ENGINEERING FACULTY DEVELOPMENT: GETTING THE SERMON BEYOND THE CHOIR*

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This paper describes a faculty development program designed specifically for engineering faculty and implemented on an 8-campus coalition of engineering schools. In the five years of the program's existence, a large percentage of the faculty has participated in faculty development activities and adopted proven but (in engineering) non-traditional teaching practices. Each of the participating campuses now has a sustainable engineering faculty development program of its own.

The difficulty of involving engineering and science faculty in instructional development is well known to faculty developers who have tried. Shulman (2002) notes that each discipline has its own "pedagogical content knowledge," so pedagogical techniques that are perfectly suitable in some disciplines may be ineffective in others. Lee (2000) supports this notion, observing that most faculty developers work with ease in the soft disciplines (e.g., English, psychology, social work) due to their own academic training in related areas, but have difficulty in engineering and the physical and mathematical sciences, being less familiar with the nature of the subject matter and methods of inquiry in those areas.

Engineering professors are particularly quick to discount the relevance of teaching workshops to their subjects, students, and problems, with many arguing that the learner-centered teaching methods presented in the workshops are just "spoon-feeding" and inevitably lead to lower standards and inflated grades. Persuading them to try those methods—or even inducing them to attend workshops or seminars—is consequently a continuing challenge for faculty developers.

Since 1992, the NSF-sponsored Southeastern University and College Coalition for Engineering Education (SUCCEED) has had considerable success in encouraging large numbers of engineering faculty to participate in faculty development programs and adopt proven but (in engineering) non-traditional instructional methods. This paper outlines the faculty development program structure, summarizes program assessment data, and discusses possible implications of the results for faculty development in engineering and the sciences.

The Engineering Education Coalitions and SUCCEED

In 1991, the National Science Foundation began funding coalitions of engineering schools to develop, implement, institutionalize, and disseminate reforms in engineering instruction and learning outcomes assessment. In its second year, the Engineering Education Coalitions program funded SUCCEED, a coalition of eight institutions in the Southeastern United States (Clemson, Florida A&M/Florida State University, Georgia Tech, North Carolina State, North Carolina A&T, University of Florida, University of North Carolina at Charlotte, and Virginia Tech) with a combined engineering faculty of over 1500. In its first five-year funding period, SUCCEED focused primarily on developing innovative instructional materials and programs, including integrated first-year engineering programs, a take-apart freshman laboratory, multimedia instructional modules, partnerships with industry, and programs to promote retention of minorities and women. In 1997 SUCCEED was awarded funding for an additional five years, with its mission shifting from program development to scale-up, institutionalization, and dissemination of the innovations developed in the first funding period.

When the second funding period began, an estimated 10% of the SUCCEED faculty had participated in coalition activities. Moving the innovations developed in the first five years into the mainstream curriculum would clearly require the involvement of a much larger segment of the faculty, so in 1997 SUCCEED initiated a coalition-wide faculty development (FD) program. The program goals were to design and implement a model for sustainable engineering faculty development on all of the Coalition campuses and to involve at least 60% of the faculty in FD activities by the end of the second five-year period. The authors of this paper have served as FD program co-directors and have worked with a team of representatives of each of the other Coalition campuses. As SUCCEED approaches the end of its second five years, the FD model has been formulated, implementation is well under way at all of the Coalition campuses, and faculty participation in FD programs has exceeded its target level.

The Succeed Faculty Development Model

Two primary challenges faced the SUCCEED Faculty Development Team at its inception. The first was the previously mentioned reluctance of most engineering faculty members to participate in faculty development programs. The second was the fact that faculty development is not generally a funded activity within engineering schools, and the chances were that any engineering FD program created and maintained with SUCCEED funding would disappear when the funding ended. The team therefore set out to devise a model program that would attract and involve a substantial fraction of the engineering faculty and could be sustained permanently without requiring extraordinary levels of external funding. The result is shown schematically in Figure 1 (Brent *et al*., 1999).

The model FD program has six components. Three of them involve instructional development and support: (1) programs open to all faculty, (2) programs specifically for new faculty members, and (3) programs for graduate students. The other three involve campus infrastructure and climate: (4) a faculty or staff member within engineering whose principal responsibility is coordinating faculty development efforts, (5) links to campus-wide faculty development programs (e.g., campus centers for teaching and learning), and (6) administrative procedures for evaluating and rewarding teaching effectiveness and educational scholarship. The components are briefly described in the sections that follow.

Learning and networking opportunities open to all faculty

The principal vehicles for instructional development are workshops designed primarily for faculty in engineering and the physical and mathematical sciences (the technical disciplines normally included in the engineering curriculum). The programs include a 1½day teaching effectiveness workshop covering various aspects of pedagogy and shorter workshops on topics that include cooperative learning, teaching with technology, learning outcomes assessment, supporting women and minorities in engineering, and incorporating multidisciplinary design in the engineering curriculum.

One of SUCCEED's goals is to equip each participating campus with its own sustainable faculty development program. To this end, most workshops given in the first two years were coalition-wide and were followed by half-day sessions in which FD personnel and engineering "teaching leaders" from each campus were given instructional materials and guidance on presenting workshops on their home campuses. Most workshops and seminars currently offered are presented locally by campus teaching leaders and/or invited presenters working collaboratively with campus faculty development specialists.

The faculty development training that followed the general and topical workshops served several different functions. The engineering teaching leaders were taught elements of effective instruction for adult learners, with particular emphasis being placed on the need to maintain a high level of activity and interactivity. The faculty development personnel—many of whom were affiliated with campus centers for teaching and learning and had backgrounds in education or psychology—were given tips on establishing credibility with engineering faculty:

- emphasize practical suggestions (things that can be done next Monday);
- use engineering and science examples to illustrate all recommended techniques;
- de-emphasize educational theories and jargon, but make liberal use of engineering and science terminology to help establish the relevance of the material and the credibility of the presenters;
- cite (but don't dwell on) solid cognitive and empirical research—the latter preferably in technical fields—that supports program recommendations.

The advantages of collaboration between engineering teaching leaders and FD personnel are obvious once all those points have been made, and representatives of the two groups were strongly encouraged to co-present with each other to the greatest possible extent.

In addition to workshops and seminars, *learning communities* play an important role in the SUCCEED faculty development model. These programs—which often take the form of brown-bag lunch forums—may be department- or college-based or campus-wide. They are usually organized around pre-announced topics, such as a book chapter or recent article in an education-related journal, a specific instructional method or device, a problem that one of the community members wishes to discuss, or a classroom research study. Communities may also take the form of teaching support groups that include mutual observation and critiquing of classes, assignments, and tests.

Programs for new faculty

A good faculty development program can reduce the 4–5 year learning curve experienced by most new faculty to the 1–2 years characteristic of what Robert Boice terms "quick starters" (Brent & Felder, 2000). In the first year of the SUCCEED FD program, a coalition-wide new faculty teaching effectiveness workshop was held, followed by a training session for engineering teaching leaders and campus FD personnel on how to conduct such events on local campuses. New faculty events are currently in place on all but one of the campuses. One of the most successful new offerings involves a 2½-day effective teaching workshop for new engineering faculty led by a team of two engineering teaching leaders, an education specialist, and the director of the campus center for teaching and learning. At another institution, a 4½-day workshop for new engineering, science, and mathematics faculty covers effective teaching, building and maintaining a successful research program, time management, and learning about and integrating into the campus faculty culture (Brent *et al.*, 2001).

Administrative support and individual mentoring by experienced colleagues can do much to help new faculty get their careers off to a good start. To foster the development of such programs at the college and department levels, a half-day workshop on mentoring and supporting new faculty members is presented to deans, department heads, and senior faculty on the SUCCEED campuses. The workshop first reviews material of Boice (2000) and Sorcinelli (1992) on the stresses and problems typically faced by new faculty. It then gives models and examples of formal and informal mentoring programs, outlines steps department heads can take to support their new faculty, and suggests incentives and rewards that can be provided to senior faculty who serve in mentoring capacities.

The promotional material for this workshop stresses that the workshop is not just about making new faculty members good teachers (a function that would not necessarily appeal to all engineering deans and department heads) but also about helping them to become productive in research in their first two years. The best results have been on campuses where the dean personally invited department heads to attend, attended himself, and communicated a clear expectation of follow-up to the heads. For example, one dean required departments to include their new faculty support measures in future annual reports and indicated that such programs would play an important part in his annual department review.

Programs for graduate students

The learning curve for new professors can also be shortened by providing them with some orientation before their first faculty appointment. Programs for graduate students and postdoctoral fellows are an important component of the SUCCEED model. Workshops and seminars on topics such as addressing different student learning styles, effective lecturing techniques, active and cooperative learning, dealing with common student problems, and the success strategies outlined by Boice (2000) provide a positive and realistic introduction to the challenges and rewards of a faculty career, and also benefit the students with whom the graduate students work as teaching assistants.

College-level faculty development coordinator

One of the following situations usually occurs in colleges of engineering: (1) no one assumes responsibility for faculty development, with professors and administrators arguing that either it is not needed or the campus teaching center is responsible for it; (2) engineering faculty development is one of many charges given to an associate or assistant dean but no one has it as a principal responsibility; or (3) an individual is designated as engineering FD coordinator and charged with improving teaching in the college but is given too little staff support and funding to accomplish anything meaningful. An important component of the SUCCEED model is the designation of a respected person within the college whose primary responsibility is to coordinate faculty development activities. The FD coordinator is expected to involve engineering faculty (teaching leaders) in activities such as leading workshops and facilitating learning communities.

Linkages to campus-wide faculty development programs

Engineering FD programs in SUCCEED coordinate their activities with campus-wide programs in several ways. Campus teaching center personnel participate as co-presenters or co-facilitators in engineering FD programs and coordinate participation of non-engineering faculty members (particularly those in technical fields) in workshops and other instructional development programs, and engineering FD coordinator keeps engineering faculty informed about opportunities available to them through the teaching center.

Institutional incentives for improving teaching.

Designing and implementing any of these programs on a continuing basis requires a substantial commitment of faculty time and energy. For systemic institutional change to take place (as opposed to isolated changes made by a few dedicated individuals), administrators must demonstrate with more than rhetoric that they value efforts by faculty members to improve teaching. The demonstrations might involve providing support for teaching improvement efforts, educational scholarship, or professional development activities related to teaching, and including those efforts in a meaningful way in faculty performance evaluation.

Model Implementation

The eight SUCCEED institutions vary considerably in size, mission, and resource levels and their implementations of the FD model vary accordingly, but all of the schools have something in place for each of the six model components. Every school offers teaching workshops and seminars to all faculty; all but one offer separate programs for new faculty; and all but one have instituted faculty learning communities or teaching circles that meet regularly. All but two schools either offer programs to graduate students or invite graduate students to participate in the faculty workshops, and the remaining two rely on university-level workshops for graduate students. All eight schools have faculty development as a formally recognized college-level function, although the goal of designating an individual within engineering whose primary responsibility is faculty development has so far only been realized on one campus. FD coordination is currently done by a faculty or staff member at four schools, by the associate dean for academics at three schools, and by a teaching effectiveness committee at one school. All eight schools have formal links between engineering faculty development programs and campus centers for teaching and learning.

Incentives and rewards for teaching quality and improvement also vary from one campus to another. They include an endowed chair for teaching innovation, release time and summer support for course development and re-design, travel support to attend education-related conferences and workshops, small grants for education-related projects, student assistance, payment of dues in the American Society for Engineering Education, awards for effective mentoring and teaching, and formal inclusion of teaching innovation and scholarship in the promotion and tenure review procedure.

In April 1999, representatives of all of the active NSF Engineering Education Coalitions met at North Carolina State University to discuss the problem of establishing and sustaining faculty development programs in engineering and attracting widespread faculty involvement in the programs. The participants in this meeting agreed to use the SUCCEED faculty development model as a framework for the ideas collected. A paper presented a year later at the annual meeting of the American Society for Engineering Education described a broad spectrum of implementations of the model elements at different coalition campuses (Brent *et al.*, 2000).

Assessment of Program Effectiveness

In 1997 when the focus of SUCCEED shifted from innovation to dissemination and institutionalization, the newly formed faculty development and program assessment teams confronted the challenge of assessing the effectiveness of the faculty development programs. In a survey of FD program evaluation practices published at about that time, Chism and Szabó (1997) observed that the assessments reported by their respondents had one or more of three goals: (1) ascertaining participant satisfaction with FD programs, (2) judging the impact of FD programs on the teaching of the participants; (3) discovering whether the programs had an impact on the participants' students. Assessment of participant satisfaction using written rating forms or (much less often) interviews was by far the most common practice. Assessing impact of FD programs on teaching practices was much less common, and direct assessment of impact on student learning was virtually never done. Explaining the last observation, survey respondents noted the high cost and intense difficulty (or, in the opinion of many of them, impossibility) of obtaining meaningful data conclusively linking improvements in student learning to changes in the teaching practices of their instructors.

Taking these considerations into account, the team designing the SUCCEED faculty development program assessment decided to focus on the second of the stated goals. Participation satisfaction surveys are routinely collected for all SUCCEED programs, but with very few exceptions they all indicate a high level of satisfaction and provide little useful information about the impact of the programs on teaching and learning (Chism and Szabó make the same observation), and direct assessment of program impact on students was ruled out for the reasons given above.

Having made this decision, the team constructed an e-mail survey to be administered to the active engineering faculty at all eight SUCCEED institutions. The respondents were asked about their involvement in faculty development programs, the frequency with which they used various teaching techniques emphasized in coalition workshops (including writing instructional objectives, active learning, team homework, and incorporating writing assignments in engineering courses), changes in their teaching practices that came specifically as a result of participating in workshops, and their assessment of the effects of the changes on their students' learning. The survey was first administered late in 1997 and a modified version was administered late in 1999.

The 1999 survey was sent by e-mail to 1621 faculty e-mail addresses, and a follow-up survey was sent a month later to non-respondents. After blank surveys and duplicates were eliminated from the returns, 586 valid and usable surveys remained, a return rate of 36%. Of those, 75 were excluded from most analyses because the respondent had not taught undergraduates in the prior three years. The demographic profile of the respondents closely matched that of the full faculty with respect to sex, rank, position, engineering discipline, and participation in SUCCEED-sponsored activities. (The last of these claims is supported by independent participation data.) A copy of the survey and a complete report of the results are given by Brawner *et al.* (2001). Following is a summary of the principal survey results that relate to faculty development.

- *Participation in faculty development activities:* 82% of the respondents reported attending one or more teaching workshops on their campuses, 64% attended a meeting or brown-bag lunch dealing with teaching, 62% consulted books, 59% consulted a newsletter or a web site, 40% observed a videotape, 35% participated in a mentoring program, and 13% worked with a teaching consultant.
- *Use of non-traditional instructional methods:*
  - *Active learning:* 60% assigned small group exercises for brief intervals in their classes with 22% doing so once a week or more, and 37% used active learning for most of a class period with 8%

doing so once a week or more. Participation in teaching seminars was associated with an increased use of active learning.

– *Team-based learning:* 73% gave assignments on which students had the option of working in teams with 35% doing so weekly or more often; 54% gave assignments on which teams were required with 16% doing so weekly or more often; and 82% reported assigning a major team project in some or all of the courses they taught.
– *Writing instructional objectives:* 65% reported usually or always writing instructional objectives for courses they taught.
– *Giving writing assignments:* 88% gave writing assignments in engineering classes they taught, with 21% doing so weekly or more often.

The survey data also show that the frequency of use of the techniques correlated positively with the number of teaching workshops attended.

The frequencies of use of the given techniques reported in 1999 were higher than the frequencies reported in 1997, although the differences were generally not statistically significant; however, 1997 was SUCCEED's fifth year, and most of the faculty likely to adopt nontraditional methods would probably have already done so by then. Although no data were collected when SUCCEED began in 1992, anecdotal evidence suggests that at that time well below 10% of the coalition engineering faculty had ever participated in faculty development activities and far fewer were using (or even knew about) such nontraditional instructional methods as active and cooperative learning.

The most telling evidence of the impact of the coalition faculty development programs is provided by responses to questions asking about instructional methods the respondents had adopted as a consequence of attending teaching workshops, seminars, or conferences. Of roughly 500 respondents to these questions, 59% reported that they either began or increased their use of active learning, 43% wrote instructional objectives, 43% used cooperative learning, 28% provided study guides before tests, and 18% participated in a mentoring program. When asked how the changes they made affected their students' learning, 69% of the respondents reported improvements, 6% said that they could see no improvement, and 25% indicated that they had not made any changes.

For a detailed summary and discussion of the survey results, see Brawner *et al.* (2001).

Implications for Faculty Development in Engineering and the Sciences

We believe that several factors have contributed to the success of the SUCCEED faculty development program. We offer them as suggestions to faculty developers seeking to reach engineering faculty and faculty in the sciences (who have much in common with the engineers) in their programs. For the sake of brevity, we will use the term "engineers" to signify faculty members in technical disciplines.

- **Make faculty development the primary responsibility of a college-level staff position increases the chances of building a successful program.** Asking an administrator or faculty or staff member to add faculty development to a long list of other responsibilities significantly decreases the chances of creating an effective program.
- **Emphasize disciplinary relevance in faculty development programs.** Perceived relevance may be the feature of FD programs most likely to induce engineers to sign up for them and to take them seriously. In workshops and seminars, include discipline-specific examples of the teaching strategies you recommend. Beware of "games" that are not clearly related to engineering education, such as name-learning icebreakers. Many engineers have a strong aversion to that sort of thing, and having to do it in a workshop may confirm their fear that they are about to waste their time on fluff. If the presentation has indeed been tailored to the needs of the targeted audience, be explicit about it in promotional materials. Engineers are most likely to come to a workshop with an open mind if they believe that the presenters are aware of their specific needs and problems and plan to address them.
- **Keep it practical.** Most engineers who attend teaching workshops are not in search of philosophical discussions about the nature of learning; they just want to know what they can do to make their classes work better. Some material from educational and cognitive psychology (especially research data) can be valuable, but it should be brought in to support the concrete ideas that constitute the bulk of the workshop rather than being an end in itself.

- **Include both disciplinary and pedagogical expertise on workshop facilitation teams.** A workshop co-facilitator with an engineering background can easily construct practical examples and exercises with technical content. For example, one of the authors (Rebecca) has a background in education and the other (Rich) is from chemical engineering. Many engineering faculty members who come to their workshops do so because they know that one of the presenters is one of them, and he goes out of his way to reinforce that notion early in the workshop, injecting terms like "partial differential equations" and "entropy" whenever he can shoehorn them into the discussion. Once the participants hear those magic words, they tend to be more willing to listen to what both presenters have to say.
- **Cite the research.** Most engineers are *thinkers* on the Myers-Briggs Type Indicator, tending to make decisions based on facts, logic, and hard evidence (Felder *et al.*, 2002). The methods recommended in most teaching workshops have solid theoretical foundations and are supported by extensive empirical research, some of it in science, mathematics, engineering, and technology. [See, for example, references cited by Felder *et al.* (2000) and Woods *et al.* (2000).] Workshop handouts should include summaries of relevant research results and references for those who wish to check the research for themselves.

Final words

Faculty development programs are like college courses: you can do the same thing in two successive offerings and it will work like a charm one time and fall flat the next. We therefore offer no guarantees of success if these suggestions are adopted. We only say that based on our experience, they should significantly increase the chances of presenting a faculty development program that effectively reaches a broad spectrum of the engineering and science faculty on your campus.

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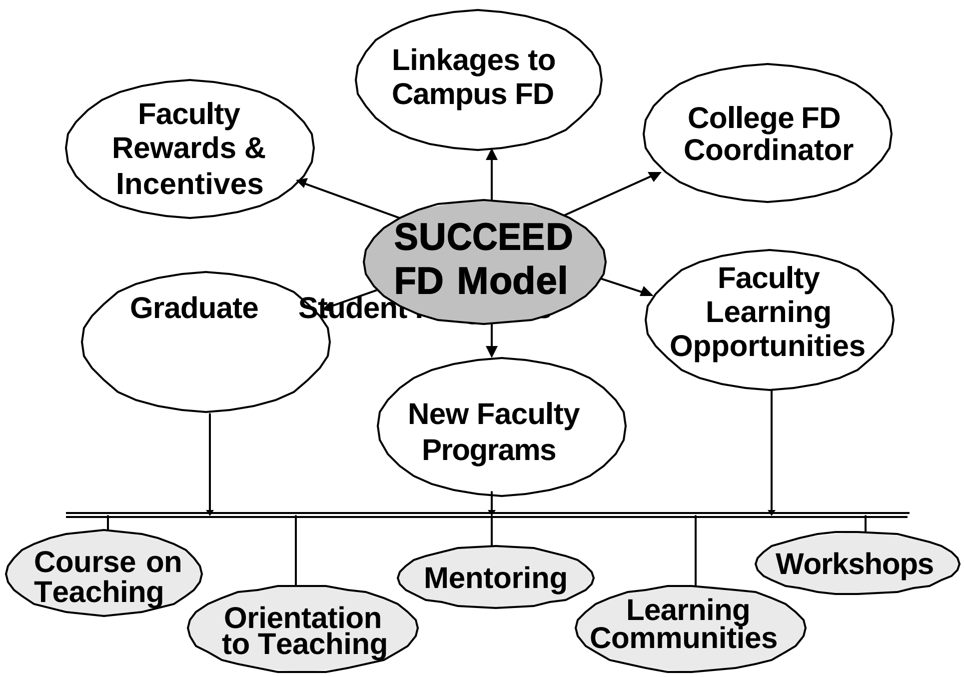

Figure 1. SUCCEED Faculty Development Model