

The NSF Foundation Coalition: Curriculum Change and Underrepresented Groups

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Abstract

The Foundation Coalition was funded in 1993 as the fifth coalition in the National Science Foundation's Engineering Education Coalitions Program. The member institutions are developing improved curricula and learning environment models that are based on four primary thrusts: integration of subject matter within the curriculum, cooperative and active learning, technology-enabled learning, and continuous improvement through assessment and evaluation. The Foundation Coalition partners draw on their diverse strengths and mutual support to construct improved curricula and learning environments; to attract and retain a more demographically diverse student body; and to graduate a new generation of engineers who can more effectively solve increasingly complex, rapidly changing societal problems. The improvement of recruitment and graduation of traditionally underrepresented groups is an integral part of the Foundation Coalition strategic plan. This paper discusses Coalition projects to date and other efforts focused on increasing the participation of underrepresented groups in engineering education.

Introduction

The National Science Foundation's Engineering Education Coalitions program was established to “stimulate bold, innovative, and comprehensive models for systemic reform of undergraduate engineering education. The purpose of the program is to join universities and colleges of differing characters in collaboration to experiment and implement, acting as change agents for the engineering education community at large.” In 1993, the NSF Foundation Coalition (FC) was funded as the fifth coalition in the EEC program. The member institutions - Arizona State University, Maricopa Community College District, Rose-Hulman Institute of Technology, Texas A&M University, Texas A&M University - Kingsville, Texas Woman's University, and the University of Alabama - draw on their diverse strengths and mutual support to construct improved curricula and learning environments; to attract and retain a more demographically diverse student body; and to graduate a new generation of engineers who can more effectively function in the 21st century.

Foundation Coalition Vision

The vision of the NSF Foundation Coalition is an engineering education partnership between students, faculty, and industry that will produce graduates who have an

- Increased appreciation and motivation for life-long learning,
- Increased ability to participate in effective teams,
- Effective oral, written, graphical, and visual communication skills,

- Improved ability to appropriately apply the fundamentals of mathematics and the sciences,
- Increased capability to integrate knowledge from different disciplines to define problems, develop and evaluate alternative solutions, and specify appropriate solutions, and
- Increased flexibility and competence in using modern technology effectively for analysis, design, and communication.

Foundation Coalition Mission

The mission of the FC to provide national leadership in creating a new culture of engineering education: students, faculty, and employers working in partnership to produce an enduring foundation for student development and life-long learning. This cooperative partnership places new demands on all of the principals: students take a more active role in their education; employers become more fully engaged in characterizing the skills and attributes required of the 21st century engineer; faculty redefine their relationship to the students and to each other across disciplines, and more directly address the building of student skills and attributes. The FC, first on our own campuses and then nationally by dissemination and replication, will establish improved curricula and learning environments, attract and retain a more demographically diverse student body, and graduate engineers who reflect the FC vision.

Access and Equity for Underrepresented Groups and Women

The Foundation Coalition members are developing curricula and academic environments at each institution which are accessible and provide equitable opportunity for success for all students. The focus on underrepresented minorities and women is necessary because these groups have a history of being significantly underrepresented in engineering graduates. This underrepresentation is due to both low initial numbers in the first year and to higher attrition rates in the engineering programs. This has been pointed out as a concern both nationally and at all of the FC institutions.

Outreach To Underrepresented Minorities And Women

How students in pre-college are attracted to and successfully matriculated into engineering programs is a very complex issue. Stereotyping any group of people as having a single or unique method for recruitment is dangerously misleading. The FC schools recognize this and have approached outreach to underrepresented groups in a variety of activities. The common idea for all students is that they must develop and aspiration for engineering and an expectation of success in the field.

Aspiration in an area requires an awareness and valuing of the field, as well as an interest in serving in the roles found in that field. Expectations are influenced by individuals confidence that they can achieve and aspiration. It is crucial to provide mentors, role models, and sound information networks so that underrepresented minorities and women, whose expectations typically fall well below their aspirations, have opportunities to raise both their aspirations and expectations. Many people who have focused on this issue will confirm that it is never too early to start influencing the students aspirations. In the FC schools outreach efforts to pre-college students are facilitated by numerous internal organizations. For the engineering programs most of these efforts are led by personnel in the Minority and Women Engineering Programs.

At ASU, TAMU, UA and TAMUK, a Minority Engineering Programs existed prior to the formation of the FC. In addition MCCD and TWU had numerous activities to outreach to underrepresented minorities and women in their communities. TAMU and TAMUK also had existing programs which outreached to girls. The FC has aided in the formal organization of Women in Engineering Programs at ASU, TAMU, TAMUK, and UA. These programs now conduct numerous conferences and camps for minorities and girls at the pre-college level. The FC teams on the campuses have all provided some level of cooperation with these programs. It is important to recognize that the directors for the MEP and WEP are continually raising internal and external funds to support their efforts, and on most campuses the FC funded only a small part of these efforts. The following table is meant to illustrate examples of the type of outreach and level of FC involvement.

Examples of Pre-College Outreach Efforts

Level	School	Comment	FC Involvement
Elementary	TAMU	Engineering students and faculty take design activities to the 5th and 6th grade campuses at local schools	Several FC faculty have volunteered time and materials
	TAMU	Tours of campus and laboratory activities for local community centers serving 2nd through 4th graders.	One FC faculty arranged with MEP and WEP the tours and raised funds for the buses.
	ASU	Collaboration with girl scouts to offer 1 week camps for 1&2, 3&4, and 5&6 graders.	WISE
Middle School	TAMU	SWE one week residential camp	FC faculty gave many of the tours and demonstrations. FC faculty developed team projects for the camp.
	TAMU	Mentoring for at risk students	FC faculty made contacts, MEP and WEP matched undergraduate mentors to middle school students
High School	ASU, TAMU, TAMUK	3 day activities for students to expose them to design and teaming	ASU-direct FC support TAMU & TAMUK-FC faculty facilitated design competition
	RHIT, TAMU	One-week residential camps	FC faculty helped develop activities and design projects. FC faculty and undergraduate students delivered team training
	TAMU	Three-week camp (sponsored by Young Scholars program in NSF)	FC faculty PI for the camp. Included integrated course materials, technology and teaming.
	TAMU, TAMUK	Year round interaction with predominantly minority high schools	FC faculty and students provided tours and activities.

Recruitment Of Underrepresented Minorities And Women

In addition to these outreach activities, the FC teams have made special efforts to recruit students into their pilot curricula programs. These efforts included mail outs describing the programs. At most campuses, students come to register prior to the start of the semester and sessions were set up for parents and students from underrepresented groups to discuss campus life and the FC curricula.

Retention Of Underrepresented Minorities And Women

Retention of undergraduates in engineering is also a very complex situation. Many students who enter engineering or pre-engineering leave the field for other science, mathematics, business or educational fields. Across the nation and at the FC schools the retention of underrepresented minorities and women are below the retention levels of other engineering students. All of the schools participate in numerous activities to address these issues. The NSF has a highly successful program called the Alliances in Minority Participation, which focuses on networks of 4 and 2 year institution focusing on the retention and graduation of BS level science, mathematics, engineering and technology students from underrepresented minorities. TAMU and TAMUK are part of the Texas AMP, ASU is part of the Southern Rocky Mountain AMP, and UA is part of the Alabama AMP. At these schools the FC teams have worked to get involved in numerous bridge, mentoring, and research programs sponsored by the AMPs. At TAMU the Bridge programs for matriculating first year students and for transfer students were modified to better facilitate entry into the FC curricula. All of these campuses have worked to interface the FC students with programs (such as brown bag luncheons, lecture series, peer tutoring, mentoring, internships, and undergraduate research) and organizations (such as NSBE, MAES, SHPE, AISES, SWE, and SOCNAS).

In the FC curricula research is underway on the effects of the curricula content, teaming and cooperative learning, and technology on the underrepresented groups. Figures 1 and 2 shows how the retention of students in engineering compares between the FC curricula and the traditional curricula at TAMU.

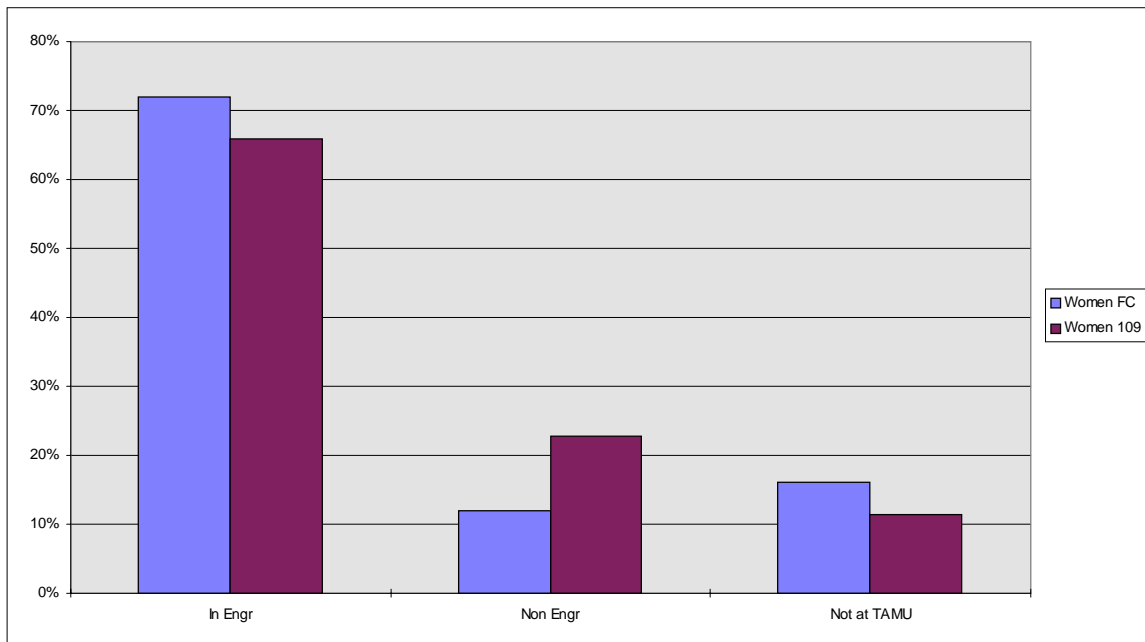


Figure 1 TAMU retention of women in FC and Traditional Curricula- Freshmen 1994-95

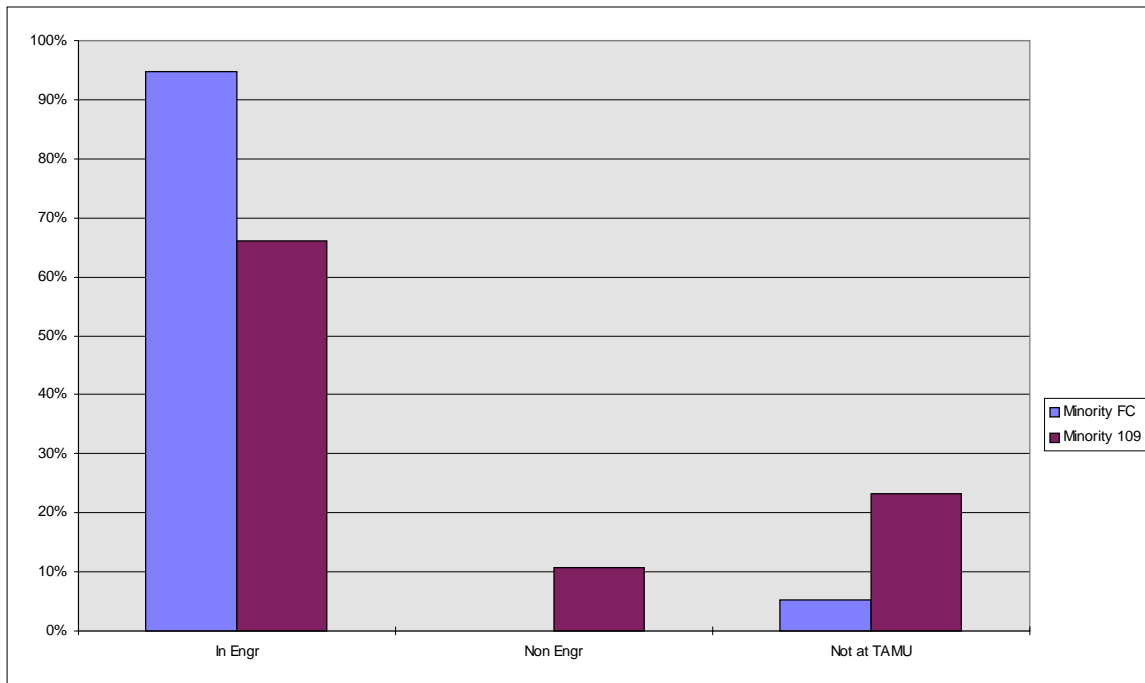


Figure 2 TAMU retention of underrepresented minorities in FC and Traditional Curricula-Freshman 1994-95

At TAMU an assessment of the students learning styles was conducted using the Gregorc Style Delineator. This instrument focuses on two dimensions of functioning, abstract-concrete and sequential-random. Clearly the abstract-concrete construct is taken from Piaget, while the author of the test might argue otherwise. This preference for either actions, events, and things in the world versus abstract ideas has a long history in both learning theory and personality theory. The sequential-random construct has been discussed by Luria, a Russian cognitive theorist, as a preference and differentiation in ability in individual mental processing based on either sequential or simultaneous processing of information. Sequential processing demands access to working memory in which elements are stored, compared, ordered, or transformed in sequence. Intelligence tests typically have such tasks, including recalling numbers presented orally or visually either forward or backward. Sequential tasks often are identified more with holistic processing of information, emphasizing pattern, spatial arrangement, integration of input modes, and nonverbal processing in general. In intelligence tests such tasks are represented by block design tasks in which a person attempts to construct a pattern presented them from blocks that have part of the design. Puzzles also fit this task, as well as geometric analogies. There is considerable debate about whether true simultaneous processing exists or is simply a concatenation of sequential tasks. Nevertheless, research clearly supports differentiation of such processes in mental functioning.

The results from this delineator showed that concrete-sequential scores correlated positively and significantly with all course grades. Abstract-random scores correlated negatively with the Force Concept Inventory and with physics and English grades. Concrete-random scores correlated negatively with calculus grades. In addition, several univariate and multivariate analyses were done between the learning styles and test achievements and grades. It is apparent that students

who think in an abstract-random dominant mode are less likely to perform well in the FC first year program at TAMU. This was even more likely if the an abstract-random dominant student was Hispanic. Other than this finding almost no sex, ethnicity or teaming effects were found, either as main effects or in interaction with learning styles, in the program. The results indicate that we have no clear evidence to require specific changes in order to accommodate underrepresented groups. On the other hand, the FC will continue to investigate approaches which enhance the success level of students who are an abstract-random dominant.

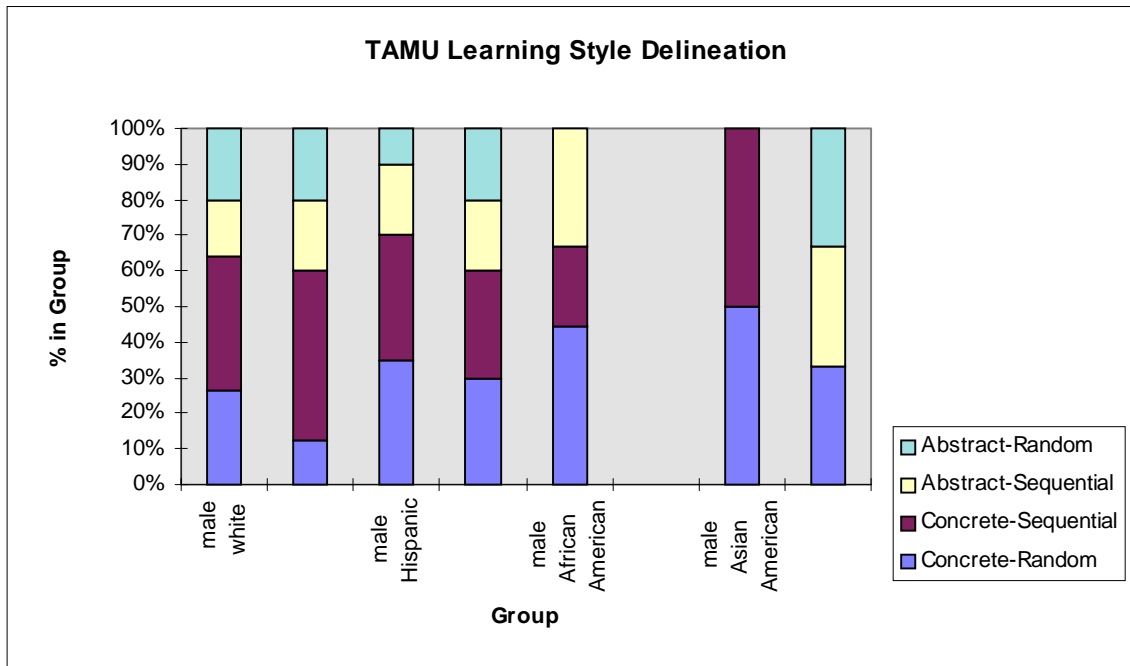


Figure 3 Gregorc Learning Style Delineation in TAMU Freshman FC Program 1995, by grouping

Conclusion

The Foundation Coalition is developing curricula and learning environments at each institution that are accessible and provide equitable opportunity for success for all students. We are focusing on underrepresented minorities and women because these groups have a history of being significantly underrepresented as engineering graduates. This underrepresentation is due to both low initial numbers in the first year and to higher attrition rates in the engineering programs. This is a concern both nationally and at all of the FC institutions.

All FC campuses have worked to interface the FC students with appropriate targeted programs, such as brown bag luncheons, lecture series, peer tutoring, mentoring, internships, and undergraduate research, as well as organizations such as NSBE, SHPE, AISES, and SWE. In addition, additional research is underway on the effects of the curriculum content, teaming and cooperative learning, and technology on the underrepresented groups.

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Biographical Information

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Dr. Frair received the B.S. from the University of Tulsa and the M.S. and Ph.D. from the University of Oklahoma, all in mechanical engineering. She joined the faculty at the University of Alabama in 1992, where she is currently Professor of Mechanical Engineering and Project Director for the NSF Foundation Coalition. She has served in administrative capacities at several universities and as a program officer at the National Science Foundation.

KARAN WATSON:

Dr. Watson received the B.S., M.S., and Ph.D. degrees from Texas Tech University, all in electrical engineering. She joined the faculty of Texas A&M University in 1983, where she is currently Professor of Electrical Engineering and Associate Dean. She has received numerous awards, including the 1996 IEEE Undergraduate Teaching Award, the 1996 Harriett Rigas Award, the Tenneco Meritorious Teaching Award, and the Women's Week Administrator of the Year Award..