Engaging Engineering Students in Learning – A College-wide First Year Seminar Program

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Abstract

This paper describes the inception, design and implementation of a First-Year Seminar Program in the College of Engineering at Penn State. Emanating from coincidental activities of a college-based colloquy and working group on the engineering curriculum, and a re-evaluation of the general education program by the University Faculty Senate, the new first-year seminars were piloted in the College in 1998-99 and became a requirement for all students entering the University, effective summer 1999. The overall objective was to foster an understanding and appreciation for the importance of general education within the context of students' undergraduate experience; and specifically to engage students more quickly in the scholarly community and facilitate their adjustment to the high expectations and challenges of college life. Other than stipulating that the seminars should be offered in small classes (20 students or less), and led by faculty with at least several years of teaching experience, the format and approach were left very flexible. Each of the University's colleges was free to develop a seminar program that would be attractive to, and effective for, both its students and faculty. In the College of Engineering, the seminar program was configured as a mix of offerings tuned to the differing needs of the 1000 incoming first-year students, as well as to stimulate interest among the faculty to teach them. The resultant array of more than 50 distinct courses ranges from those that allow exploration of a variety of majors and careers, sections that emphasize particular disciplines, offerings that help students develop key academic skills or that provide hands-on and laboratory experiences, and seminars that are developed around a special interest of a faculty member or a professional or technical theme. An attractive funding mechanism was developed to help motivate faculty participation and address the department workloads. Overall coordination is provided at the College level, along with help on course development and assessment. Early evidence suggests the program is successful: a pilot program has been scaled up to include all new first-year students, and the model adopted for the program appears to work in the environment of a large, research university. This paper describes the "why and how to" -- detailing the origins, structure and operation of the program. A companion paper attempts to answer the question of "how well we did" -- as gleaned from the early results of assessment activities and instruments. These include input from students on their satisfaction with the seminars, compilation of what activities are actually taking place in the seminars, attempts to measure educational outcomes, and feedback from faculty members on their experiences with the program.

I. Origins of the First-Year Seminar Program

The impetus for the Engineering First-Year Seminar Program came from the establishment of a new, university-wide general education requirement. In early 1996, a Special Committee on General Education was charged by the University Faculty Senate to assess and make

recommendations for changes to the general education curriculum. At the time, the General Education program at Penn State had been in place in roughly the same form for over 10 years. Several attempts had been made recently to update and upgrade the curriculum to make it more meaningful and relevant to students, but these efforts failed to achieve the endorsement of the Senate. The Committee worked for eighteen months: doing research into best practices, evaluating course enrollment trends, obtaining input and considering alternative strategies before bringing back a proposal to the Senate membership. The broad consultation with students, faculty, student services and academic support personnel, alumni and employers of Penn State graduates was a key component of the process and, ultimately, to the success of the initiative.

What emerged from these many conversations is that the content, while important, is not the most significant factor in ensuring a vital and successful general education experience. Exposure to skills courses in communications and quantification and to knowledge domains such as the arts, humanities and social and behavioral sciences is crucial for all students. However, just as important to *what* they learn, is *how* they learn. The Committee concluded that: "Good general education is associated with a culture that values high expectations, recognizes diverse talents and learning styles and emphasizes early engagement. Good general education promotes coherence and wholeness, interdisciplinarity and continuity, integration and synthesis (of instruction, practice and experience). It encourages active learning and collaboration and commitment to inquiry beyond the curriculum. Finally, good general education builds dynamic assessment and improvement into curricular processes."[1]

The recommendations that were eventually adopted unanimously by the Faculty Senate emphasized, above all, the active engagement of students in their education. A variety of measures were taken to foster curricular experimentation, encourage dialogue and critical thinking, and incorporate collaboration and teamwork into the courses that comprise the general education program. In order to establish this kind of expectation right from the start for incoming students, a new first-year seminar requirement was established. Rather than prescribe the content and format for the seminars, however, the Committee advocated that the faculty in the individual colleges should have broad authority and flexibility in the design and delivery of the seminars. This decision did not come without pressures to do otherwise. The Committee received many suggestions for required content, from typing to software training, library to Internet literacy, time management and study skills to personal finances. Student leaders and student activities staff advocated mandatory alcohol awareness training and guidance on other aspects of responsible social behavior. The Committee concluded, however, that if the program was going to be successful, faculty buy-in would be critically necessary to make seminars available to the over 12,000 first-year students entering the University's colleges and campuses each year. Further, the Committee felt that the objective of immersing entry-level students quickly and deliberately in a small, discussion-centered setting (in contrast to the larger "survey" courses they often take in the first year) could be accomplished through a variety of formats. The only boundary conditions that were therefore specified for the seminars were that they be offered in class sizes not exceeding twenty students, should be taught by "regular" full-time faculty and must be portable (in other words, would count towards the seminar requirement regardless of the college in which they were taken). Otherwise, the stated objective was simply to foster in students "an understanding of the importance of general education within the larger context of their undergraduate experience;" to facilitate their adjustment to the high

expectations, demanding workload, (and) increased academic liberties that accompany the transition to college life; to engage them in the scholarly community and help provide a bridge to other academic and co-curricular experiences. Secondary goals included familiarizing students with university resources, learning tools and fields of study and enhancing their contact with the full-time faculty.

II. The Engineering First-Year Seminar Initiative

The University-level initiative coincided serendipitously with the conclusion of a College-based task group that we needed to give new students more and better information with which to make an informed choice of major and to enhance their contact with the engineering faculty . An elective course for first-year students providing an overview of the College's various majors – delivered in part by invited alumni speakers and industrial representatives --- had been offered for a number of years, and the class enrollment had grown to 150 each semester. Studies at that time showed that almost 40% of incoming students had no clear preference for major, and that a third of those indicating a preference coming into the University changed their minds by the end of the first year. 25% modified their choice of intended major between the end of their first year and the spring semester of their sophomore year. Further, it was clear that some disciplines functioned as "discovery majors," attracting little attention among prospective or newly arriving students, but eventually enrolling significant numbers of students by the beginning of the junior year. Finally, surveys indicated that many lower-division students do not get to know any faculty members well enough to ask them for academic or career advice or to write a recommendation, in part because they are intimidated by the prospect of visiting faculty offices. Yet, both students and faculty frequently voiced their interest in, and the importance of, establishing these kinds of relationships, as distinct from the "procedural" advising that is effectively conducted in an advising center.

The University requirement was viewed as a way to formalize the, up to that point, voluntary seminar, and to expand on it to meet the diverse needs and interests of new engineering students. The challenge associated with designing and implementing an effective seminar program was clear. Foremost among these was how to deliver seminars to about 1000 first-year engineering students who begin their studies at the University Park campus each year (another 1000 students start at Campus Colleges and move to University Park after two years), while maintaining a class size averaging only twenty students. In addition, about 150 of the students who enroll each year in an exploratory program for first- and second-year students – the Division of Undergraduate Studies – intend ultimately to enter majors in engineering. A second concern was how to offer seminars that would be attractive and useful to students with many different perspectives and needs. No less significant was how to interest faculty in teaching the seminar sections, particularly those who rarely teach courses below the 300 (junior) level. And finally, there was the issue of resources to develop the seminars and to address the additional instructional workloads that would need to be absorbed within the departments.

Through a variety of forums, including standing faculty councils and joint faculty-student workshops, the following specific goals were adopted, along with potential strategies for achieving them:

(1) Introduce students to a specific field, or encourage their exploration of a number of fields, of study in engineering;
   - familiarization with the engineering majors and career options and with the objectives of general education and other components of the curriculum
   - development of a particular topic, contemporary issue, emerging or inter-disciplinary field of concentration, or professional responsibilities in engineering
   - plant tours or demonstrations of engineering facilities

(2) Acquaint students with tools, resources and opportunities available to them in the Department(s), College and University;
   - exposure to learning support services and career development resources
   - information on participation in cooperative education, internships, international experiences, professional societies and other student organizations
   - help in developing effective study, time-management, decision-making, critical thinking and learning skills

(3) Provide exposure to some of the professional skills and competencies associated with academic study and practice of engineering;
   - practice in skills such as use of e-mail and the Web, computation and library research
   - introduction to design, case studies, global perspectives, teamwork and problem-solving
   - opportunities to use laboratory facilities or engage in hands-on activities

(4) Encourage networking and interaction with faculty, other engineering students, alumni and other industry practitioners;
   - in-class discussions or debate
   - guest visits and presentations
   - collaborative projects and other group activities

III. Program Design

Owing to its early internal study, the College of Engineering was ready to launch a pilot seminar program in the Fall 1998, a year earlier than the implementation timetable for the University requirement. Other Colleges, too, had already experimented with seminar programs for first-year students: The College of Liberal Arts, for instance, had begun offering an array of 3-credit seminars on various academic topics directed towards lower division students, with each seminar paired with another course.[2] The College of Agricultural Sciences, on the other hand, had implemented a college-wide seminar program entitled *Be A Master Student*. The multiple-section, 2-credit course was designed for students to explore agricultural issues and research methodologies through literature review, library searches, field studies, and critical thinking.[3] The College of Engineering decided on a more diverse approach. Partly this was because students seemed to want or be comfortable with different formats from which to choose, and faculty members were more intrigued by the opportunity to design their own seminars.

For the pilot year, the Associate Dean simply communicated the concept of the program to faculty via e-mail and other means, describing some of the possible formats and encouraging creative entries. The central administration had made some modest resources available to all the colleges for development of the first-year seminars and other general education projects on a competitive basis. By matching these awards with College funds, funding for course proposals ranging from $3,000 to $10,000 could be secured for most interested faculty. Much to

everyone's surprise, over 30 faculty members volunteered to develop and/or offer about 25 different seminars that enrolled 630 students in that inaugural year. Faculty from eight of the eleven engineering programs participated. The most active departments were those attempting to recruit more students, while the non-participating departments were all subject to formal enrollment control measures. Total start-up costs amounted to about $207,000 for the first year.

Although most of the seminars were developed around themes and activities devised by the faculty, the Offices of Undergraduate Studies and Engineering Student Services also coordinated and/or "commissioned" the development of a number of modules that could be easily imported into any course plan. These included alumni and industry speakers, web-based modules on professional ethics, introductory sessions on education abroad and cooperative education, an orientation program presented by University Libraries, on-line tutorials on popular software or other computer technology and programs offered through the Learning Resource Center, Career Services and Health Services. These served to both provide useful information to a wide cross-section of students and to reduce the burden on faculty to provide the programming for every class period. Typically, these class meetings were dialogue-rich, with the instructor serving as a participant instead of the leader.

The pattern of seminars that emerged over the experimental year included entries that fell into four principal categories:

Exploratory -- courses that allow students to explore all major disciplines offered in the college and develop various academic skills, professional competencies and familiarity with educational and campus resources;

Introduction to a specific major or discipline -- courses that provide information on one particular major or a subset of disciplines/career options, along with an introduction to selected skills, competencies and resources;

Topical -- courses designed around a topic or contemporary issue in engineering (failure analysis, sustainable design, digital music, ethics, etc.) or an interdisciplinary or emerging field (manufacturing management, bioengineering, the environment, etc.) and featuring exposure to the academic skills associated with information gathering, research, interpretation and presentation;

Hands-on or laboratory -- courses that feature hands-on activities, laboratory experiences and/or team projects that will acquaint students with interpersonal skills, lab techniques, instrumentation and equipment, design and analysis and applications in engineering practice in the disciplines.

Because small classrooms were likely to be in short supply as the first-year seminars were put in place institution-wide, and the desirable class periods were already over-subscribed, faculty were encouraged to experiment with different delivery modes and scheduling patterns. For example, approximately 150 open time slots in the Monday-Wednesday-Friday class scheduling sequences were available in general purpose classrooms of proper size – 450 weekly class meetings for one-credit offerings – that could accommodate 9000 students in class sizes of 20. These were, however, not the most popular times of day for students, typically occurring very early in the morning or late in the afternoon. Other options included offering seminars in the residence hall lounges or commons, perhaps in conjunction with a Special Interest House, in the evening, or during the summer session. Although the distribution of time between in-class and outside

preparation may vary from course to course, according to Senate policy, to earn one credit it is stipulated that a student should spend, in a semester, at least forty hours on work that is planned and arranged by the faculty (ACUE Policy C-1). Example seminar patterns were proposed to include:

One 1-hour class, once a week for 15 weeks (with at least 25 hours of assigned outside work or activities);

Two 1-hour classes, or a single 2-hour class each week for 15 weeks (with at least 10 hours of assigned outside work or activities);

Two 1-hour classes each week for 7 weeks and one class in the 8th week (with 25 hours of outside activity).

IV. Full Implementation

With the effective date of the Senate requirement for all students approaching in Summer 1999, a plan was put in place to expand the program. A schedule of recommended seminar "spaces" to be provided by each department was prepared. The number of 20-space seminars "assigned" to each department was determined by evaluating the data from freshman preference of major surveys and the final distribution of students among the disciplines as they formally entered majors in the junior year. The suggested participation by "discovery majors" was closer to the latter number, while other majors that tend to see a decrease in the number of interested students between the first year and end of the sophomore year were assigned participation levels in between these two figures. Also, seminars developed and organized by the Advising Center; Minority and Women in Engineering Programs; and Science, Technology and Society Program, taught by faculty recruited from the departments, helped to meet some of the anticipated demand. In all, the plan called for provision of 1100 spaces in 55 seminar sections.

The central administration fulfilled its commitment to support the reform of general education by allocating new permanent funds to each of the colleges in relation to their enrollments and role in delivering the general education curriculum. The $240,000 provided to Engineering was dedicated primarily to the First-Year Seminar Program. The majority of these monies was passed directly to the departments to compensate their efforts in offering seminars. At approximately $3,000 per seminar, with some adjustments when multiple seminars in the same format were offered or a given seminar was under-enrolled, larger departments could realize income on the order of $30,000 for their participation. A small amount was reserved to provide development funding for new seminars, often as a match for one-time funds from the University's Special General Education Project Fund.

Several other key components of the program were also activated at this time. First, the program needed some dedicated coordination and leadership. This was important, in part, because the new program needed to reside in an academic department rather than being administered out of the Dean's office. Second, provision needed to be made for participating faculty to share ideas and experiences, as well as for training of new faculty in what works and what doesn't. Ideally, a sufficient number of interested faculty should be available so as to rotate the teaching responsibility on a regular basis. Another important ingredient was an advising process that would facilitate the enrollment of incoming students in appropriate seminars. Given the mix of different kinds of seminars, helping students sort through the options to select the seminar that

would meet their individual needs and interests would be crucial to their satisfaction with the program. Finally, a plan for assessment of the individual seminars, instructors and overall program needed to be devised. The program had to be seen by students and faculty alike as valuable and stimulating if it was to have any hope of achieving its ambitious goals. A fair and impartial process needed to be put in place for improving or phasing out seminars that were not effective, no matter how well-intentioned.

A new tenure-track faculty position was created to accommodate the First-Year Seminar Coordinator. Two-thirds of the faculty line involves administration of the new program and one-third time is devoted teaching, research, service and other regular faculty duties in the home academic unit. The coordinator responsibilities include working with the departments in developing and scheduling their fair share of seminars; recruiting faculty into the program and assisting them with new seminar ideas; facilitating course proposal submissions to the University Faculty Senate (for curricular approval) and Office of Undergraduate Education (to obtain development funding); developing or commissioning educational and informational modules (preferably interactive and/or web-enabled) that can be integrated into any of the seminars; planning and organization of other faculty development opportunities; coordinating informational materials for both students and faculty on the web and through printed media; publicizing offerings and other procedural matters to advising center staff and undergraduate program coordinators in the departments; managing the program budget and reporting to the College and departments on program progress and expenditures; and design and implementation of a comprehensive assessment process and representing the College on University-level groups or activities connected with the general education requirement.

Under the guidance of the new Coordinator, the program was scaled up to accommodate all incoming first-year students. Thirty-nine seminars were offered in the fall 1999 semester, with a total enrollment of 781 students. In Spring 2000, an additional twenty-six seminars were offered, serving 375 students. The total of sixty-five seminars, in 51 different topics and/or formats, surpassed the target of fifty-five by 20% with every department participating. This year, forty-one seminars were offered in the fall with an average class size of 20.1 students, and twenty-seven sections are scheduled for the spring. Several seminars have been successfully offered in the summer and a number of new seminars will be offered as honors courses for engineering students enrolled in the Schreyer Honors College. A typical distribution of seminars among the various types is illustrated in Figure 1 for the academic year 1999-2000. New students entering the University each semester meet with Advising Center staff and a representative from the faculty during the Freshman Testing, Counseling and Advising Program, where they receive help on selecting an appropriate seminar and are scheduled for their first semester's classes.

One lesson that has been learned in conjunction with the seminars is that care must be exercised in developing engaging titles and descriptions if the topics are to attract students' interest and enrollment. The full descriptions for the current seminars may be found at the website,[4] but some abbreviated examples include:

Endurance (compares the college experience with Shackleton's legendary Antarctic expedition)

Solar Racers (explores this sustainable energy resource through hands-on activities, research and case studies)
Green Engineering: From Nuts & Berries to Nuts and Bolts (involves students in community-based problem solving using green design)
Toy FUNdamentals (examines the history of toys, marketing and toy design, including a prototyping project and field testing at a local daycare center)
Highway Accident Reconstruction and Engineering (involves the study of forensic accident reconstruction, collision physics, design and safety)
Bits and "Bites" (deals with interfacing and programming of microcontrollers to operate a robotic insect and other devices)
Introduction to Digital Music (applies digital signal processing to music synthesis and computer audio formats)
Weird, Wild and Wonderful Materials and Devices (investigates the exploitation of unique properties and behavior of engineered materials to serve as the sensors, transducers and actuators in common and not-so-common devices and appliances)
How Good Engineers Solve Tough Problems (critiques classic and novel ethical cases from industry and academia through small group discussions and problem-solving)
Managing the Real (Un)Predictable World (explores operations research techniques, including probability and its application to quantitative decision making)

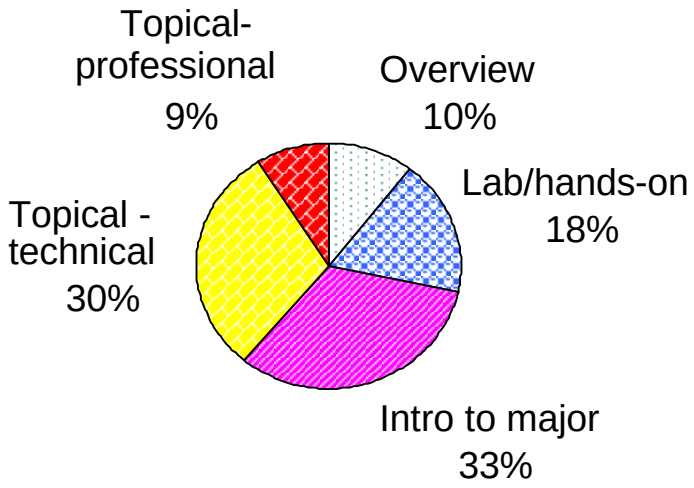

Figure 1. Distribution of seminars among various types and primary objectives, AY 1999-2000
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V. Conclusions

So far, a total of 58 faculty have participated in the instruction of seminars, or 21% of the 270 full-time, continuing faculty in the College. Theoretically, if all faculty were involved equally in the program, each member of the faculty would volunteer or be called upon to teach a section only once in every five years. In practice, not all faculty have the inclination or time to devote to the first-year program, and many of the faculty who have participated report that they found the experience (in some cases, unexpectedly) enjoyable and rewarding. The evidence so far is that

sufficient interest can be generated to insure a reasonable rotation of the program's instructional duties so that it can be successfully scaled-up and sustained despite, or perhaps even capitalizing upon, the research-intensive environment of the College.

A companion paper at this conference will report on the ongoing assessment efforts. These include focus groups of instructors and students, evaluation of teaching effectiveness through questionnaires tuned to the seminar objectives and formats, a web-based survey instrument to evaluate student satisfaction as they near completion of a seminar, and follow-up with participants later in their studies to ascertain whether they still feel, in hindsight, that the seminars added value to their college experience. Since the College has taken an approach that contrasts with the more common, and arguably more efficient and consistent, "one-size-fits-all" format that most other colleges and campuses have recently adopted, it will be important to determine to what extent the diversity in seminar types impacts the variability in quality outcome.

An unanticipated benefit of the seminar program has been its attractiveness to prospective students and their parents. Questions during recruiting events pertaining to the programming available to students to help them choose a major and learn about engineering careers are increasingly common. In fact, they are so frequent, and the seminar program proved to be so responsive to these concerns, that a special brochure was printed for distribution to prospective students.

Bibliography

1. URL: http://www.psu.edu/ufs/gened.html; Final Report and Recommendations of The Special Committee on General Education, Penn State University (1997).
2. URL: http://www.la.psu.edu/laus/FYS-info-sheet.htm.
3. URL: http://www.psu.edu/bulletins/bluebook/$agmenu.htm.
4. URL: http:// www.engr.psu.edu/fys; First-Year Seminar Course Descriptions, College of Engineering.

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