resembled textbook problems (Harris & Carlton, 1993; O'Neill & McPeek, 1993). Females also tend to receive higher scores on teacher-constructed tests and course grades, whereas males have the advantage on externally administered tests (Kimball, 1989; Rennie & Parker, 1991). This pattern may stem from the relative novelty of different kinds of tests: Haggerty (1987) suggests that males may excel at dealing with novel situations.

The research on the effects of item content and format on gender achievement test scores reveals the importance of looking beyond total score when making conclusions about student performance. Results indicate that format and content do matter. However, other studies have revealed the importance of "neighborhood and extracurricular activities" on math and science performance: Males are more likely to engage in activities that develop math and science skills and therefore receive more opportunity than females to improve their math and science reasoning skills (Entwisle, Alexander, & Olson, 1994; Linn & Hyde, 1989). Males more often experiment with cameras, conduct experiments using materials found in the home or neighborhood, and participate in activities such as hiking, which helped develop spatial-orientation skills. Females were less likely to engage in such activities.

Action Strategy- The FC program and ASU administration could share the responsibility to close gender disparities exacerbated by test format and societal norms by implementing the following strategies:

It is recommended that the College collaborate with diverse constituencies (i.e., ASU administrators and faculty, industry advocates, and elementary and secondary school systems) and effectively share the responsibility to narrow the gap between males and females and some disadvantaged groups. This effort could incorporate joint projects, field trips, speaker sessions, student exchange programs, workshops, and intern programs which are all consistent with ABET EC 2000 criterion.

Acknowledge and use multiple and alternative methods of measuring student achievement. The FC A&E team and faculty are continuing to explore and use alternative and multiple methods to measure student performance by assessing students with formats other than multiple-choice tests (i.e., through the use of projects, portfolios, journals, site based teacher-constructed tests rather than externally developed tests, etc.), and by assessing competence in the 4 additional thrusts required by the FC and ABET EC2000: teaming, technology, curricular integration, and life long learning which are assessed through projects, students' self assessments, and A&E team and instructor observations.

provide more opportunities for all students to participate in relevant hands-on activities during school hours and projects and field trips after school (week ends, evenings, and during the summer months). These findings have implications for efforts to reduce gender, racial/ethnic and socioeconomic group differences because these also tend to be larger on the test items that call on outside knowledge or experiences. For members of some disadvantaged groups, increasing opportunities to learn outside of school may be just as important as improving classroom experiences. The FC freshman program is continuing to promote inquiry-based, hands-on activities as integral components of all course projects which is consistent with national research and ABET EC2000 objectives.

The FC program needs to continue working with females and underrepresented minorities to improve their technology skills.

The FC program needs to strengthen the life long learning effort. Students need to have diverse opportunities to pursue their professional and personal development. FC faculty and staff should continue to bring relevant speakers to campus; help students select and enroll in professional associations and societies; attend and present in conferences; and develop relationships with other colleagues in their chosen profession.

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Faculty Buy-In: Institutionalization

Although a discrepancy was evident in the faculty survey on some FC components, it was evident that the CEAS faculty overall agreed that FC strategies (i.e., teaming, cooperative learning, utilization of technology in coursework) increase student learning and marketability in the workplace. We need to build on this foundation to promote institutionalization. To prepare for institutionalization, it is recommended that we:

- ♦ Demonstrate FC successes to the teaching and learning community (i.e., provide success stories and case study examples to reveal accomplishments)

- ♦ Educate faculty on how to imbed the 4 thrusts into their curriculum. One faculty misconception (or fear) is that they have to use all 4 components (teaming, technology, life long learning, and curricular integration) simultaneously in all classroom instruction. Faculty members need to understand that these thrusts need to be carefully chosen and imbedded appropriately.

- ♦ Demonstrate the Value and Utility of Assessment-Another faculty misconception or fear is that assessment really means measuring faculty performance. We need to emphasize that formative assessment is (and will be) conducted in order to continually modify and improve the engineering program. Faculty members need to feel confident that all student and faculty data will be aggregated, confidential, and will be used to improve the program not to reprimand the instructors.

It is suggested that the FC provide models for faculty involvement in assessment and evaluation; tie assessment and evaluation to EC 2000 effort; and link assessment and evaluation to promotion and tenure.

Publications and Presentations

Publications

(1997, June). "Internal and External Challenges for MEP Programs," American Society for Engineering Education Annual Conference, Milwaukee. Authors: Mary Ann McCartney, Maria A. Reyes and Mary R. Anderson-Rowland.

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(1998, July). "Space-age Projects for Multi-variable Calculus," International Conference of Teaching of Mathematics, Pythagorion, Greece. Author: Matthias Kawski.

Prensentations

Outside ASU Presentations

(1997, October 24). "Re-envisioning Collaboration: Using Webnotes to Construct Relations between Student, Text, and Teacher through an Asynchronous Electronic Journal." A presentation delivered at the Western States Conference in Rhetoric and Composition at ASU. Presented by Meredith Green, Sarah Duerden and Jeanne Garland.

(1997, November). "A Java Microscope to Zoom for Derivatives of Vector Fields," presented by S. Holland and M. Kawski, International Conference on Technology in Collegiate Mathematics, Chicago.

(1998, March). "Creating the Physics Studio Courses: How a Research Physics Department Leads the Campus in Educational Innovation," Seminar on Educational Changes at Rensselaer, given by Dr. Jack M. Wilson of Rensselaer Polytechnic Institute for ASU faculty.

"Team Training," delivered by D. Evans at South Carolina Advanced Technical Education Meeting.

"Team Training," delivered by D. Evans at College of Engineering, Clemson University.

(1998, March). ABET Engineering Criteria 2000 presentation to the Dean's Advisory Council ABET 2000 Committee, facilitated by D. Evans.

(1998, March). Presentation on Integrated Learning Cultures at the Action Agenda Workshop, Atlanta, Georgia, presented by D. Evans.

(1998, April). 1998 Boeing Outstanding Educator Award Presentation, participants included Foundation Coalition students and Teri Reed Rhoads.

(1998, April). Presentation to the Dean’s Advisory Council by D. Evans.

(1998, April). Presentation to High School students in the pre-registration process by D. Evans.

(1998, August 23). ICPE/GIREP International Conference on “Hands-On” Physics Education Duisburg, Germany

Arizona State University Presentations

(1998, February) Workshop on “Using Maple,” delivered by M. Kawski to the Women in Science and Engineering Program at ASU.

Workshop on “Tune Up for Cooperative Learning,” delivered by D. Linder from the Department of Psychology to ASU faculty participating in Foundation Coalition courses.

One-day retreat for Foundation Coalition faculty, held for ASU Faculty teaching in or participating in the FC programs, Gainey Ranch Hotel in Scottsdale, Arizona.

Presentations at FIE 1998 based upon FC Year 5

Duerden, Sarah, J., and Jeanne Garland. Goals, Objectives, & Performance Criteria: A Useful Assessment Tool for Students and Teachers,” Frontiers in Education (FIE) Conference, November, 1998, Tempe, AZ.

Haag, Susan G., and Teri Reed Rhoads, “Assessing the Effectiveness of Integrated Freshmen Curricula in Engineering.” Frontiers in Education (FIE) Conference, November, 1998, Tempe, AZ.

Rhoads, Teri Reed, Sarah J. Duerden and Jeanne Garland. “Views about Writing Survey- A New Writing Attitudinal Survey Applied to Engineering Students.” Frontiers in Education (FIE) Conference, November, 1998, Tempe, AZ

Roedel, Ron J., S El-Ghazaly, Teri Reed Rhoads, and E. El-Sharawy. “The Wave Concepts Inventory- An Assessment Tool for Courses in Electromagnetic Engineering.” Frontiers in Education (FIE) Conference, November, 1998, Tempe, AZ.

Roedel, Ron J., S. El-Ghazaly, and J.T. Aberle. “An integrated Upper Division Course in Electronic Materials and Electromagnetic Engineering- Wave Phenomena for Ees” Frontiers in Education (FIE) Conference, November, 1998, Tempe, AZ.

APPENDIX A

Table A
Arizona State University
Foundation Coalition and Non-FC Freshman Exit Survey 1998

Exiting freshman were asked to identify the level of agreement with the statements below using the following scale:
Strongly Disagree=1, Disagree=2, Neutral=3, Agree=4, Strongly Agree=5

	FC N=50	Non-FC N=25	
Question	Mean SD	Mean SD	Significance P value
1. Retention: I intend to remain at ASU as an engineering student	.84 .3703	.64 .4898	
2. Overall, I think my freshman educational experience was a positive experience.	3.89 .7969	3.92 .8124	
3. The use of teaming and group work helped me learn.	3.95 .789	3.60 1.15	
4.The emphasis on computer technology helped me learn.	4.04 .6109	3.80 .7637	
5. I had good training in my courses in how to work in teams.	3.836 .7731	3.80 .9128	
6. The faculty provided encouragement for my learning.	3.83 .8978	3.36 .9521	* .0377
7. My peers were helpful and cooperative.	3.61 .8615	3.96 .7895	
8. The course material was presented too fast.	3.06 1.106	2.80 1.040	
9. Instructors were available to help me with course work.	3.81 .8335	3.28 .9797	* .0161
10. The workload in my program was heavy compared to other engineering courses.	3.08 1.017	3.36 1.075	
11. My high school education prepared me for my program.	3.06 1.068	3.689 1.180	* .0260
12. Because of program demands, I could not be involved in as many other campus activities.	2.89 1.176	2.76 1.011	
13. Participating in the program helped me learn how to integrate knowledge from a variety of disciplines	3.79 .7354	3.04 .7895	* .0001
14. The design projects were interesting.	4.30 .7693	3.36 .9949	* .0000
15. Participation in the program gave me confidence in my ability to learn on my own.	3.81 .8081	3.48 .8717	

16. I have better communication skills because of my freshman program.	3.857 .5400	3.48 .7702	* .0351
17. As a result of the program, I have increased confidence in my ability to apply engineering problem-solving methods.	3.81 .6348	3.44 .7118	* .0235
18. Participation in the program helped me learn how to apply skills and concepts from math and science to engineering systems.	3.89 .6206	3.68 .5567	
19. I seek out new intellectual experiences.	4.04 .7894	3.84 .553	
20. I feel uncomfortable learning new concepts on my own.	2.06 .9221	1.56 .7118	* .0201
21. I avoid areas of knowledge that are unfamiliar to me.	1.81 .7266	1.44 .5066	* .0235
22. I frequently participate in experiences that contribute to my personal development.	3.93 .6261	3.40 .5773	* .0006
23. I seek out activities related to my future profession.	3.89 .7412	3.60 .6454	
24. Courses in engineering helped me integrate knowledge.	3.79 .7354	3.56 .7681	
25. As a result of my freshman program, I am confident in my ability to apply engineering knowledge.	3.73 .7846	3.48 .8225	
26. I received formal instruction on basic team skills.	3.89 .7704	3.80 .8660	
27. I was assigned to work in groups on a regular basis.	4.24 .6624	4.04 .7348	
28. My instructors monitored and assessed my team skills.	3.10 .8718	3.20 .9574	
29. I received formal technology instruction.	3.69 .6832	3.32 .9000	* .0498
30. Faculty expected me to use computer technology on a regular basis for course work.	4.18 .6668	3.52 .9183	* .0007
31. Faculty monitored and assessed my competence in computer technology.	3.22 .9189	2.80 .8660	
32. Faculty emphasized how concepts covered in their courses related to math, science, & engineering courses.	3.91 .5714	3.52 .8717	* .0460
33. My assigned activities required me to integrate ideas from mathematics, science, or engineering	4.0 .6123	3.28 .8906	* .0009
34. Faculty formally monitored and assessed my ability to integrate ideas from math, science, & engineering.	3.22 .7709	2.88 .8326	
35. Working in assigned teams helped me understand the material presented in class.	3.877 .7808	3.72 1.137	
36. Working in assigned teams is a bad idea.	2.22	1.84	

	.9413	1.067	
37. Using computer technology helped me understand material presented in class.	3.83 .7457	3.60 .8164	
38. The added technology did not add to my learning.	2.0 .8660	1.96 .6110	
39. I can integrate ideas from math, science, & engineering.	3.98 .4782	3.56 .7681	* .0176
40. Integrating topics from diverse courses should be avoided.	2.06 .5556	1.96 .676	
Course Workload: 1=overwhelming, 2=average, 3=easy			
41. The required workload in Physics	1.40 .5454	1.60 .7539	
42. The required workload in Chemistry	2.167 .7177	2.08 .6539	
43. The required workload in Engineering	2.0 .5547	1.64 .5686	* .0142
44. The required workload in Math	1.92 .7299	1.80 .6454	
45. The required workload in English	2.25 .5430	2.72 .5416	* .0012

Table B
ASU Foundation Coalition Freshman Exit Survey
3-Year Comparison
End-of-Years 1996, 1997, and 1998
Years 3, 4, and 5

Exiting freshman were asked to identify the level of agreement with the below using the following scale:
Strongly Agree=1, Disagree=2, Neutral=3, Agree=4, Strongly Agree=5

	FC 1996 Year 3 N=31	FC 1997 Year 4 N=59	1997-98 Compare	FC 1998 Year 5 N=50
Question	Mean SD	Mean SD	Significance P value	Mean SD
1. Overall, I think my freshman educational experience was a positive experience.	4.16 1.24	4.08 1.0659		3.89 .7969
2. The use of teaming and group work helped me learn.	4.16 1.09	4.22 .81541		3.95 .789
3.The emphasis on computer technology helped me learn.	4.43 .56796	4.17 .91649		4.04 .6109
4. I had good training in my courses in how to work in teams.	4.47 .56985	4.32 .65278	* .0011	3.836 .7731
5. The faculty provided encouragement for my learning.	4.13 1.00322	4.18 .91896		3.83 .8978
6. My peers were helpful and cooperative.	3.93 .87498	4.102 .98414	* .01	3.61 .8615
7. The course material was presented too fast.	2.7 .964978	3.24 .99017		3.06 1.106
8. Instructors were available to help me with course work.	4.37 .667204	3.88 .6590		3.81 .8335
9. The workload in my program was heavy compared to other engineering courses.	4.13 .73470	3.36 1.064		3.08 1.017
10. My high school education prepared me for my program.	3.33 .919327	2.54 1.1466	* .0214	3.06 1.068
11. Because of program demands, I could not be involved in as many other campus activities.	2.9 1.0796	3.64 1.0644	* .0014	2.89 1.176
12. Participating in the program helped me learn how to integrate knowledge from a variety of disciplines	4.13 .898027	3.94 .7117		3.79 .7354
13. The design projects were interesting.		4.46 .6131		4.30 .7693
14. Participation in the program gave me		3.5		3.81

confidence in my ability to learn on my own.		.99488		.8081
15. I have better communication skills because of my freshman program.		3.64 .8980		3.857 .5400
16. As a result of the program, I have increased confidence in my ability to apply engineering problem-solving methods.		3.80 .9035		3.81 .6348
17. Participation in the program helped me learn how to apply skills and concepts from math and science to engineering systems.		3.86 .8573		3.89 .6206
18. I seek out new intellectual experiences.		2.82 1.0631 1	* .0001	4.04 .7894
19. I feel uncomfortable learning new concepts on my own.		2.94 .97750	* .0000	2.06 .9221

Note: The 1997 FC Survey only asked the above 19 questions. The 1996 FC Survey only asked 12 of the above questions

APPENDIX B

Felder Learning Styles

Following a seminar presented by Dr. Richard Felder on the ASU campus in January of 1998, it was decided that the students and the faculty would benefit from an understanding of their learning styles. The students were given a brief presentation that focused on the survey and why learning styles were important. Following the presentation, the students were asked to complete the Learning Styles Survey in duplicate. One copy was retained by the student for their own purpose the second copy was collected and aggregated for a presentation to the freshmen faculty. The results were as follows;

Felder Learning Styles Survey Results

	11a	9a	7a	5a	3a	1a	1b	3b	5b	7b	9b	11b	
Active	2 4.7%	7 16.3%	9 20.9%	7 16.3%	3 7.0%	3 7.0%	5 11.6%	4 9.3%	3 7.0%	0	0	0	Reflective
Sensor	3 7.0%	2 4.7%	3 7.0%	4 9.3%	6 14.0%	5 11.6%	4 9.3%	4 9.3%	3 7.0%	4 9.3%	4 9.3%	1 2.3%	Intuitor
Visual	3 7.0%	11 25.6%	8 18.6%	7 16.3%	8 18.6%	2 4.7%	2 4.7%	0	2 4.7%	0	0	0	Verbal
Sequential	0	1 2.3%	6 14.0%	3 7.0%	8 18.6%	14 32.6%	7 16.3%	2 4.7%	2 4.7%	0	0	0	Global

The following observations were made to the freshmen faculty;

- Not all students fit into any one singular category of learners.
- The majority of the students were active learners.
- The majority of the students were visual learners.
- The students were evenly divided between sensors and intuitors.
- The majority of the students were sequential.
- Professors tend to be reflective, verbal, and sequential learners which does not always match their students.

Pittsburgh Freshman Engineering Survey Results

The following table represents results on the Pittsburgh Freshman Engineering Survey given to students in the Foundation Coalition, ECE100 (Introduction to Engineering Design), and ECE300 (Intermediate Engineering Design). The data reveal differences between the Foundation Coalition freshmen and freshmen from ECE 100 during Year 5. To our knowledge, the administration of this instrument to upper division students was the first of its kind. We are now linking the results to the learning objectives tied to the upper division course.

Pittsburgh Freshman Engineering Survey Results, AY 97-98

Change in Attitudes (Post - Pre)

Student Attitude and Self Assessment	Foundation Coalition (Suspect Results)			ECE 100			ECE 300		
	Mean Std Dev	Sig. p-value n	Trend	Mean Std Dev	Sig. p-value n	Trend	Mean Std Dev	Sig. p-value n	Trend
General Impressions of Engineering	0.27 0.84	24	↗	-0.22 0.70	* .0013 113	↘	-.022	41	↘
Financial Influences for Studying Engineering	0.63 1.03	* .0069 24	↗	-.083 0.73	113	↘	.065	41	↗
Perception of the Work Engineers Do and the Engineering Profession	0.92 0.78	* .0001 24	↗	-0.17 0.52	* .0008 113	↘	0	41	—
Enjoyment of Math and Science Courses	1.81 0.91	* .0001 24	↗	-0.12 0.74	113	↘	0.037	41	↗
Engineering Perceived as Being a "Precise" Science	-0.58 1.20	* .0263 24	↘	-0.15 0.86	113	↘	0	41	—
Engineering Comparing Positively to Other Fields of Study	-0.33 0.68	* .025 24	↘	0.009 0.62	113	↗	0.089	41	↗
Family Influences to Study Engineering	-1.35 1.08	* .0001 24	↘	0.16 0.70	* .0179 113	↗	0.12	41	↗
Confidence in Chemistry	0.58 1.53	24	↗	0.10 0.85	111	↗	0.25	41	↗
Confidence in Communication Skills	0.17 1.15	24	↗	0.27 0.63	* .0001 111	↗	0.085	41	↗
Confidence in Basic Engineering Knowledge and Skills	-0.06 0.13	24	↘	0.13 0.59	* .0259 111	↗	0.12	41	↗
Adequate Study Habits	-0.92 0.89	* .0001 24	↘	0.06 0.83	111	↗	0.22	41	↗
Working in Groups	-0.25 0.89	24	↘	-0.007 0.52	111	↘	-0.18	41	↘
Confidence in Engineering Skills	0.16 0.38	* .0442 24	↗	0.08 0.46	111	↗	0.12	41	↗

Further analysis of the Pittsburgh Engineering Attitude Survey indicated a discrepancy existed in the FC data. An analysis of the internal reliability was performed by the Assessment Coordinator. This type of analysis is typical with instruments that combine multiple measures for one result. Therefore, Cronbach's Coefficient Alpha was calculated on each of the 13 categories professed to be measured by the Pittsburgh instrument. Based on this analysis, the results of the Year 5 Foundation Coalition data should be considered cautiously.

A possible source of this error was in the transition to a new assessment coordinator. The versions of the instrument had changed at the end of Year 4 and this new version might not have been administered at the beginning of Year 5. This problem has been addressed and solved in Year 6. This problem did not occur within the ECE 100 and ECE 300 administrations since these were done in the spring semester by the same coordinator. The results of the Cronbach's analysis are included in the following table and have been passed on to the authors of the instrument and used in the further validation of the instrument.

Cronbach's Coefficient Alpha

	FC		ECE100		ECE300	
	Pre	Post	Pre	Post	Pre	Post
Overall	.66	.88	.87	.90	.88	.85
General Impressions of Engineering	.67	.87	.84	.91	.83	.80
Financial Influences for Studying Engineering	-.70	.73	.65	.68	.59	.39
Perception of the Work Engineers Do and the Engineering Profession	.11	.89	.83	.88	.87	.78
Enjoyment of Math and Science Courses	.60	.51	.67	.67	.48	.27
Engineering Perceived as Being a "Precise" Science	.07	.64	.54	.65	.71	.76
Engineering Comparing Positively to Other Fields of Study	-.48	.48	.52	.48	.37	.77
Family Influences to Study Engineering	.59	.53	.35	.35	.53	.47
Confidence in Chemistry	--	--	--	--	--	--
Confidence in Communication Skills	.25	.56	.62	.72	.81	.37
Confidence in Basic Engineering Knowledge and Skills	.26	.57	.63	.54	.77	.67
Adequate Study Habits	-.21	.73	.57	.62	.67	.79
Working in Groups	.14	.58	.53	.44	.43	.64
Confidence in Engineering Skills	.69	.87	.82	.81	.83	.77

Student Assessment Journal

This Assessment Journal assignment was designed to inform the formative evaluation effort and to aid in the development of the evaluation feedback loop. Ultimately, this feedback was used to better the program. On Thursday, October 30, 1997, an e-mail message was sent to all 78 of the freshman FC program students. This message asked the students to complete their journal assignment differently from previous weeks. This week, the students were asked to share their perceptions about the FC program with the Assessment Coordinator in order to improve the program.

> Specifically, I would like you to revisit your Journal #2 where you discussed your goals for the semester. After reviewing what you stated in week 2 of the semester, reflect upon the progress you have made so far in achieving these goals. Have you altered your goals and if so why? What tools do you feel you need to achieve your goals? Do you or have you been provided the tools you need to achieve the goals and if not why? What are the areas you are having difficulties with (for example, subject matter, time commitment, self-discipline, etc.) and what might you do to overcome these difficulties? What can we (the support staff or the faculty) do to help you overcome these difficulties? Give specifics and end your submission with one overall statement that is a summary of your current feelings about the Foundation Coalition program. Be honest! Remember, this will have no effect on your grade and it might help improve the program for you and the next group of freshman engineering students.

Their replies were due by November 6 and the following is the report generated from the replies given to the faculty team the second week in November. Fifty eight of the students responded to the request. The student feedback ultimately helped to make changes in the overall program and the administration of the class:

- *The grading policies and the grades were provided more often to the students.*
- *A seminar on Time Management was administered to the students during class time.*
- *New in-class rules were established on web-surfing and e-mail during class time.*
- *Future teams were made where commuter students were teamed together according to where they live in the metropolitan area.*
- *A pizza party was planned during the final day of the Bungee Project to help with the overall moral of the students.*

Summary of Assessment Journals

Overall, the student responses were positive about the FC program; few students stated that they planned on leaving the program. Teaming was repeatedly reported as a strength of the Coalition. Second, faculty were identified as assets to the FC. Students failed to comment on courses or design projects. Of those students who replied, the majority completed the Journal with a positive statement about the Coalition and a recommendation that it continue. The students felt that the Coalition supported students and gave them an "edge in their future studies or work endeavors."

Teaming- Teaming was viewed as a strength of the FC program. Although the journals revealed some positive comments, most of the negative comments were a result of the team make-up during the first set of teams. There was a request for inner-team accountability on more than one occasion. It was evident that hard work and diligence were not valued by all members of the teams. Also, several students stated that individual learning needed to be a priority. Some stated that the self-learning is also important to successful teaming. Self-selection of teams was mentioned as well as reducing the time in Team 1. Most feel that the teaming environment is very supportive and positive and leads to enhanced learning.

Communication of Grades- Students asked that instructors keep students advised about their grades in a timely manner. A number of the students are scholarship recipients and they are very concerned that they keep these scholarships into the next semester. They are of the opinion that they have no clue as to what their grades might be except in physics. The posting of current grades or a very brief review or even statement referring the students to the grading policies on the syllabi may be warranted. An outside observer reading these journals would think that there had been no reporting of grades, though I know differently. There was very little discussion about how grades are formed other than the suggestion that math homework be graded for attempt, as well as correctness. Also, the feeling that the physics labs are much harder than outside students' labs and that the grading is not explained well or justified. A few comments were made about journaling as to slow response time and lack of grade explanation (why a 1 and not a 2).

Curricular Integration-There were numerous comments that the integration was a good thing. There were also requests that the Calculus and Physics needed to be more integrated. There was one suggestion of a universal syllabus covering all Coalition classes instead of individual subject syllabi. A point to ponder. One quote I would like to lift is the following, "From the first chapter on vectors (referring to physics) I was lost until I was able to relate physics to math."

When discussing the overall integration a suggestion was made that the reading be assigned earlier when an essay is also due. There were several students that felt that though the courses and subject matter were integrated and obviously discusses by all instructors, the amount and timing of homework assignments were not.

Teaching and Instructors-Most students feel they have the cream of the crop with the faculty and assistants. In fact, this is one of the most frequently stated advantages of the program. The students feel like individuals instead of numbers and appreciate the time that the instructors provide them for office hours. Caring and compassionate were two of the adjectives used to describe the teaching team. (I am suppose to give you all a cookie from one thankful student!) There were a few instances where students felt that the teaching was on a level above them or that the instructor was "too good" for the students. Suggestions were made to use more interesting ways of presentation or involvement of the students and more integration of subject matter. Motivation was used a few times in reference to the fact that they were motivated to "like" or "want to" learn or do something (i.e., write!). There were several requests for choice in writing assignments and several comments that they like that the audience is clearly defined. It was stated that the faculty had been asking for feedback and then using it to make adjustments.

Technology-Even the students that consider themselves to be "computer illiterate" liked the use and amount of technology offered by the FC. Several stated that they are actually saving themselves course hours by learning several types of software "on the fly". The students feel they have a definite advantage over non-FC students. The negative comments about technology were limited but can be summarized in a few short sentences. Limit the web surfing and e-mail use when not required by the course. There were also comments that requests had been posted to WebNotes with no replies received.

Workers and Commuters-It is quite obvious that a majority of those individuals who work as well as go to school are having problems with their abilities to complete all that they feel is necessary. A few have problems in meeting with their teams and a suggestion was made to incorporate schedules in the selection of the teams. A few commuters expressed similar opinions.

The Hour- Timing seems to be an issue. Numerous comments on the 7:40 hour and how such a time does not go with college life. However, most seem to like being done in the morning. Also, a number of comments on the 3 hours of physics in one day. There was also a comment about the number of hours spent in class is 16 hours for 13 hours of credit. This is a misconception the students have about the program that should be easy to clear.

Time Management-The skill that may be considered for future inclusion in the program is time management. Procrastination and lack of time management skills were mentioned as a downfall of the individual student as often as teaming was mentioned as an advantage of the Coalition. Perhaps the Coalition could provide a seminar or presentation or even just an announcement of where one such seminar is taking place (I know the WISE center does this).

Preparation-One suggestion made was to give a placement exam to see who is ready and who is not! Some felt that they were just not prepared to take too many hard classes together or that they are playing catch up. Several stated that they now needed to study whereas they did not need to study in high school. Some feel the class size is too large (while others acknowledge that it is small). Whenever the "Survive. Then do well." (Evans, 1997) quote was made, it made an impact on a few. However, the point needs to be made to many more students! This may be one of those things that each must learn for themselves, but some expressed the opinion that they were not warned or not ready for such a large transition from high school to college. Several felt that the culture shock was magnified by the workload and others felt that the FC has helped them make the transition. It was amazing to me to see the number of students who referenced trying to achieve a 4.0 and are now having to lower that goal. Another transition from high school problem.

Office Hours-Most comments were positive with only a few students stating that they could not make established office hours (typically from students that work). Have there been offers to make appointments for those students unable to make established office hours?

Perceptions-Some students feel that the FC is a weed out program (one student even stated that we try to weed them out at this point so it would look good in the end with the graduation rate). We may want to take the time to present some of the retention data and state the overall goals of the Coalition.

Interesting One Liners-
Would like a recitation added in math.
Would like the computer classroom open around 5:00 instead of 7:00. Also would like it to be available more than just Monday through Wednesday.

Feels the amount of stress is good preparation for the future.
Need to do more getting to know each other within the Coalition. Tend to stick with teams and the people you live around. (Perhaps a social should be scheduled.)
Unsure about wanting to major in engineering now, since self-discipline is lacking and the student feels that this is a requirement for success in engineering.

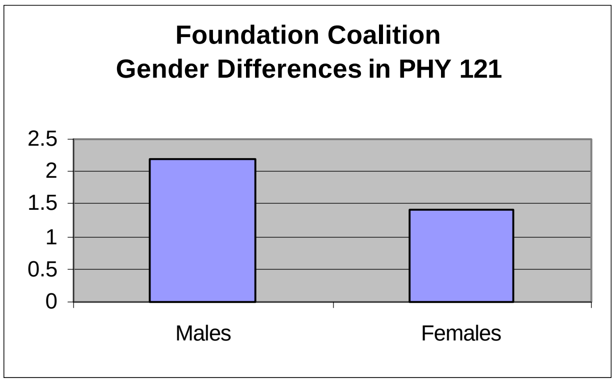
APPENDIX C

GENDER AND ETHNIC DIFFERENCES IN COURSES
Year 5

Gender differences were significant in Physics only within the Foundation Coalition group.

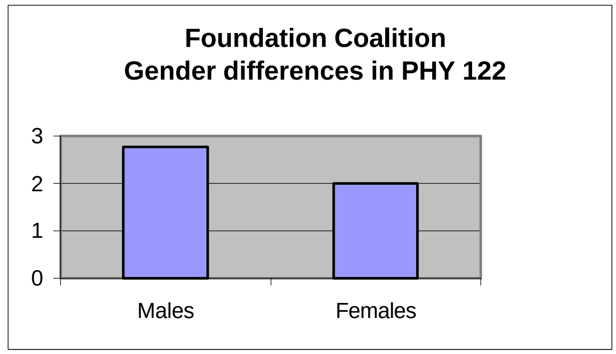
	Mean	St. Deviation	N
Males	2.18	1.22	65
Females	1.42	1.24	12
P-value =	0.05		

Figure 6



	Mean	St. Deviation	N
Males	2.77	.825	65
Females	2.	.739	12
P-value	.0035		

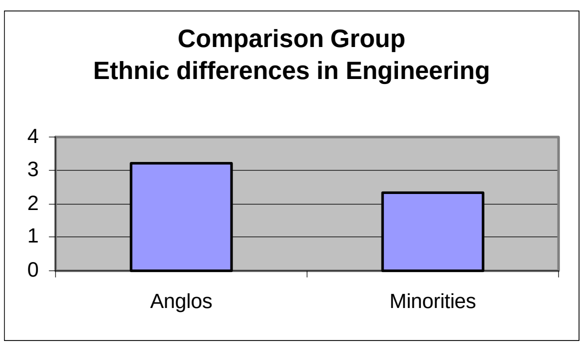
Figure 7



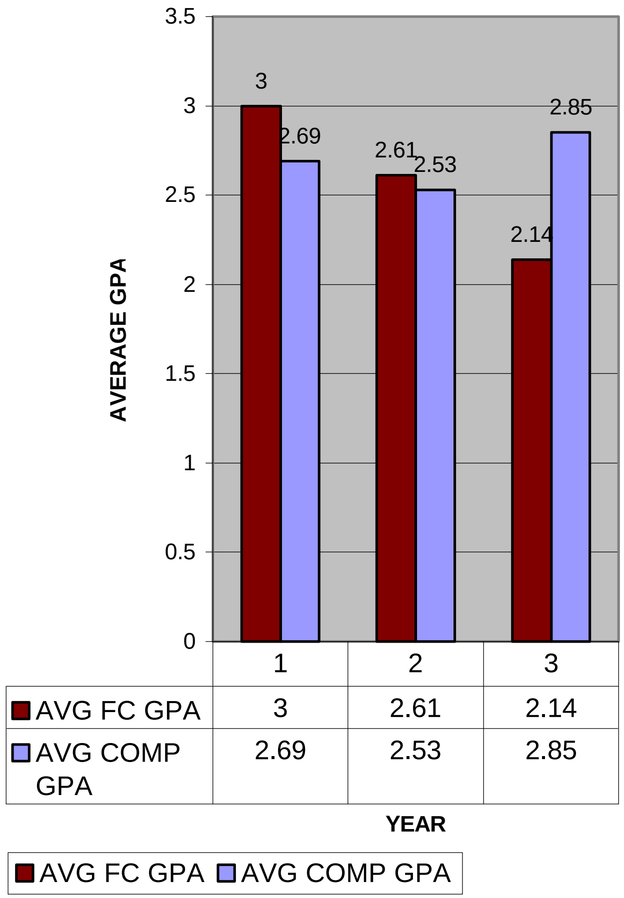
Ethnic differences were significant in Engineering only within the non-FC comparison group

	Mean	St. Dev	N
Anglos	3.217	.736	23
Minorities	2.33	1.22	9
P-value =	.017		

Figure 8 Non-FC



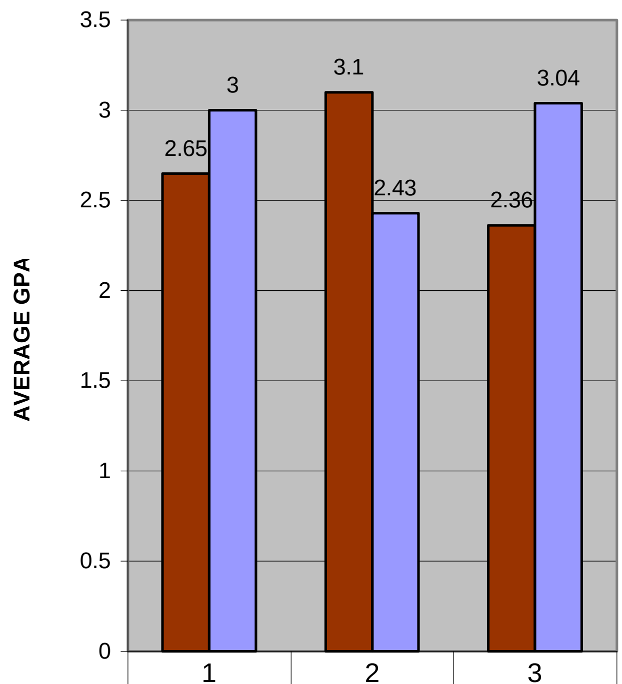
MAT 272 FC Vs COMPARISON
Years 2, 3, and 4



	FC	COMP
YEAR	MAT 272 AVERAGE STD DEV (n)	MAT 272 AVERAGE STD DEV (n)
2	3 O.853 (23)	2.69 1.13 (29)
3	2.615 0.96 (13)	2.53 1.24 (32)
4	2.14 1.35 (51)	2.85 0.91 (21)

X AXIS : YEAR ENTERED
1- YEAR 2 (FALL 1994)
2- YEAR 3 (FALL 1995)
3- YEAR 4 (FALL 1996)
Y AXIS : AVERAGE CLASS GPA

MAT 274 FC Vs COMPARISON
Years 2, 3, and 4



	1	2	3
AVG FC GPA	2.65	3.1	2.36
AVG COMP GPA	3	2.43	3.04

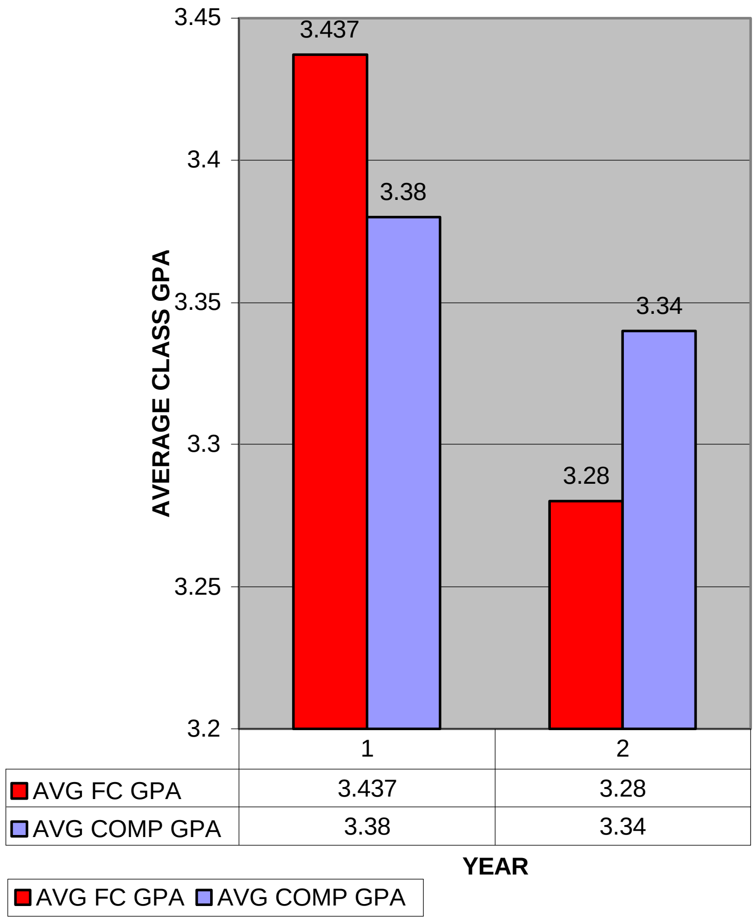
YEAR

AVG FC GPA AVG COMP GPA

	FC	COMP
year	MAT 274 AVERAGE STD DEV (n)	MAT 274 AVERAGE STD DEV (n)
2	2.652 1.15 (23)	3 1.13 (26)
3	3.1 1.1 (10)	2.43 1.27 (29)
4	2.36 1.15 (36)	3.04 0.92 (21)

X AXIS : YEAR ENTERED
1- YEAR 2 (FALL 1994)
2- YEAR 3 (FALL 1995)
3- YEAR 4 (FALL 1996)
Y AXIS : AVERAGE CLASS GPA

ECE 300 FC Vs COMPARISON
YEARS 2 & 3



YEAR	FOUNDATION STUDENTS AVERAGE S DEV (n)	COMPARISON STUDENTS AVERAGE S DEV (n)
2 (1 ON X AXIS)	3.4375 0.63 (16)	3.38 0.697 (18)
3 (2 ON AXIS)	3.285 0.488 (7)	3.34 0.8164 (15)
4	2.4 1.14 (5)	NO ONE HAS TAKEN ECE 300
5	NO ONE HAS TAKEN ECE 300	NO ONE HAS TAKEN ECE 300

X - AXIS : STARTING YEAR FOR STUDENTS
` 1-YEAR 2 (FALL 1994)
2-YEAR 3 (FALL 1995)
Y AXIS - GE CLASS GPA

APPENDIX D

TOTAL *FC STUDENTS* RETAINED IN THE COLLEGE OF ENGINEERING BY YEAR (FALL ’98)

YEAR	START	FALL 98 TOTAL	MALE	FEMALE	WHITE & ASIAN	AFRICAN AMERICAN	HISPANIC	NATIVE ANERICANS
2	31	23 (74.2%)	18 (67.2%)	5 (83.4%)	18 (75%)	1 (100%)	4 (66.6%)	0
3	31	14 (45.2%)	10 (50%)	4 (36.4%)	11 (45.8%)	0 (0.0%)	2 (50.0%)	1 (100%)
4	79	36 (45.6%)	**30** (46.1%)	6 (42.8%)	31 (46.2%)	2 (66.6%)	2 (33.3%)	1 (33.3%)
5	78	64 (82%)	53 (80.3%)	11 (91.6%)	50 (83.3%)	3 (75%)	10 (76.9%)	1 (100%)
	219	137 (62.5%)	111 (63.0%)	26 (60.5%)	110 (62.8%)	6 (60.0%)	18 (62.0%)	3 (60.0%)

TOTAL STUDENTS STARTING IN THE *FC PROGRAM* BY YEAR

YEAR	START	TOTAL	MALE	FEMALE	WHITE & ASIAN	AFRICAN AMERICAN	HISPANIC	NATIVE ANERICANS
2	32	31 (100%)	25 (80.6%)	6 (19.4%)	24 (77.4%)	1 (3.2%)	6 (19.4%)	0 (0.0%)
3	31	31 (100%)	20 (64.5%)	11 (35.5%)	24 (77.4%)	2 (6.4%)	4 (12.9%)	1 (3.2%)
4	79	79 (100%)	65 (81.1%)	14 (18.9%)	67 (85%)	3 (3.8%)	6 (7.6%)	3 (3.8%)
5	78	78 (100%)	66 (84.6%)	12 (15.83%)	60 (76.92%)	4 (5.1%)	13 (16.7%)	1 (1.3%)
	219	219	176 (80.4%)	43 (19.6%)	175 (79.9%)	10 (4.5%)	29 (13.2%)	5 (2.3%)

TOTAL *NON-FC COMPARISON* STUDENTS RETAINED IN THE COLLEGE OF ENGINEERING BY YEAR (FALL '98)

YEAR	START	FALL 98 TOTAL	MALE	FEMALE	WHITE & ASIAN	AFRICAN AMERICAN	HISPANIC	NATIVE ANERICANS
2	50	30* (60%)	24 (57.1%)	6 (75%)	23 (57.5%)	0 (0.0%)	4 (57.1%)	2 (100%)
3	62	30 (48.4%)	23 (47%)	7 (53.8%)	24 (44.4%)	1 (50%)	4 (80%)	1 (100%)
4	39	22 (56.4%)	18 (53%)	4 (80%)	20 (58.8%)	1 (100%)	0 (0.0%)	1 (50%)
5	32	21 (65.6%)	17 (63%)	4 (80%)	17 (74%)	0 (0.0%)	4 (57.1%)	0 (0.0%)
	183	103* (56.3%)	82 (53.9%)	21 (67.7%)	84 (55.6%)	2 (50%)	12 (57.1%)	4 (66.6%)

TOTAL *NON-FC COMPARISON* STUDENTS STARTING PROGRAM BY YEAR

YEAR	START	FALL 94 TOTAL	MALE	FEMALE	WHITE & ASIAN	AFRICAN AMERICAN	HISPANIC	NATIVE ANERICANS
2	50	50 * (100%)	42 (82.7%)	8 (17.3%)	40 (80.8%)	0 (0.0%)	7 (14%)	2 (4%)
3	62	62 (100%)	49 (64.5%)	13 (35.5%)	54 (87%)	2 (3.2%)	5 (8%)	1 (1.6%)
4	39	39 (100%)	34 (87.1%)	5 (12.8%)	34 (87.1%)	1 (2.6%)	2 (5.2%)	2 (5.2%)
5	32	32 (100%)	27 (84.6%)	5 (15.83%)	23 (71.9%)	1 (3.1%)	7 (21.9%)	1 (3.1%)
	183	183*	152 (83%)	31 (17%)	151 (82.5%)	4 (2.2%)	21 (11.5%)	6 (3.3%)

*One student did not provide information regarding ethnicity

ENROLLMENT FIGURES FOR *FC* STUDENTS WHO BEGAN IN YEAR 2 (FALL '94)

Academic Year	Total	Male	Female	White & Asian	African American	Hispanic	Native American
Fall '94 (Freshmen)	31 (100%)	25 (80.6%)	6 (19.4%)	24 (77.4%)	1 (3.2%)	6 (19.4%)	0 (0.0%)
Spring '95 *	30 (96.8%)	25 (100%)	5 (83.3%)	23 (95.8%)	1 (100%)	6 (100%)	0 (0.0%)
Spring '95 (FC)	23 (74.2%)	18 (72.0%)	5 (83.3%)	17 (70.8%)	1 (100%)	5 (83.3%)	0 (0.0%)
Fall '95 * (Sophomore)	27 (87.1%)	23 (92.0%)	4 (66.7%)	20 (83.3%)	1 (100%)	6 (100%)	0 (0.0%)
Fall '95	13 (41.9%)	11 (44.0%)	2 (33.3%)	10 (41.7%)	0 (0%)	3 (50%)	0 (0.0%)
Spring '96 **	27 (87.1%)	22 (88.0%)	5 (83.3%)	20 (83.3%)	1 (100%)	6 (100%)	0 (0.0%)
Fall '96 ** (Junior)	26 (83.9%)	21 (84.0%)	5 (83.3%)	19 (79.2%)	1 (100%)	6 (100%)	0 (0.0%)
Spring '97	27 (87.1%)	20 (80%)	7 (83.3%)	21 (87.5%)	1 (100%)	5 (83.33%)	0 (0.0%)
Fall '98	23 (74.2%)	18 (72%)	5 (83.4%)	18 (75%)	1 (100%)	4 (66.6%)	0 (0.0%)
Graduates	3 (10%)	1	2	3 (13%)			

Notes: * Includes students who remained in FC curriculum and students who merged with the traditional curriculum.
** Students in the Sophomore program merged with their respective traditional programs in spring '96.
*** One female student enrolled again in Spring '96

ENROLLMENT FIGURES FOR *COMPARISON* STUDENTS WHO BEGAN IN YEAR 2 (FALL ‘94)

Academic Year	Total	Male	Female	White & Asian	African American	Hispanic	Native American
Fall ’94 (1) (Freshmen)	50* (100%)	42 (82.7%)	8 (17.3%)	40 (80%)	0 (0.0%)	7 (14%)	2 (4%)
Spring ’95 (2)	49** (98%)	40 (95.2%)	9 (100%)	40 (100%)	0 (0.0%)	5 (71.4%)	2 (100%)
Fall '95 (3) (Sophomore)	41* (82%)	33 (78.6%)	8 (100%)	34 (85%)	0 (0.0%)	4 (57.1%)	2 (100%)
Spring ’96 (4)	38* (76%)	31 (73.8%)	7 (87.5%)	31 (77.5%)	0 (0.0%)	4 (57.1%)	2 (100%)
Fall ’96 (5) (Junior)	37* (74%)	30 (71.4%)	7 (87.5%)	29 (69.0%)	0 (0.0%)	5 (71.4%)	2 (100%)
Spring ’97 (6)	37* (74%)	29 (69%)	8 (100%)	30 (75%)	0 (0.0%)	4 (57.1%)	2 (100%)
Fall '98 (7) (Senior)	30* (60%)	24 (57.1%)	6 (75%)	23 (57.5%)	0 (0.0%)	4 (57.1%)	2 (100%)
Graduates	4	3	1	3		1	

* One student (2.0%) did not provide ethnicity information (i.e., reflected in the following rows: 1,3,4,5,6 & 7)
**Two students (4.0%) did not provide ethnicity information (i.e., reflected in the following row: 2)

ENROLLMENT FIGURES FOR *FC* STUDENTS WHO BEGAN IN YEAR 3 (FALL '95)

Academic Year	Total	Male	Female	White & Asian	African American	Hispanic	Native American
Fall '95 (Freshmen)	31 (100%)	20 (64.5%)	11 (35.5%)	24 (77.4%)	2 (6.4%)	4 (12.9%)	1 (3.2%)
Spring '96*	29 (93.5%)	20 (100%)	9 (81.8%)	22 (91.7%)	2 (100%)	4 (100%)	1 (100%)
Spring '96 (FC)	21 (67.7%)	14 (70.0%)	7 (63.6%)	16 (66.7%)	0 (0.0%)	4 (100%)	1 (100%)
Fall '96 (Sophomore)*	23 (74.2%)	15 (75.0%)	8 (72.7%)	19 (79.2%)	1 (50.0%)	2 (50.0%)	1 (100%)
Fall '96 (FC)	12** (38.7%)	10 (50.0%)	2 (18.2%)	10 (41.7%)	0 (0%)	1 (25.0%)	1 (100%)
Spring '97	18* (58.1%)	13 (65.0%)	5 (45.5%)	14 (58.3%)	1 (50%)	2 (50.0%)	1 (100%)
Fall '98	14 (45.2%)	10 (50%)	4 (36.4%)	11 (45.8%)	0 (0.0%)	2 (50.0%)	1 (100%)

Notes:
*Includes students who remained in FC curriculum and students who merged with the traditional curriculum.
** 5 of these students who remained in FC curriculum in their freshman year. Among 7 (22.6%) of these students who have been in FC curriculum since fall'95, 5 (25.0%) are male, 2 (18.2%) female, 5 (20.8) are white, 1 (25.0%) Hispanic and 1(100%) Native American.

ENROLLMENT FIGURES FOR *COMPARISON* STUDENTS WHO BEGAN IN YEAR 3 (FALL '95)

Academic Year	Total	Male	Female	White & Asian	African American	Hispanic	Native American
Fall '95 (Freshmen)	62 (100%)	49 (64.5%)	13 (35.5%)	54 (87%)	2 (3.2%)	5 (8%)	1 (1.6%)
Spring '96*	55 (88.7%)	44 (89.8%)	11 (84.6%)	48 (88.9%)	2 (100%)	3 (60%)	1 (100%)
Fall '96* (Sophomore)	46 (74.2%)	36 (73.5%)	10 (76.9%)	39 (72.2%)	2 (100%)	3 (60%)	1 (100%)
Spring '97*	41 (66.13%)	33 (67.3%)	8 (61.5%)	34 (63%)	2 (100.0%)	3 (60.0%)	1 (100%)
Fall '98	30 (48.4%)	23 (47%)	7 (53.8%)	24 (44.4%)	1 (50%)	4 (80%)	1 (100%)

* One student did not provide ethnicity information.

ENROLLMENT FIGURES FOR *FC* STUDENTS WHO BEGAN IN YEAR 4 (FALL '95)

Academic Year	Total	Male	Female	White & Asian	African American	Hispanic	Native American
Fall '96 (Freshmen)	79 (100%)	65 (81.1%)	14 (18.9%)	67 (85%)	3 (3.8%)	6 (7.6%)	3 (3.8%)
Spring '97	75 (94.9%)	61 (93.8%)	14 (100%)	62 (92.5%)	3 (100%)	6 (100%)	2 (66.7%)
Spring '97 (FC)	57 (72.2%)	44 (67.7%)	13 (92.9%)	48 (75.4%)	3 (100%)	2 (33.3%)	2 (66.7%)
Fall '98	36 (45.6%)	30 (46.1%)	6 (42.8%)	31 (46.2%)	2 (66.6%)	2 (33.3%)	1 (33.3%)

ENROLLMENT FIGURES FOR *COMPARISON* STUDENTS WHO BEGAN IN YEAR 4 (FALL 1995)

Academic Year	Total	Male	Female	White & Asian	African American	Hispanic	Native American
Fall '96 (Freshmen)	39 (100%)	34 (87.1%)	5 (12.8%)	34 (87.1%)	1 (2.6%)	2 (5.2%)	2 (5.2%)
Spring '97	39 (100%)	34 (100%)	5 (100%)	34 (100%)	1 (100%)	2 (100%)	2 (100%)
Fall '98	22 (56.4%)	18 (53%)	4 (80%)	20 (58.8%)	1 (100%)	0 (0.0%)	1 (50%)

ENROLLMENT FIGURES FOR *FC* STUDENTS WHO BEGAN IN YEAR 5(FALL '97)

Academic Year	Total	Male	Female	White & Asian	African American	Hispanic	Native American
Fall '97 (Freshmen)	78 (100%)	66 (84.6%)	12 (15.83%)	60 (76.92%)	4 (5.1%)	13 (16.7%)	1 (1.3%)
Fall '98	64 (82%)	53 (80.3%)	11 (91.6%)	50 (83.3%)	3 (75%)	10 (76.9%)	1 (100%)

ENROLLMENT FIGURES FOR *COMPARISON STUDENTS* WHO BEGAN IN YEAR 5(FALL '97)

Academic Year	Total	Male	Female	White & Asian	African American	Hispanic	Native American
Fall '97 (Freshmen)	32 (100%)	27 (84.37%)	5 (15.6%)	23 (71.9%)	1 (3.1%)	7 (21.9%)	1 (3.1%)
Fall '98	21 (65.6%)	17 (63%)	4 (80%)	17 (74%)	0 (0.0%)	4 (57.1%)	0 (0.0%)

APPENDIX E

METROPOLITANISM OBJECTIVE: CEAS will collaborate with the Phoenix metropolitan area constituent communities, including the University, industry, government, etc., in order to respond to local, state, and global engineering needs through educational activities and projects.

Outcome	Performance Indicators	Strategies & Actions	Assessment Methods & Metrics	Evaluation	Feedback	ABET 2000 criteria, University, College, and Departmental Links
#1 CEAS will provide the opportunities for continued education and professional development to the community.		JACMET, state-wide masters, WISE investments				
#2 CEAS will work with the community to serve the educational needs of a diverse student population		Statewide masters program; provide educational opportunities for the physical, social, geographical, and economic communities associated student diversity: part-time, transfer, ASU West students etc.				
#3 CEAS will work with the community to emphasize how engineers integrate technical expertise with the values of society.		Service learning				
#4 CEAS will develop partnerships among elementary & secondary education systems, colleges, universities, government, and industry to promote appreciation, recruitment, and preparedness for engineering.						

PROFESSIONALISM & ETHICS OBJECTIVE # Students will understand and practice professional and ethical responsibility.

Outcome	Performance Indicators	Strategies & Actions	Assessment Methods & Metrics	Evaluation	Feedback	ABET 2000 criteria & links to University, College, & Depts.
Students are aware of and sensitive to social & political issues (i.e., the needs of the community and the broader global setting)	Open ended projects, Student organizations, Array of general studies	Review content of design courses to integrate social & political issues Use open-ended problems that involve issues Integrate case studies into key courses				j, h
Students are aware of and sensitive to the needs of individuals including diverse populations.	Students work effectively with other students. Students interact positively with faculty Students give constructive feedback.	Teach interpersonal skills required for teaming, Attract & retain a diverse student population Students work in a diverse team environment	Survey instruments, peer evaluation in teams, faculty evaluation, self evaluation, campus climate survey			d, g
Students are aware of engineering as a profession, identify as a member, and demonstrate collegiality in the profession.	Participation in local and or national student societies. Participation in field trips (plant tours) Participate in multi-disciplinary capstone experience Share professional experiences	Provide resources for local/ national professional societies Provide resources and planning assistance for tours Encourage use of multi-disciplinary experiences Student presentations on work experiences	Collect student data regarding memberships and participation in coop, internships,			
Student actions and decisions demonstrate awareness of legal & ethical issues (e.g.,	Students will demonstrate knowledge of these issues in open-ended	Offer faculty workshops on legal & ethical issues Integrate ethics & profess-	Multiple choice exams, student projects, industrial and faculty review			f, h,

environmental, safety, health, confidentiality, intellectual property rights, etc.).	projects Students are aware of and comply with student code of conduct	ionalism into curriculum Encourage use of issues in courses Distribute student code of conduct	of projects, examine student files for misconduct actions, etc.			
Students demonstrate personal attributes that are positive (e.g., self-respect and self critical, open minded, innovative, diligent and tenacious)	Reflective writing in journals, Opinions of peers, Retention rates Students accept constructive feedback.	Encourage "journaling" Collect and provide peer feedback Provide climate & opportunities for innovation	Peer evaluations			

OBJECTIVE Students will be able to communicate effectively.

Outcome	Performance Indicators	Strategies & Actions	Assessment Methods & Metrics	Evaluation	Feedback	ABET 2000 criteria, University, College, and Departmental Links
Students will be able to plan, prepare, deliver, and assess formal and informal oral presentations.	- Students demonstrate audience awareness when they make oral presentations - Students can effectively communicate ideas within a specified time frame. - Students use effective visual aids.	Inform students and faculty of presence of Engineering Writing Center. Embed requirements for oral presentations within the curriculum (e.g., ECE 100 and 300)	Individual classroom assessment using checklists, rubrics Instructor observation and evaluation Peer assessment Outside professionals Self Assessment Portfolios Videotape Quizzes, tests, and exams Web Presentations GRE Verbal	Committee for random sampling of graduates Outside professionals evaluate communications Longitudinal studies Assessment of grades and distributions	Feedback to college or program curriculum committee to improve course outlines, topical structures within courses, and resource allocations.	
Students will be able to plan, prepare, write and assess	- Demonstrate audience awareness when they write. - Employ appropriate	Embed requirements for written communication within the				

appropriate written reports.	structures, formats, and logical content. - Students can assess their own work and the work of their peers.	curriculum (e.g., ENG 101, 102, ECE 100, 300, L2 and capstone)				
Students will be able to prepare appropriate graphical material.	Prepare graphical material according to professional standards.	Embed requirements for graphical communication within the curriculum (e.g., ECE 100 and 300) Embed appropriate use of technology for effective communication and improve the infrastructure to support this objective. (e.g., technology equipped classrooms) (e.g., ECE 100 and 300)				
		Establish acceptable guidelines and examples for common oral, written, and graphical forms.				

APPENDIX F

FIE 98 Paper T4G.4

Freshman Introductory Engineering Seminar Course: Coupled with Bridge Program Equals Academic Success and Retention

Arizona State University

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Mary Ann McCartney

ABSTRACT

Arizona State University's (ASU) Office of Minority Engineering Programs (OMEP) has hosted the Minority Engineering Program (MEP) Summer Bridge Program for the past two years. The purpose of the program is to promote greater awareness of and recruit potential candidates to the College of Engineering and Applied Sciences (CEAS) at ASU. The program content and curriculum were designed to prepare underrepresented ethnic minority students for success in the College at ASU. The program focused on building community and utilized undergraduate student role models as instructors, while the curriculum focused on engineering design, technical communications, and a design project. Academic scholarships were awarded to all participants based on a team design project competition.

The Summer '96 program participants were encouraged to participate in the MEP Academic Success Seminar course offered in the Fall '96. Twelve of the 43 participants chose to do so. Since the instructor for the course was also the director of the bridge program, the MEP used this as an opportunity to continue building community, reduce student isolation, and monitor student progress throughout the semester. In fact this is exactly what occurred with those who participated, however, continuing all these facets was difficult with the remaining 31. Therefore, the following year, the Summer '97 program participants were required to participate in the course as a stipulation to receive their scholarship. As a result, all 38 participants chose to register for the seminar course or the Foundation Coalition Match program at ASU.

The academic success of these students during their first semester is evaluated, compared, and correlated with several measures including 1) a comparative analysis of seminar course success between the students who participated in the bridge program and those who did not; 2) student's scores on the university mathematics placement examination and the student's class grade earned in their beginning mathematics class; and 3) the student's use of the MEP support system (i.e. Tutoring program, Academic Excellence Program).

INTRODUCTION

In Fall 1997, Arizona State University (ASU) enrollment figures including the East, West and Main campuses grew to over 47,000 students, placing it as the fourth largest university in the United States. The Main campus supports 44,255 students: 33,497 are undergraduate (75.7%) and 10,758 are graduate students (24.3%). The undergraduate underrepresented minority students included 2.2% Native American, 3.1% African American, and 10.5% Hispanic students. The graduate underrepresented minority students included 1.3% Native American, 2.4% African American, and 6.3% Hispanic students [1].

Within the College of Engineering and Applied Sciences (CEAS), the Fall 1997 enrollment of undergraduate engineering students increased by 5.9% (3,625) with an increase in graduate level students by 1.4% (1,791) constituting an overall 4.4% (5,416) growth in the college enrollment. During this same period, the minority undergraduate engineering enrollment grew by 15.8% (to 579 students, representing 16.0% of the undergraduate engineering students), while at the graduate level the minority enrollment decreased by 7.3% (to 89 minority graduate students, representing 5.0%) [2].

The Office of Minority Engineering Programs (OMEP) is a growing support system for underrepresented minority students (African American, Hispanic, and Native American) in the College. The goals of the program are to increase the number of underrepresented minority students who enroll in the CEAS and to increase the number of underrepresented minority students who successfully complete their undergraduate engineering degree at ASU. These goals are accomplished through programs such as the Peer/Tutor Program, Academic Excellence, skill workshops, MEP New Student Orientation, and <u>ASE 194: MEP Academic Success Seminar.</u>

These programs have been built on the existing literature for the retention of minority students, as well as the incorporation of unique techniques that have been found to be successful in our CEAS activities. Summer Bridge Programs and Orientation seminars have been used successfully for some time to assist in the retention of students. Hermond [3] includes them under the category of matriculation, a term defined by Glenn and Landis [4] as activities done with students between the time they are admitted and their first semester of enrollment, to assist their transition to college life.

Bridge Programs vary in length from a few days to one week, such as the Mathematics Bridge Program used at Purdue [5] to five weeks such as the Academic Enrichment Program at Hampton University [6]. Others are eight weeks [7] or 10 weeks with the participants taking two courses for credit [8]. Bridge programs may also concentrate on just mathematics [5], tutorials in several subjects [6], on survival skills [8], or other combinations of the above [8]. The programs often are offered free of charge and may include stipends or scholarships based on performance during the session.[6,7,8]. Reichert and Absher [8] identified 13 engineering schools that either graduate large classes of African Americans or that retain relatively high percentages of African American students in engineering. Six of the 13 schools offered minority students “survival skills” bridge programs and workshops. At the same time, coalition schools are interfacing their bridge programs with their coalition effort [9].

The bridge program at ASU was primarily created to promote community and to ease the transition into the first introductory engineering class. This program and the academic success seminar also relied heavily on the theories and practice of Raymond B. Landis as described in his text Studying Engineering [10] and in his workshops. As a member of the Foundation Coalition, the bridge program was also designed to interface with the integrated curriculums developed through that program. A unique feature of the bridge program was that although a faculty member coached engineering students, the students themselves delivered the instruction and program [11].

MEP SUMMER BRIDGE PROGRAM

The OMEP has hosted the Minority Engineering Program (MEP) Summer Bridge Program for the past two years. The purpose of the program is to promote greater awareness of and recruit potential candidates to the College. The program content and curriculum were designed to prepare underrepresented ethnic minority students for success as an engineering student. The program focused on building community and utilized undergraduate student role models as instructors, while the curriculum focused on engineering design, technical communications, and a design project. Academic scholarships were awarded to all participants based on a team design project competition.

The curriculum focused on the introductory engineering course ECE 100: Introduction to Engineering Design. The catalog description of the course is the following:

> Introduction to engineering design philosophy and methodology: computer modeling of systems, processes, and components; design for customer satisfaction, profitability, quality and manufacturing; economic analysis; flow charting; sketching CAD; and teaming. A term design project is included [12].

ASU engineering students will usually take this course in their first year. It is a four-semester hour, open-ended design course with three components: laboratory, projects, and modeling.

During the summer of 1996, 44 students participated and completed the program. As a recruitment tool, the program was an overwhelming success with 43 of the 44 students completing the academic year (one chose not to because of the family’s financial situation). During the summer of 1997, 39 students also completed the program. Currently, 38 of the 39 from the 1997 program have enrolled in the CEAS (one chose not to enroll because of problems with financial aid).

ASE 194: MEP ACADEMIC SUCCESS SEMINAR

In an effort to build community and increase academic success, the MEP offers a two-semester hour introductory course for new freshman/transfer students called ASE 194: MEP Academic Success Seminar. The purpose of the course is to assist and to prepare students to excel in their academic pursuit of a baccalaureate degree in engineering and the applied sciences. This course emphasizes academic success, leadership development, time management, the transition from high school/community college to the university, and professional development. The intent is to utilize a comprehensive approach to both academics and leadership development that will unilaterally prepare students for their academic career, as well as develop role models for future students.

The Summer ’96 program participants were encouraged to participate in the MEP Academic Success Seminar course offered in the Fall ’96. Twelve of the 43 participants chose to do so. Since the instructor for the course was also the director of the bridge program, the MEP saw this as an opportunity to continue building community, reduce student isolation, and monitor student progress throughout the semester. In fact this is exactly what occurred with the 12 that chose to participate. However, continuing all these facets was difficult with the remaining 31. Therefore, the following year, the Summer '97 program participants were required to participate in the course as a stipulation to receive their scholarship. These students were given the option to either participate in the Foundation Coalition Match program offered at ASU or to register for the seminar course. The Foundation Coalition Match program, funded by the National Science Foundation, is a blocked curriculum that requires the students to take all their courses as a cohort. The program includes ECE 100, Calculus, Physics and English. The students take their classes in one classroom that is equipped with 40 computers. A team of instructors delivers the entire curriculum and the students are required to work in teams on all assignments. As a result of this requirement, all 30 participants chose to register for the seminar course and eight joined the Foundation Coalition Match program. However, of the 30 that registered for the seminar course, two of the youngest participants stopped attending classes and withdrew during the semester.

Overall, the 42 participants of the Summer '96 program performed well academically with an average semester GPA of 2.65 in their first semester (Fall 96). The average GPA for the twelve students who also took ASE 194 was 3.00 while the average GPA for those who did not take ASE 194 was 2.51 (p=0.067). The average GPA of the '96 ASE 194 students who were in the Bridge Program was 3.00. However, the average GPA for the students in the seminar class who had not participated in the bridge program was 1.85. These means were significantly different at p=0.013.

Overall, the 36 participants of the Summer '97 program (two withdrew from their courses completely) also performed well academically with an average semester GPA of 2.39 in their first semester (Fall 97). All of the '97 participants were required to participate in the seminar course or the Foundation Coalition Match program. The 28 who participated in and completed ASE 194 seminar course had an average GPA of 2.34, while the eight who participated in the Foundation Coalition Match program had a GPA of 2.57 (p=0.429). Overall, the seminar course had 37 students who completed the semester (other students had registered for the course who had not participated in the bridge program). The 28 Bridge Program participants who were in the ASE 194 class had an average GPA of 2.34. The average GPA for the 9 students in this class who did not participate in the Bridge Program had an average GPA of 2.03. While the average GPA is lower for those who did not participate in the Bridge Program, it is not statistically significant (p=0.408).

MATHEMATICS PLACEMENT EXAM

An additional concern was the welfare of the freshmen engineering students in their first mathematics class. It was well known that many of the engineering freshmen do not do well in their initial mathematics class. In a 1995 survey of freshman students enrolled in ECE 100, it was shown that the grades in the first mathematics class were very significantly different for the students who were retained to their sophomore year versus those who were not retained [13]. See Table 1. This particular concern of mathematics preparation is a common problem and special mathematics sessions are included in many summer bridge programs [5, 6, 7, 8, 9].

At ASU, math placement tests had not been used in some years [14]. When the Mathematics Department was approached by the CEAS about the possibility of reinstituting the math placement exam, they were most receptive. In response to the CEAS request, the Mathematics Department, in the summer of 1996, made available a pilot math placement exam for MAT 270, the first calculus class required by CEAS.

The pilot group, on which this exam was first tested, was the 43 participants of the 1996 program. No math review was given before the exam. The math placement scores ranged from 2 to 23. The Mathematics Department conservatively suggested, based on past history, that a student had a high chance of obtaining a grade less than a C in MAT 270 if their math placement score was less than 13.

Math Class Grade Earned Fall 95	**Still CEAS (n=99)**	**Left CEAS (n=31)**	**p**
A, B, or C	81.8%	41.9%	0.0001*
D, E, or W	18.2%	58.1%	

Table 1: Comparison of Math Grades earned in Fall 1995 by Students Enrolled in ECE 100 Between Those Who Were Retained for Fall 1996 and Those Who Were Not.
* *with Yates' correction*

Of the Summer '96 participants, fifteen students took MAT 270. Their math placement scores ranged from 10-22. For those with placement scores of 15 or higher, over 83% of the students received a C or better. Three scores were below 15 and these students received a B (score 10), an E (score 11), and a W (score 14).

Twenty of the students chose to enroll in MAT 170 (pre-Calculus). Their placement scores ranged from 5 to 15. Over 91% of the students received a C or better if their placement score was 8 or higher. The math placement scores were lower (13.0 average) for the students who took the ASE 194 course, than for those (13.68 average) who did not. However, the difference was not significant (p=0.0731). All of the students who were enrolled in the ASE 194 received a C or higher in their math class except for one student who withdrew from Calculus I (he had been advised to take Pre-Calculus). Over 32% (n=31) of the students who did not enroll in the ASE 194 course received a D, E, or W in their math course.

During the 1997 MEP Summer Bridge Program, some math review was given before the math placement test was administered. Perhaps, due to this review, the '97 students scored an average of 13.64, slightly higher than the '96 students who scored an average of 13.50. However, this difference was not statistically significant (p=0.908). The math placement exam was revised slightly for use in Fall 1997 and specific advisement recommendations were made. If a student scored less than 15, they were strongly recommended by the Math Department, to take MAT 170. If a student scores less than 10, an academic advisor must approve enrollment to MAT 270. All of the '97 Bridge Program students were counseled and advised on which math class they should take. Only one student took MAT 270 who was advised to take MAT 170. The student withdrew from school during the semester.

Twenty-two of the thirty-eight '97 participants took MAT 270 their first semester at ASU. Their placement scores ranged from 8-22. For those with placement scores of 15 or higher, all received a C or better. Ten of 22 students took MAT 270 with a placement score of less than 15. None of these students earned a grade better than a C and six earned a grade below C. Six of their scores were less than 13 (actually less than 10) and all earned a grade of D, E, or W. Eleven students chose to enroll in MAT 170. Their placement scores ranged from 6-15. Only two of the students earned less than a C: a student with a placement score of 13 earned a D and a student with a placement score of 6 earned an E [14]. Of the students enrolled in ASE 194, only 20% (n=25) received a D, E, or W. Of the students not enrolled in ASE 194, 25% (n=8) received a D, E, or W.

Although the 97 students had a higher average math placement score, on average their grades in their first math class was 2.09, lower than the 2.23 average of the '96 class. However, this difference was not significant (p=0.621). The average GPA of the '96 students after one semester was 2.65. The average GPA of the '97 students after one semester was 2.39 (p=0.202).

MEP SUPPORT SYSTEM

Supported by the Foundation Coalition, the MEP has begun an Academic Excellence Program that clusters underrepresented minority students enrolled in calculus, chemistry, physics, and the introductory engineering design course. The students develop their own community of peers and collectively come to conclusions on how to process information. The workshop helps to move away from traditional tutoring that is often a short term fix. These sessions enhance the mastery of engineering concepts as opposed to isolated problems by collaborative learning between the students and an upper-division undergraduate student who acts as the session facilitator. It is the intent of the process to prepare students for potential curriculum integration in the future, as well as for team participation in industry.

The MEP Peer/Tutor/Mentor Program provides tutorial services to minority students based on their needs and requests. The program includes one-on-one or group-tutoring sessions in a variety of required courses such as mathematics, chemistry, physics and the engineering core courses. The program offers flexible hours because tutoring sessions are scheduled between the tutor and students. The program also serves as a mentor program in that students who are in their junior and senior level curriculum or graduate program serve as tutors. In addition, the program allows for those tutors who work with the incoming freshman and transfer students to work one-on-one in areas that may concern the new student.

The students who participated in both summer programs were strongly encourage to also participate in either the Peer/Tutor/Mentor Program, the Academic Excellence Program or both depending on their courses.

The 1997 MEP Summer Bridge students were given two additional support systems for retention during their fall semester. As discussed before, the first was required participation in the MEP Academic Success Seminar or a program that clustered students. The second was clustered tutoring sessions offered by the MEP. The overall effect of these additional support programs is shown in Table 2.

Math Grade	Seminar & Tutoring		Seminar & No Tutoring	
	MAT 270	MAT 170	MAT 270	MAT 170,106
A, B, C	8 (88.9%)	6 (85.7%)	8 (61.5%)	4 (66.7%)
D, E, W	1 (11.1%)	1 (14.3%)	5 (38.5%)	2 (33.3%)

Table 2: Comparison of Math Grades depending on Use of Seminar and Tutoring

These numbers are small, but if we contrast the students that made use of the tutoring services as well as the seminar, with those that did not use the tutoring services, there is a significant difference at p=0.2101 (with Yates'correction).

CONCLUSIONS

In spite of the lack of strong grade prediction due to the math placement exam, over 88% (n=43) of the 1996 MEP Summer Bridge Program students enrolled at ASU in Fall 1997 for their sophomore year. Over 77% of these were retained in the CEAS for Fall 1997. (Only 76.2% of the Fall 95 students returned to the CEAS for the 1996 Fall.) The overall comparable retention rate in the CEAS for the Fall 1996 class was over 66.2%, a significant increase over the 54% that were retained from Fall 1995. In addition, entering students were retained at a 77.3% rate in the University, a dramatic increase from 68.5% of the year before. This increase is believed to be due, at least in part to the increased retention activities of the College in general, and the MEP, in particular.

Students	Category	ASU: Retained after one year	CEAS: Retained after one year
F 95	All	68.80%	54.00%
	Minority	68.10%	
F 96	All	77.30%	66.20%
	Minority Bridge Program (n = 43)	88.40%	79.10%

Table 3: Retention of CEAS First-Time Freshman

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