A FRESHMAN ENGINEERING EXPERIENCE
THE FOUNDATION COALITION AT TEXAS A&M UNIVERSITY

by

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ABSTRACT

This paper represents an overview of the freshman year of the Foundation Coalition program at Texas A&M University. Future directions of this program, taught in groups of one hundred, are highlighted. The curriculum includes chemistry, English, engineering, math and physics taught in an integrated just in time fashion using technology and delivered in an active-collaborative environment to students working in teams of four. Through our thrusts of integration, teaming, active learning and technology we hope to produce engineers who can more effectively solve increasingly complex problems. This enhanced problem solving skill demands:

- increased appreciation and motivation for life-long learning;
- effective oral, written, graphical, and visual communication skills;
- increased capability to integrate knowledge from different disciplines to define problems, develop and evaluate alternative solutions; and
- increased flexibility and competence in using modern technology effectively for analysis, design, and communication.

Information on learning styles and performance of students is presented and compared to that of the students in the traditional freshman engineering program at Texas A&M University.

THE COURSES

The freshman year of the Foundation Coalition program at Texas A&M University consists of 4 credit hours of chemistry, 4 credit hours of English, 5 hours credit of engineering, 8 credit hours of mathematics, and 6 credit hours of physics. These courses include a semester of chemistry (including lab), a two semester English class (including freshman rhetoric and part of technical writing), a two semester engineering course (including engineering graphics, and an introduction to engineering problem solving and computing), two semesters of calculus (although not all materials comes from the first two semesters of a traditional calculus class), and two semesters of physics (including mechanics and E&M). The courses are delivered to students as 12 semester hours in the fall semester plus 15 semester hours in the spring semester. The engineering component of the curriculum has as central goals to: provide the student with the necessary skills to perform effective problem solving; to help the student develop a logical

thought process; to introduce the students to some of the basic engineering tools; to enable the students to have better spatial analysis skills; to help the students develop appropriate sketching skills; and to teach the students how to read and/or interpret technical presentations.

LOGISTICS

Each class is taught by faculty in the respective departments and students receive a grade for each class. Students must be enrolled in **all** foundation classes. This means they must forgo any AP credit (except English for which they may receive a humanities credit), and can not drop individual courses during the semester. Since several of the courses span both semesters, the students should view this program as "at least" a one year commitment. However, if a student chooses to leave the coalition after the first semester, they do receive credit for the first traditional calculus course and (with the addition of a 1 credit hour lab course) the mechanics physics course.

Each student is assigned to a team of 4 (or 3) and works with the same team in all classes until reassigned. Student teams are changed once during the fall semester (before midterm) and again at the start of the second semester. Pseudo-random team assignments account for academic ability, gender and ethnicity. The goals during team assignment are: no team with a single member of an underrepresented group, and all teams with equal academic ability. Students also are given the opportunity to participation in an interaction team (composed of five or six students and one member from the faculty team). The purpose of the interaction teams is to improve communication between the faculty and the students, and to provide a mechanism for student "ownership".

Grades in each class are a combination of individual and team efforts on homework, quizzes, exams, projects, and in class assignments. Exams including engineering, math and physics components in the fall semester (plus chemistry in the spring semester) **and** an integrated team exam are given every three weeks. The exam grade for each of the courses is composed of 75% from the disciplinary component and 25% from the integrated component.

The classroom is a converted theater style lecture room. Some of the tables were removed to facilitate access by instructors (faculty and teaching assistants) to the student teams. Each team of four students share two laptop computers which are connected to a Novell server and to the campus backbone. The instructor machine also is connected to a BARCO projector

THRUSTS

The primary thrust areas used in the development of this program are integration, teaming, active learning and technology. Each of these thrusts contributes to the goal of producing the following attributes in our graduates:

- good grasp of engineering science fundamentals
- profound understanding of the importance of teamwork
- curiosity and desire to learn - **for life**

- good communication skills
- ability to think both critically and creatively - **independently and cooperatively**

Integration - The first goal was true integration of chemistry, English, engineering, mathematics, and physics in order to motivate engineering problem solving and design. Students can be held accountable in all courses for material for information which is presented in any one of the disciple specific courses. This requires a large commitment of time in course development **and** a continued commitment to maintain the level of coordination necessary to respond to student needs and opportunities. At Texas A&M this means a weekly meeting of the entire faculty team and regular electronic communication in between.

Teaming - The second goal is to develop each students ability to work as a productive member of a technical team. Each student is a member of three different teams during the course of the year. Formal team training is given at the beginning of each semester with periodic refresher and team maintenance seminars. The time for these activities is donated by each of the disciplines and results from the savings of in class time provided by integration and collaborative learning.

Active Learning - The third goal is to change the pedagogy of the classroom from a passive lecture to a collaborative learning experience. This requires a different type of preparation for class **both** for the faculty and the student. The faculty post learning objectives **before** class. The students are given frequent **Readiness Assessment Tests** (RATs) to encourage reading and preparation for class. *Lecture* time is limited to those concepts which are difficult for the students to pick up from reading or from teammates, and time for in class activity by the students (individually and in teams) is *maximized*. The goal is for a class with ten to fifteen minute lecturettes interspersed with student exercises. Many classes start with an exercise for the students to tell us what they do not (and then what no one on their team) understand(s).

Technology - The fourth goal is to use technology inside (and outside) the classroom in order to provide the students with enhanced design and problem solving tools. The classroom computers are armed with Maple, Microsoft Word, PowerPoint and Excel, as well as internet tools and other software. A central freshman web page (http://coalition.tamu.edu) and several local web pages are used by the faculty (in addition to files on the Novell server) to keep the students informed of what has been covered, what will be coming, and what they are responsible for whether or not it was covered explicitly in class.

RESULTS

The Coalition has been successful in both recruitment and retention in the College of Engineering (number at the start of their third semester as a percentage of those starting the first semester). students in the Coalition than for those in the traditional freshman program. This is especially true of students from underrepresented groups: Women, Hispanic, and African-American engineering students. Recruitment and retention statistics for underrepresented students in the college of engineering and in the Coalition are presented below:

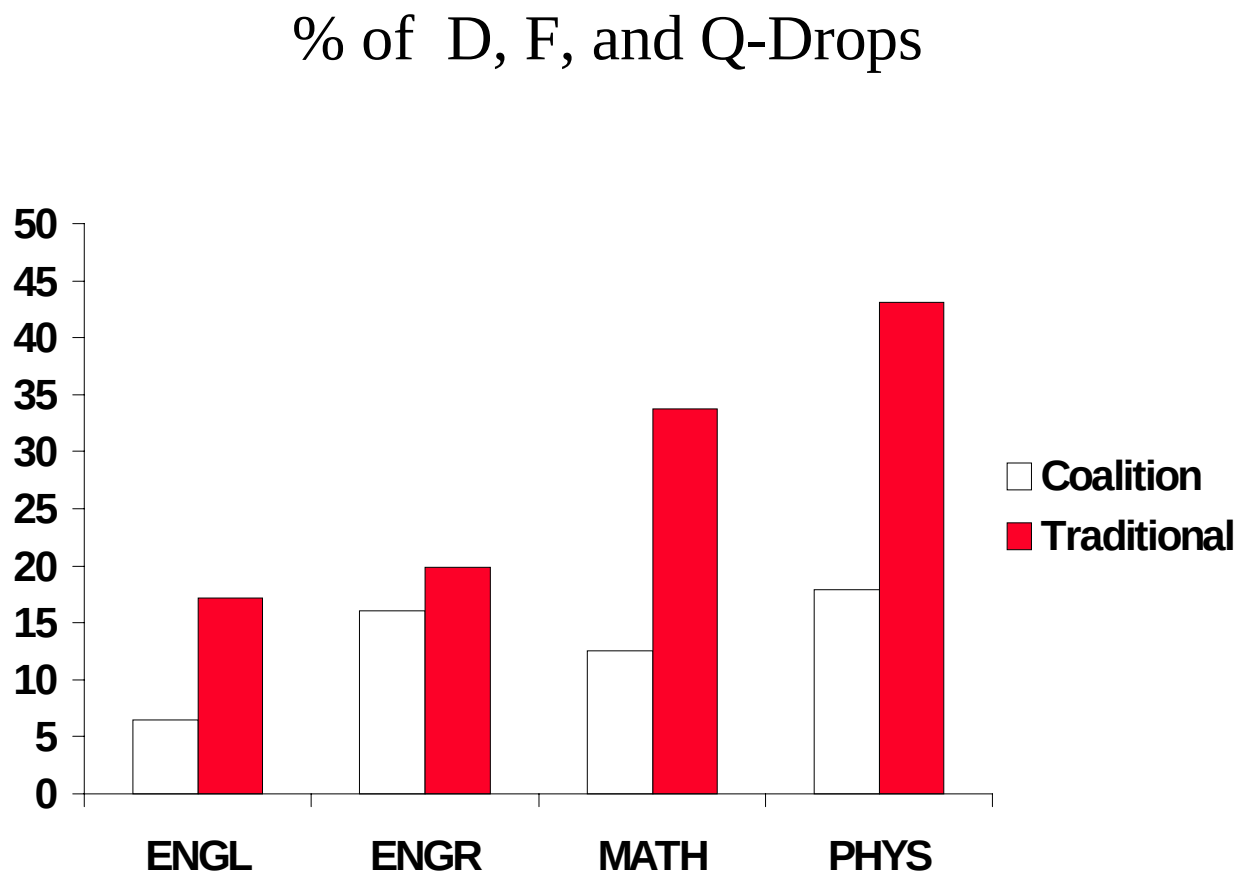
Enrollment by gender & ethnicity (1995-96 freshmen)

	Women	Hispanic	African-American
All Engineering	19.8%	11.0%	3.2%
Math Ready	19.8%	10.3%	1.7%
Coalition	24%	16%	5%

Retention by gender & ethnicity (1995-96 freshmen)

	Women	Hispanic	African-American
Traditional	72%	70%	70%
Coalition	88%	84%	90%

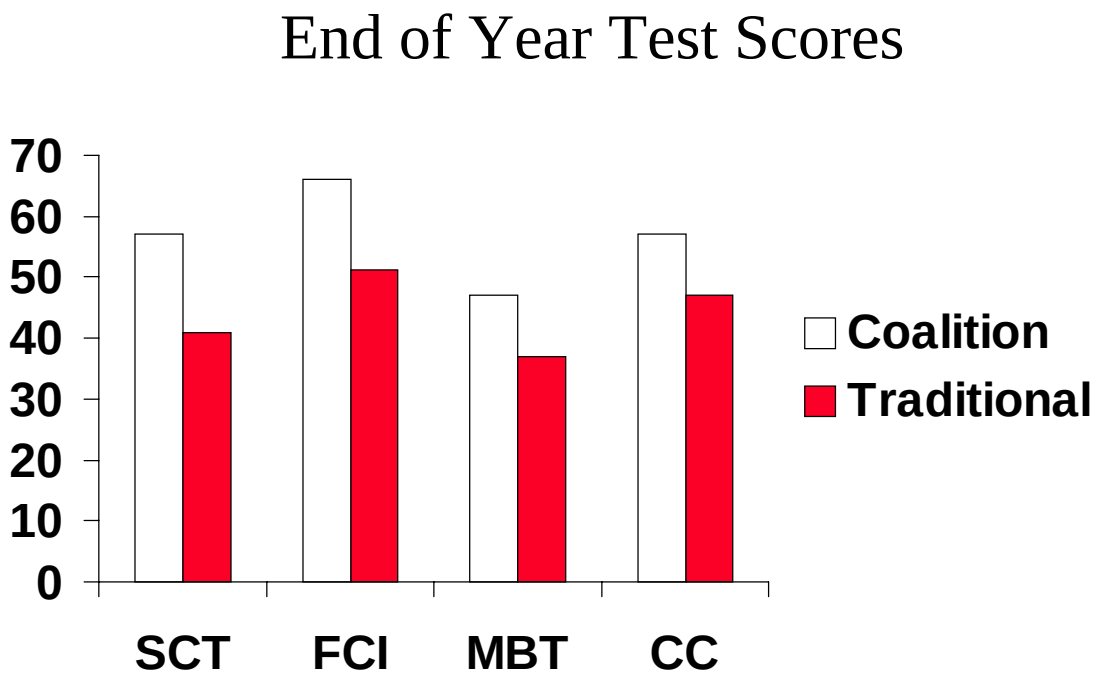
Grades can be viewed from several perspectives, the grade point averages for the coalition students and those students completing the same courses in the traditional program are essentially the same. On the other hand, as illustrated below, the distribution of grades is not the same.



Students with grades of D, F or Q (quit before end of tenth week of class) represent those

students who will be repeating the course, and therefore requiring greater resources. It should be noted that the difference between the bars in the figure above is due to Q's, and, because of integration, Coalition students are not allowed to Q-drop a course.

A series of standardized tests, including a critical thinking test (SCT), the Force Concepts Inventory (FCI)[1], A Mechanics Baseline Test (MBT)[2], and a Calculus Concepts Test (CC)[3], has been administered to the students in the Freshman Coalition classes and to a similar group of students in the traditional freshman engineering classes each year. The results obtained are virtually identical when the start of the year tests are administered. As illustrated in the figure below, substantial differences between the two groups have been found in the end of the year tests.



Learning styles of the students. The Gregorc Style Delineator[4] has been administered to the students in the Freshman Coalition classes since the Fall 1995 semester. Of the 193 students enrolled in the Fall 1995 semester, 73 were Concrete Sequential (CS), 50 were Concrete Random (CR), 35 were Abstract Sequential (AS), and 35 were Abstract Random (AR). Attempts at utilizing the information collected on the learning styles of the students have, so far, been limited to correlating this information to other data obtained from our students. The most significant correlation's [5] are with AR students who are less likely to perform well in Coalition classes (this was especially true of Hispanic students who were AR) and with CS students who are more likely to perform well in Coalition classes. This does not necessarily mean that AR students are better off in the traditional classes. There is currently no data on the comparison of learning styles versus performance in the traditional freshman engineering courses at A&M..

SUMMARY & CONCLUSIONS

The coalition students have outperformed students in the traditional freshman engineering curriculum on standardized tests and have been retained at higher rates than traditional students. The retention rates for students from underrepresented groups is dramatically improved. At this point it is impossible to pinpoint the reason or combination of reasons that are responsible for these improvements. Certainly there are contributions to this success from the primary coalition thrusts of integration, teaming, active learning and technology. Many other factors may contribute as well. Among the most important are:

- Weekly faculty team meetings which enable integration of the courses. This has resulted in significant enhancements to the engineering course in the coverage of accounting principles (tied with chemistry and physics); curve fitting (tied with math); ethics (tied with English); and static's (tied with physics).
- Teacher training in teamwork, use of technology and in teaching in a collaborative - active learning environment.
- Interaction groups which allow the students to discuss their concerns with the class[es] and increases the *buy-in*.
- Decreasing percentage of time spent lecturing in all classes.
- Increasing use of technology in all classes.

Efforts continue in many areas, especially: utilizing the information on learning styles of the students; web based evaluation of all components of the coalition effort; a web based in class testing and response system; an effective mechanism for identifying and helping weaker students; improving teacher training in teamwork, use of technology and in teaching in a collaborative - active learning environment; issues related to students who drop, repeat or transfer credits (e.g., can we continue to require co-enrollment in all classes); a meaningful transition to the coalition for students who do not arrive calculus ready; and balancing coalition teaching with university, college, and departmental workload formulas.

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Jim Morgan is in his 16th year at Texas A&M. He has served four years on the Engineering Faculty Advisory Committee (including two years as chair), six years on the Faculty Senate (including one year as Speaker), is currently the coordinator of ENGR 109 Engineering Problem Solving and Computing, and is the leader of the freshman faculty team for the Foundation Coalition. His research is in the areas of engineering education, structural dynamics, earthquake engineering and highway safety. He is a member of the faculty of the Civil Engineering Department and is an Associate Research Engineer with the Texas Transportation Institute.