

Initial Observations on Student Retention and Course Satisfaction Based on First-Year Engineering Student Surveys and Interviews

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Abstract

The College of Engineering at the University of Notre Dame will complete the third year of its new Introduction to Engineering course sequence at the end of the Spring 2003 semester. Retention statistics, student surveys and exit interviews conducted by faculty, engineering administrators and first-year student advisors have provided insight into the retention characteristics of first-year engineering intents. Some initial observations include the following: changes in the format and content of the material presented in the first semester appear to affect retention rates, particularly for women; women drop the course at a higher rate than men; and women appear both to enter engineering programs for reasons different than men and to express a lower level of confidence than men with respect to the technology-related skills and experiences they brought to the course. These observations have encouraged us to consider modifications to the course, continuing to focus on the primary goal of improving the quality of the learning experience, while also addressing student retention, particularly with regard to women. These observations have also encouraged us to refine our data collection to provide greater insight into how changes in the course structure and content affect retention.

Introduction

The College of Engineering at the University of Notre Dame has devoted significant resources to the development and implementation of a two-semester, six-credit-hour course sequence for first-year students intending to major in engineering as sophomores (engineering intents). Notre Dame's efforts arose from an identified concern over the quality of the first-year experience within the engineering curriculum. In an effort to assess how this course impacts the quality of the first-year experience, the College has conducted a number of student surveys and exit interviews. While these data have proven invaluable in assessing the overall impact of the course, they have also provided insights into student retention over the course of the first year. These insights have provided guidance with respect to such issues as whether:

the timing for presenting particular course material affect either the timing or the rate of student retention;

the topical content of the course affects student drops;

retention rates differ by gender; and

evidence exists indicating that factors outside of the first-year course experience impact differences in retention by gender.

After a test run with 25 first-year students in the 1999-2000 academic year, the College implemented the course sequence as a requirement for all first-year engineering intents in the 2000-01 academic year. Data collected over the first three years of administration of the course have enabled the College to consider the overall impact of the course on the quality of the learning experience, as well as the impact that changes to course timing and content have had on undergraduate retention. This paper presents an interpretation of initial results from data collection efforts, including an interpretation of surveys and exit interviews, in an effort to begin to address the issues listed above.

Description of the First-Year Course

Brockman *et al.*¹ present the details of the motivation and development of the new first-year course. In addition, the course web site explains the basic structure and content of the course (www.nd.edu/~engintro). It should be noted at the outset that the course development process focused on improving the learning experience for engineering intents, and did not directly address retention issues. Improving the learning experience remains the primary motivation for any improvements to the course.

The course, identified in Notre Dame's system as EG 111/112, currently consists of four projects, or modules, that expose students to a wide array of engineering disciplines. The modules advance specific learning objectives by providing opportunities for students to work in team environments, exposing students to a range of engineering disciplines and the interplay among those disciplines, and developing basic engineering skills such as computer programming. The overall course structure supports these objectives through class-wide lectures, small-group recitation sections of 25 to 30 students, and small-group activities based in Notre Dame's Engineering Learning Center (www.nd.edu/~englearn). Students work individually, on homework assignments and exams, and as members of a team, on the course projects.

The College offers this course within an overall academic structure at Notre Dame that imposes a number of constraints. Notre Dame engages in an "intent-blind" admissions process. While students might indicate a proposed major on their applications, the Admissions Office bases its decisions on student credentials, with no consideration of any proposed major. Further, the College of Engineering has no control over whether individual students may enroll in the college beginning in their sophomore year. First-year students begin their academic careers within and receive all first-year academic advising through the First Year of Studies, an academic unit designed to assist students in the transition from high school to college. All first-year students must complete particular requirements outlined by the First Year of Studies, based on initial

interest in a particular major. Finally, the curricula designed by each department within the College of Engineering offer little flexibility in terms of the sequence of courses. Consequently, students who do not complete EG 111/112 in the first year but decide later to pursue an engineering degree may experience difficulty in meeting all of the academic requirements within four years. As a result, the introductory course attracts a certain number of students who might not necessarily have a strong interest in engineering, but who nevertheless enroll to give themselves greater flexibility in selecting a major prior to entering their sophomore year.

Course grades for EG 111/112 result from a combination of individual performance on homework assignments and examinations, along with an assessment of team performance on each of the four projects. Faculty base team-performance assessments on written reports submitted during the development of the project, along with an evaluation of how well the final project meets required constraints. Considerations such as class participation, section quizzes and the quality of individual student contributions to each project may also factor into each student's final grade.

The EG 111/112 course sequence debuted in the Fall 1999 semester with a test group of 25 first-year students. Subsequently, initial enrollments in EG 111 have ranged from 350 to 400 students. At the end of the Spring 2003 semester, the College will have three years of experience with the course, with approximately 800 students completing the two-semester sequence.

Over the course of the three years that Notre Dame has required all engineering intents to take the EG 111/112 sequence, the basic four-project structure has remained the same. Some modifications to the timing and manner of delivery of various elements of the course have occurred, however, based on assessments of student performance, student satisfaction as expressed in survey data, interviews and questionnaires, and faculty assessment of the projects. Two significant changes between the first administration of the course (2000-01) and the second administration (2001-02) include: altering the course content to include more technical and less "altruistic" content on such topics as the nature of engineering, the history of engineering and the role of engineers in society; and moving the Matlab programming component from the spring semester forward to the fall semester. Changes between the second administration (2001-02) and the third administration (2002-03) include increased technical content in the lectures and better defined expectations for progressing through each project module.

Enrollment, Retention and Performance

Enrollment and retention data (Table 1), collected for each of the academic years 2000-01 through 2002-03, indicate that the number of students enrolled in the course has remained quite consistent over the past three years.

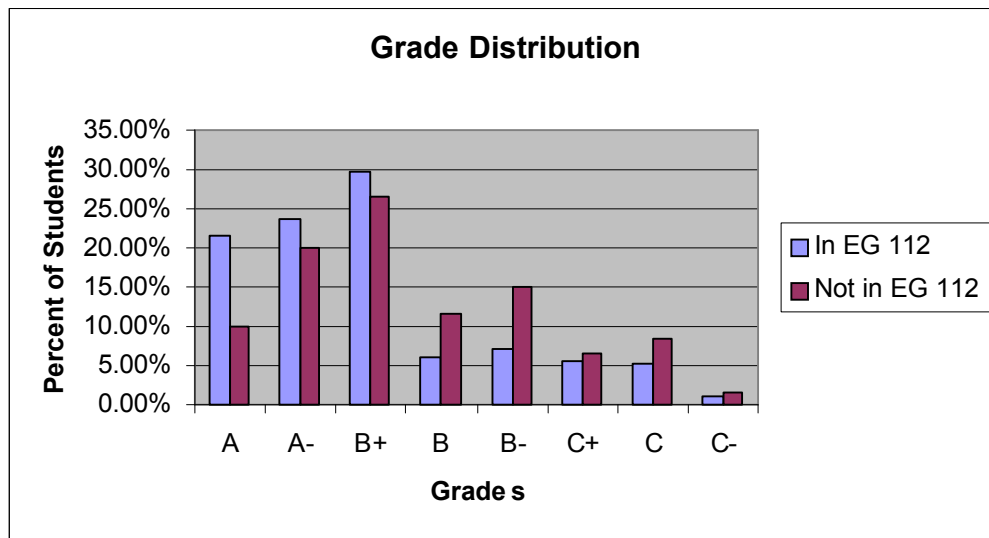
Table 1
Three-Year Enrollment and Retention Data

	2000-01 offering		2001-02 offering		2002-03 offering	
	Total	% Retained	Total	% Retained	Total	% Retained
Started EG 111	385		370		384	
Finished EG 111	358	92.99 %	323	87.30 %	331	86.20%
Started EG 112	296	76.88 %	273	73.78 %	270	70.31%
Finished EG 112	278	72.21 %	267	72.16 %		

These data require some context for interpretation. The enrollment numbers at the start of EG 111 and EG 112 each semester reflect the number of students enrolled after the last date at which students may add classes. The enrollment numbers at the end of each course reflect the number of students who earned a grade for the class. Finally, the numbers include some sophomore transfer students who elect to take the class. Since sophomore transfer students are not necessarily required to take the course, some may opt out after EG 111, while others might take only EG 112. Hence, the retention numbers for the rows titled "Started EG 112" and "Finished EG 112" are conservative in the sense that some of the students who did not enter (or complete) EG 112 after completing EG 111 may nevertheless remain in the College of Engineering.

It is perhaps important to note that this course was not designed as a "gatekeeper" course. Rather, course developers focused on providing a quality engineering educational experience and on providing students with information needed to make a sound choice of major during the spring semester of the first year. Grade data from the Fall 2002 semester support the observation that this course has not evolved into a gatekeeper course. For the 61 students who elected not to enroll in EG 112 for the Spring 2003 semester, two-thirds received grades of "B" or better in EG 111, and more than one-half of these 60 students earned a "B+" or better. The 270 students who did enroll in EG 112 performed somewhat better, with eighty percent having earned a grade of "B" or better, and seventy-five percent a B+ or better. Figure 1 depicts the grade distribution, among those who completed EG 111, of those who enrolled in EG 112 versus those who opted not to enroll in EG 112.

Figure 1
EG 111 Final Grade Distribution (Fall 2002)



Enrollment and retention data (Tables 2 through 5) also provide some indication of student satisfaction with the course and help us to understand the impact of changes made to the course from year to year. As indicated in the student-drop data presented in Table 2, most drops occur at some point before the start of EG 112. For the second and third administrations of the course, in particular, we also observe a fairly even split between those who choose not to complete EG 111 and those who choose to complete EG 111 but do not enroll in EG 112. The drop rates decrease significantly during EG 112.

Table 2
Three-Year Drop-Rate Data

	2000-01	offering	2001-02	offering	2002-03	offering
	Total Drops	% Drops	Total Drops	% Drops	Total Drops	% Drops
Dropped during EG 111	27	25.23%	47	45.63%	53	46.90%
Completed EG 111 but did not take EG 112	62	57.94%	50	48.54%	60	53.10%
Dropped during EG 112	18	16.82%	6	5.83%		

Enrollment and retention data also provide insight into the retention of female students versus the retention of male students. Tables 3 through 5 present the data for men and women in each administration of the course since 2000-01. One of the primary observations that can be made from these data is that women discontinued the course sequence at a rate substantially higher than men.

Table 3
Retention - 2000-01 Offering

	Total	% Retained	Women	% Retained	Men	% Retained
Started EG 111	385		114		271	
Finished EG 111	358	92.99%	104	91.23%	254	93.73%
Started EG 112	296	76.88%	80	70.18%	216	79.70%
Finished EG 112	278	72.21%	73	64.04%	205	75.65%

Table 4
Retention - 2001-02 Offering

	Total	% Retained	Women	% Retained	Men	% Retained
Started EG 111	370		82		288	
Finished EG 111	323	87.30%	58	70.73%	265	92.01%
Started EG 112	273	73.78%	47	57.32%	227	78.82%
Finished EG 112	267	72.16%	47	57.32%	220	76.39%

Table 5
Retention - 2002-03

	Total	% Retained	Women	% Retained	Men	% Retained
Started EG 111	384		106		278	
Finished EG 111	331	86.20%	82	77.36%	249	89.57%
Started EG 112	270	70.31%	66	62.26%	204	73.38%

Examining these data for women and men separately, as presented in Tables 6 and 7, indicates that various changes to the course may have affected men and women differently. Interestingly, the retention of women has varied to a greater degree than the retention of men. In particular, during the second offering of the course, women dropped at a higher rate than during the first offering of the course. This drop in retention appears to have reversed somewhat during the third offering, but year-end data are not yet available to assess the overall impact of the course. In contrast, the retention rates for men have remained relatively constant across all three years.

Table 6
Retention of Women

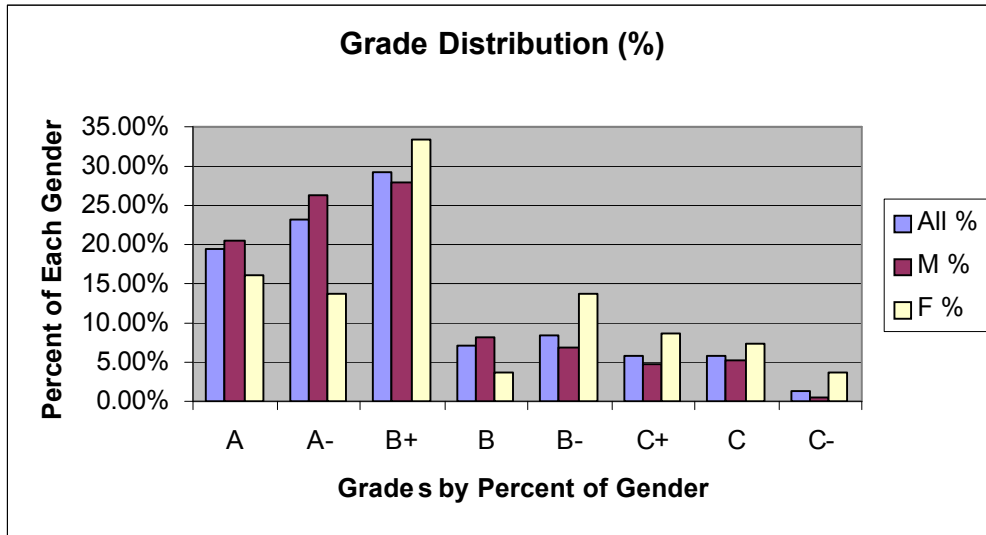
	2000-01	offering	2001-02	offering	2002-03	offering
	Total	% Retained	Total	% Retained	Total	% Retained
Started EG 111	114		82		106	
Finished EG 111	104	91.23%	58	70.73%	82	77.36%
Started EG 112	80	70.18%	47	57.32%	66	62.26%
Finished EG 112	73	64.04%	47	57.32%		

Table 7
Retention of Men

	2000-01	offering	2001-02	offering	2002-03	offering
	Total	% Retained	Total	% Retained	Total	% Retained
Started EG 111	271		288		278	
Finished EG 111	254	93.73%	265	92.01%	249	89.57%
Started EG 112	216	79.70%	227	78.82%	204	73.38%
Finished EG 112	205	75.65%	220	76.39%		

Performance data, as indicated by the grades assigned at the end of the EG 111 course for the Fall 2002 semester, differ for male and female students. As shown in Figure 2, women received a disproportionately smaller share of grades higher than "B+". The reason for this discrepancy is not yet fully understood and is a topic for continuing study.

Figure 2
Grade Distribution by Gender (EG 111 - Fall 2002)



Student Self-Assessments

As noted in the previous section, the retention and grades associated with EG 111/112 differ by gender. In an effort to understand better the meaning of and reasons for this difference, we reviewed student responses to a detailed, multiple-choice entrance survey that students have completed voluntarily for each of the three administrations of the course. The survey aimed to: identify the source of student interest in engineering; highlight attributes in the collective backgrounds of the students that might indicate potential student success in engineering; and assess student self-confidence in the skills they bring to the program, both in technical areas such as computer programming and in non-technical areas such as communication and the ability to work in a team.

Analysis of these data has yielded insight into specific differences between male and female students in the areas of motivation for studying engineering and in preparation for the course curriculum.

Pertinent to the discussion of gender differences, one section of the survey asks students to rate the influence of each of nine factors on the decision to study engineering:

1. student interest in engineering;
2. student interest in science and mathematics;
3. advice from a guidance counselor or advisor;
4. advice from parents;
5. advice from friends;

6. advice from ROTC (only for students in the ROTC program);
7. potential for making a positive contribution to society;
8. career opportunities available after graduation; and
9. salaries in the profession.

Students had five options for evaluating each of these factors:

1. a very important, positive factor;
2. a somewhat important, positive factor;
3. little influence;
4. considered and could be a mild drawback;
5. considered and could be a serious drawback.

While men and women answered similarly when ranking a number of these factors, significant gender differences were observed in three areas, as shown in Table 8:

Table 8
Influences on Decision to Study Engineering by Gender

Source of Influence	Very or Somewhat	Important
	Men	Women
Advice from guidance counselor or advisor	16 %	33 %
Advice from parents	48 %	63 %
Potential for making positive contribution to society	21 %	34 %

It appears that women, to a greater extent than men, may have considered studying engineering and decided to enroll in EG 111 on the advice of others. Additionally, women, to a greater extent than men, express some attraction to engineering because of its potential to enable them to make a positive contribution to society.

In another section of the survey, students assessed their own competence and confidence in various areas. Women and men gave themselves substantially similar ratings in questions asking about their ability to communicate ideas orally, think analytically, create original ideas and solutions, and function effectively in a team. Women did, however, tend to rate themselves lower than men on questions dealing with their perception of their ability to engage in various technology-related tasks. The only area in which women ranked themselves noticeably higher than did the men was in their ability to write effectively. Table 9 highlights a sampling of the areas of significant difference.

Table 9
Self-Assessment of Various Abilities

Ability	Good or	Very Good
	Men	Women
Run applications on a computer	77 %	44 %
Write computer programs	33 %	9 %
Solve technical or mechanical problems	69 %	38 %
Write effectively	71 %	87 %

While it is premature to make direct connections between the gender differences indicated on these entrance surveys and the gender differences in retention and performance observed in the course, these data indicate that substantial differences may exist between male and female students in terms of: the motivation for entering the engineering curriculum as a first-year student at Notre Dame; the source of advice for entering the engineering curriculum; and self-confidence in and exposure to skills related to programming and working with mechanical devices.

Anecdotal Information

Anecdotal information has also aided our understanding of the other data collected during the administration of the course. Interviews of all students opting to drop the course during the semester have provided particular value. Beginning in the Fall 2002 semester, these students participated in interviews by phone or in person, or completed an e-mailed questionnaire aimed at determining specific reasons for dropping the course. Approximately half of the students who dropped the course responded to the request for an interview or completed the e-mailed questionnaire.

The responses varied during the course of the fall semester. Those who dropped early in the semester, specifically within the first two weeks, indicated that they had enrolled in the class to allow themselves greater flexibility when deciding on a major in the sophomore year, but quickly realized that they did not want to major in engineering. Their reasons included a concern over the workload, a desire for greater flexibility in scheduling upper-level courses and a stronger interest in other subjects.

For students who dropped in the third through fifth weeks, the women, in particular, indicated that they had enrolled in EG 111 on the advice of a parent or guidance counselor and had since decided that other majors would better suit their long-term goals. Many of these students also indicated that they likely would major in chemistry or biology and had medical school as a long-term goal. For students who dropped in the sixth week and beyond, however, most cited concerns with specific aspects of the course, including the amount of time spent on assignments and individual difficulties with the computer-programming component of the course. Most of

those who indicated difficulty with the programming component also indicated that they had not had any formal or informal computer-programming activities prior to taking EG 111.

Additionally, the director of the College's Women's Engineering Program (WEP) surveyed women students who remained active in EG 111 at the end of the Fall 2002 semester to determine their overall level of satisfaction with the course. Approximately 70 percent of women who completed EG 111 responded to this e-mail survey. Overall, these women expressed a high level of satisfaction with the course. Based on feedback from students who had dropped EG 111 during the semester, one question on this survey specifically targeted the computer-programming component of the course. A number of students expressed frustration with the computer-programming component, especially when comparing their abilities with others who seemed to grasp the information more quickly and thoroughly. Nevertheless, many of these students accepted the need to learn computer programming, much as they accept the need to learn calculus or chemistry, and did not view that aspect of the course as a hindrance in future studies.

Another question on the WEP director's survey addressed the group-project aspect of the course, based on an emerging body of literature that indicates that group projects may affect women differently, and perhaps less favorably, than men. Most of the women expressed satisfaction with the group-project aspect of the course. Several indicated that working in groups provided a good way to learn and understand some of the more challenging material presented during the course.

Primary Observations

Study of the data collected in the course of administering EG 111/112 over the past three academic years has led to three major observations:

1. Slightly more than 70 percent of students who begin EG 111 complete the two-course sequence. The greatest drop in retention occurs prior to the start of the second semester, with drops during the first semester distributed relatively evenly between those who drop during the semester versus those who drop at the end of EG 111. Of those who enroll in the EG 112, well over 90 percent complete the entire second semester of the course.
2. Retention rates for women throughout the EG 111/112 sequence are lower than retention rates for men. Data collected from the EG 111 entrance survey, along with anecdotal information gleaned from informal surveys of women and men who leave the course during EG 111, indicate that women, to a greater degree than men, decided to enroll in the course on the advice of others. Additionally, self-ratings by women tend to be lower than self-ratings by men in entrance surveys that explore various areas of technical expertise and experience. When explaining their reasons for dropping the course, women tend to express either frustration with their own performance in the course or a stronger interest in another subject area, while men tend to cite either concerns over the workload or a lack of interest in the subject. We have not yet established any causal

relationship between these gender differences on entrance/exit surveys or interviews and the observed bias in the retention rate.

3. The data suggest that changes in the course between the 2000-01 offering and the 2001-02 offering may have had a particularly significant impact on the retention of women. The data also suggest that changes in the content and presentation of the course may affect the timing of student decisions to drop. Course changes between the 2001-02 offering and the 2002-03 offering appear also to have impacted both the retention of women and the timing of student decisions to drop.

Follow Through

Notre Dame's College of Engineering created the EG 111/112 course sequence to improve the quality of the first-year learning experience for engineering intents and to incorporate a more learning-centered paradigm into the program. The availability of student response data has provided a valuable resource for assessing and planning the course sequence, as well as for identifying and addressing some critical retention issues.

Evaluation of the data has resulted in structural change in the College administration and has suggested areas for further inquiry. Significantly, the College has established a Women's Engineering Program and appointed a full-time director whose responsibilities include understanding the issues that affect the retention of women students and working to address those issues. We expect further study of the data to yield other recommendations for both the course and the College.

Continuously improving the quality of the learning experience remains a goal of the Course Leadership. Toward this end, collection and evaluation of student data will continue to be an integral and formal component of EG 111/112 planning and assessment.

References

1. Brockman, J.B., Fuja, T.E, Batill, S.M., "A Multidisciplinary Course Sequence for First-Year Engineering Students," 2002 ASEE Annual Conference and Exposition, Montreal, Quebec, Canada, June 2002.

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