

AC 2007-1862: FRESHMAN ENGINEERING STUDENT RESPONSES TO A PRE-COLLEGE PERCEPTION SURVEY

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Freshman Engineering Student Responses to a Pre-College Perception Survey

Abstract

Engineering educators are constantly modifying course offerings and course structure to meet the necessities of our society. One of the ongoing challenges is how to modify the initial contact with students that will encourage them to continue seeking a career in engineering. This involves student recruitment and retention. Our Fundamentals of Engineering and Computer Science (FECS) course at Wright State University has been in place for the past six years and has seen an increase in student retention from 45% to 70%. Improving this retention rate by raising the admission standards is not possible as we have an open enrollment policy set by the state. Therefore, to better understand our students and how they perceive themselves as they enter college, we have been collecting data for the past three years as they take their FECS course using a perception survey at the beginning of the course.

Data collected from the perception survey is the focus of this paper. The database consists of responses from 539 students enrolled in FECS from 2003 to 2005. The course is offered each quarter and results are compared between quarters, between years, and between quarters of each year. Data collected and presented includes the student perceptions on math and science preparation, self appraisal, outside help and teaming. Conclusions are also presented from analysis of the survey data on how our initial interactions with the students could be improved.

Introduction

Surveys in the literature have focused on how engineering students view their perceptions from pre-enrollment choices, to academic activities support, to why they dropped out. An in-depth analysis of attrition and retention reported on by Shuman, et. al. included five main areas, two at the freshmen level and three at the upper-departmental level.¹ At the freshman level those who transferred out or resigned, and those that left while on academic probation were studied. At the upper level those that transferred out in good standing, not in good standing, or went inactive were studied. The two main reasons that freshmen and upper classmen left their programs were due to developing a dislike or loosing interest in engineering. The reasons for this appeared to be dissatisfaction with their “science and math courses” and a “perceived lack of relevance of much of their course work.”

Another study by Amenkhienan and Kogan suggested that individual effort and involvement, peer interaction, and faculty contact had a positive impact on their academic performance.² This study involved 34 second year students in nine focus groups selected from 200 student volunteers. They were selected based upon gender, ethnicity, and GPA. Study habits, completing homework, willingness to seek outside help, study groups,

networking, and faculty teaching styles and office hours were found to be important for success.

A study by Besterfield-Sacre, et.al. involved seventeen engineering schools over a three year period involving approximately 7,000 students that measured student attitudes involving thirteen areas.³ Some of these which were: “General Impressions of Engineering,” “Perception of the Work Engineers Do and the Engineering Profession,” “Enjoyment of Math and Science Courses,” “Financial Influences for Studying Engineering.” They found consistent differences based upon the students’ engineering settings of private, teaching-focused, small, or urban institutions. There were two areas that related directly to the students’ perceptions of themselves; “Confidence in Communication and Computer Skills,” and “Adequacy in One’s Study Habits.” Students attending private or teaching-focused institutions appeared to have “lower self-assessed confidence in their communication and computer skills and their study habits.”

Most of our freshman engineering and computer science students come from the major metropolitan regions of the state. The majority are from the Dayton and Cincinnati areas with some from Columbus and Cleveland, and few from out of state or country. All freshmen are required to take our Fundamentals of Engineering and Computer Science course. This course is offered each quarter with enrollment limited to 90 per quarter. Enrollment is open to any student with a high school diploma. As a result we see students with a broad range of capability in math and science. Some are prepared to enter college calculus and others are taking remedial algebra. The course is designed for retention so it is taught using basic algebra and simple trigonometry. It has been in place for six years and we have seen retention increase to 70% from 45% before the course.⁴

The course consists of one 2 hour lecture and two 2 hour labs, a computer based lab and an instrumentation based lab. There are two lecture sections, five instrumentation labs, and four computer labs. The student learns about basic engineering tools such as data acquisition and analysis, test equipment, computer aided drafting, circuit and moment analysis, and gains computer skills in web searching, web page design, simulation, and communications. They also learn about themselves as a person and as a student, and actually design and build things. There are three teaming events which comprise 30% of their grade. There is also a major writing across the curriculum component which is a university program to increase student writing competence.

Each year we evaluate the course using pre and post questionnaires and student course evaluations and make content changes, how it is taught, and how it is tested. This is done to improve the students’ grasp of the scope of engineering and computer science and help them decide which discipline they wish to pursue. In addition, to better understand our students and how they perceive themselves as they enter college, we have been collecting data for the past three years using a perception survey at the beginning of the course. This paper reports on the analysis of that survey.

Methodology

The instrument used is shown in Figure 1.⁵

EGR 190- Pre-Survey of Student Perceptions – Fall 2006

As part of our continuous course improvement efforts, we are asking first year engineering students to provide some information about yourselves and your perceptions to be compared to your impressions and perceptions later this year.

1) How well prepared for the engineering undergraduate program do you feel you were as a result of your High School MATH courses?

1 _____ 2 _____ 3 _____ 4 _____ 5 _____

Very Well Prepared _____ Not prepared _____

2) How well prepared for the engineering undergraduate program do you feel you were as a result of your High School Science courses?

1 _____ 2 _____ 3 _____ 4 _____ 5 _____

Very Well Prepared _____ Not prepared _____

3) Compared to other college-bound students in your high school's advanced math and science courses, rate yourself on each of the following traits. Please give an accurate estimate of how you see yourself

1 _____ 2 _____ 3 _____ 4 _____ 5 _____

Highest 10 % _____ Average _____ Lowest 10 % _____

- a) _____ Drive to achieve
- b) _____ Leadership abilities
- c) _____ Competitiveness
- d) _____ Interpersonal skills
- e) _____ Ability to work cooperatively
- f) _____ Listening ability
- g) _____ Oral communication skill in English
- h) _____ Mathematical abilities
- i) _____ Ability to work independently
- j) _____ Self-confidence (social)
- k) _____ Self-confidence (intellectual)

4) We are interested in learning how entering freshmen feel about receiving tutoring or outside-of-class help. Please indicate the extent of your agreement with the following statements.

1 _____ 2 _____ 3 _____ 4 _____ 5 _____

Strongly Agree _____ Strongly Disagree _____

- a) _____ Getting help for my academic work could show a lack of ability or intelligence necessary to succeed at A & M.
- b) _____ People would think less of me if I succeeded in school only because I got help.
- c) _____ I would think less of myself if I got help with my schoolwork.
- d) _____ I would prefer that my professors not know I went for tutoring.
- e) _____ I would rather risk doing poorly on my own rather than succeed in school because I got help.

5) Please indicate the extent of your agreement with the following statements:

1 _____ 2 _____ 3 _____ 4 _____ 5 _____

Strongly Agree _____ Strongly Disagree _____

- a) _____ Working in small groups is better than working alone.
 - b) _____ I like my work best when I do it myself.
 - c) _____ I prefer tasks that allow me to work with others.
 - d) _____ The less I have to rely on others, the happier I am.
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Figure 1: Pre-Survey Instrument courtesy of Dr. Rita Caso

The survey consists of five main questions with answers based upon a five point Likert scale. Two involve high school preparation in math and science, one asks the students to compare themselves with other college bound students over eleven items, another looks at how they feel about getting help outside of class, and one looks at how they perceive themselves working alone or in groups. All of questions 3, and 5a and 5c were reverse scored.

This instrument was administered to our students at the beginning of each quarter for three years starting with the 2003-04 school year. After removing surveys that had incomplete responses we ended up with 539 complete surveys. We were interested in comparing answers between quarters within each year, between quarters between each year and totals for a year compared with the other years. To do this, mean values were considered and graphs were generated on the means to help visualize the results. The items for question 3, 4, and 5 were analyzed as a scale. Related to scales, details on the psychometrics such as internal consistencies or reliabilities and factor structure can be found in Graham.⁵ In addition we looked at correlations between questions.

Results

The following graphs show the responses to questions 1 and 2 by quarter, by year. For question 1, regarding high school preparation in math, it can be seen that for each quarter most of the students felt that their preparation was adequate with rankings above 3, (Figures 2, 3, & 4). However, looking at the lower end, it is interesting that as the students progressed their first year, those unhappy with the preparation increased their percent in rank 1.

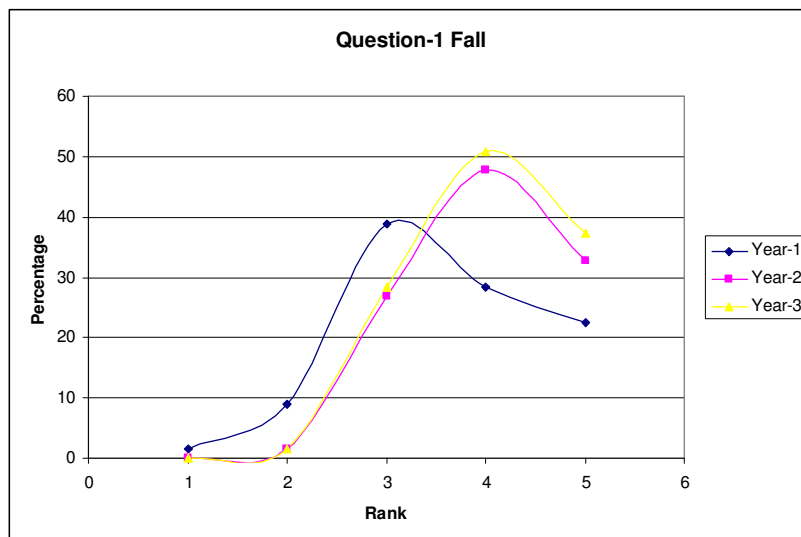


Figure 2: Three year rank answers in percent for math – Fall

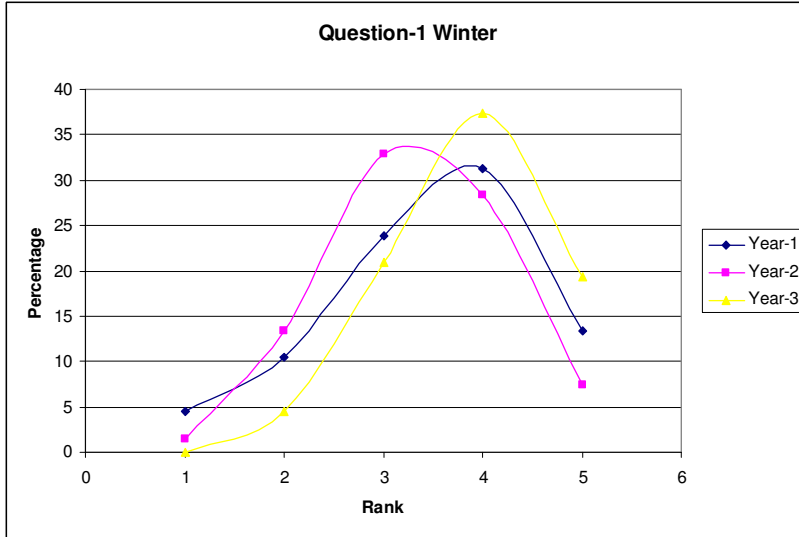


Figure 3: Three year rank answers in percent for math – Winter

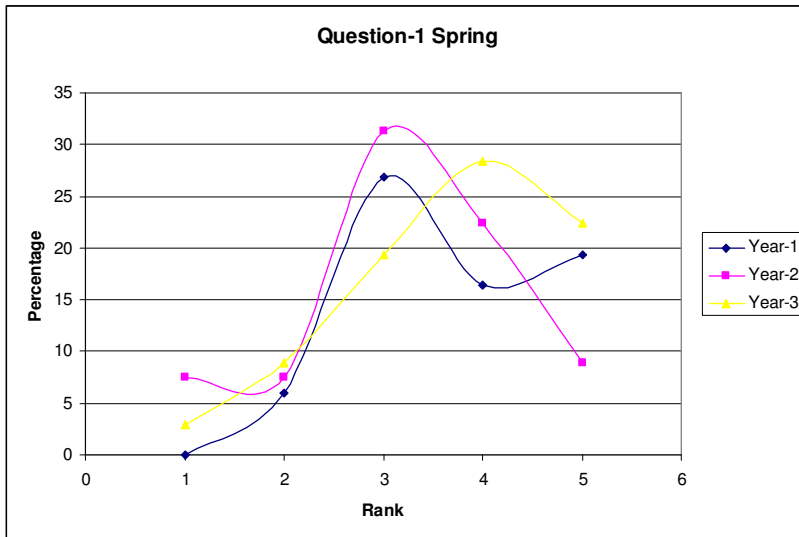


Figure 4: Three year rank answers in percent for math – Spring

For question 2, Figures 5, 6, & 7, regarding high school preparation in science, most felt their preparation was adequate but, as the year progressed, their ranking above three fell off. Again, those unhappy with the preparation showed an increase in percent below rank three as the year progressed. This was quite striking in the spring quarter, Figure 7.

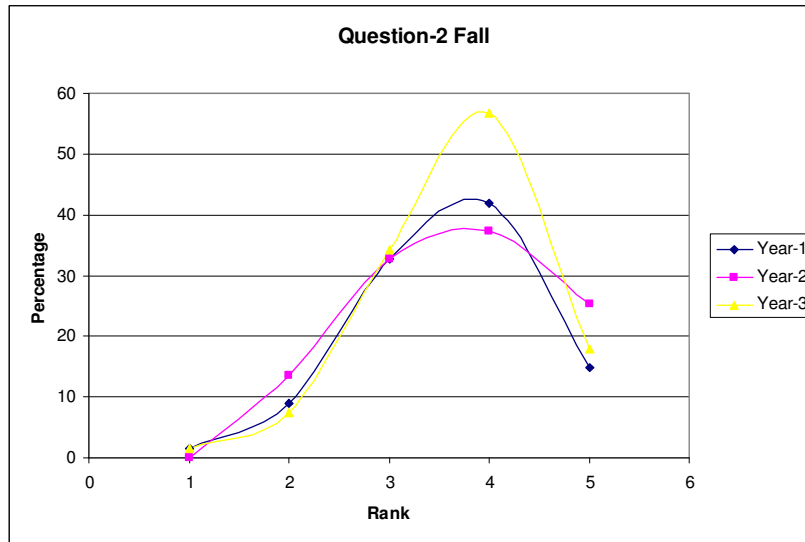


Figure 5: Three year rank answers in percent for science – Fall

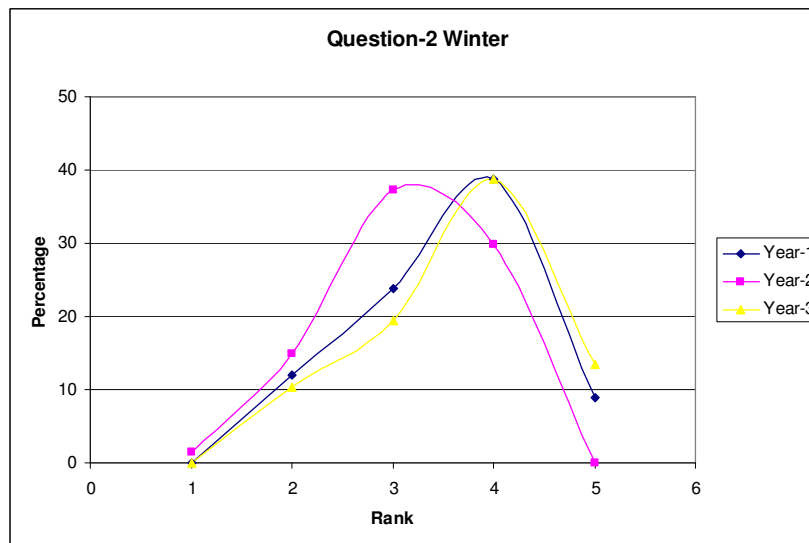


Figure 6: Three year rank answers in percent for Question 2 – Winter

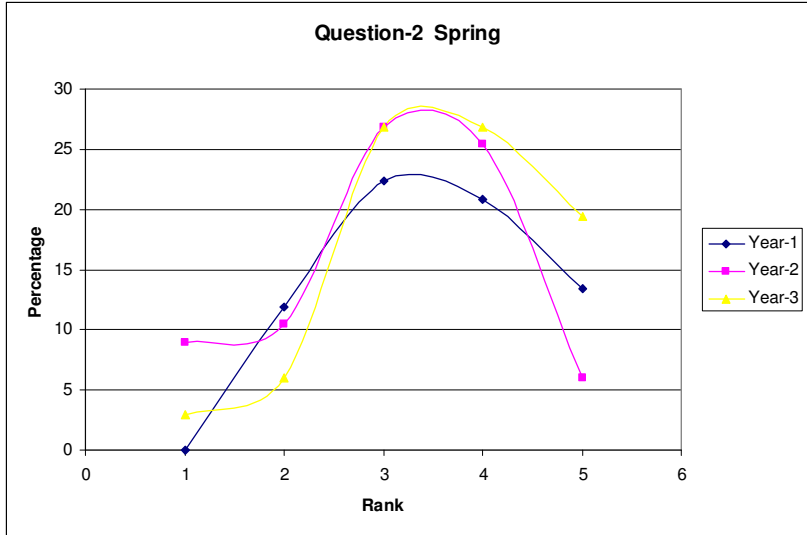


Figure 7: Three year rank answers in percent for Question 2 – Spring

Questions 3, 4, and 5 comprise the scales of self appraisal, outside help, and teaming. The means by quarter by year are given in the following figures.

Looking at Figure 8 it is obvious that students’ perceptions of how they compare to other college bound students is high. The mean rank for all quarters and years is right at four.

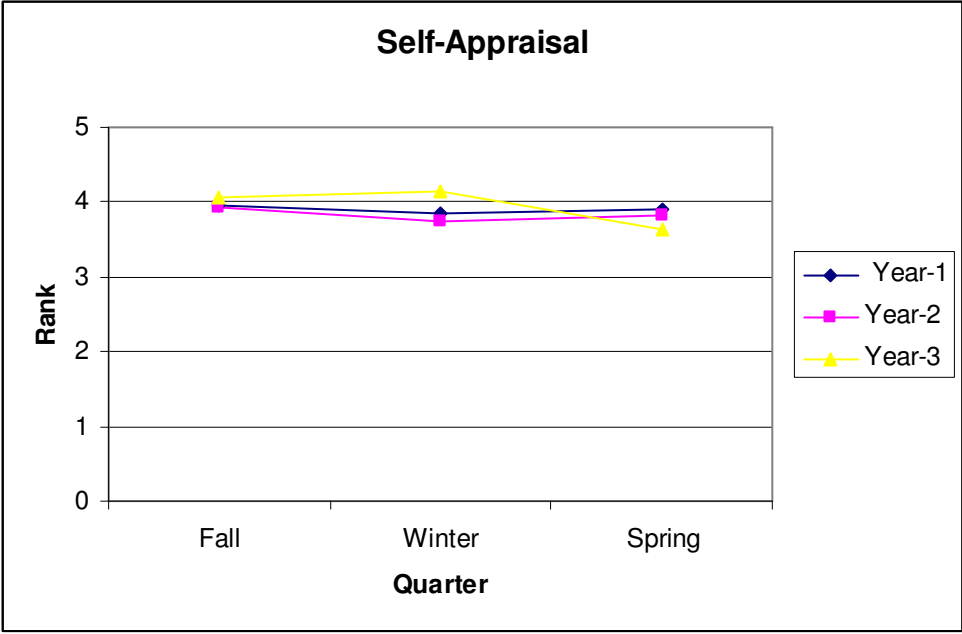


Figure 8: Scaled means for question three by quarter, by year

Students feel very positive about seeking outside help as shown in Figure 9. Remember that the answers were reversed scored from the question set.

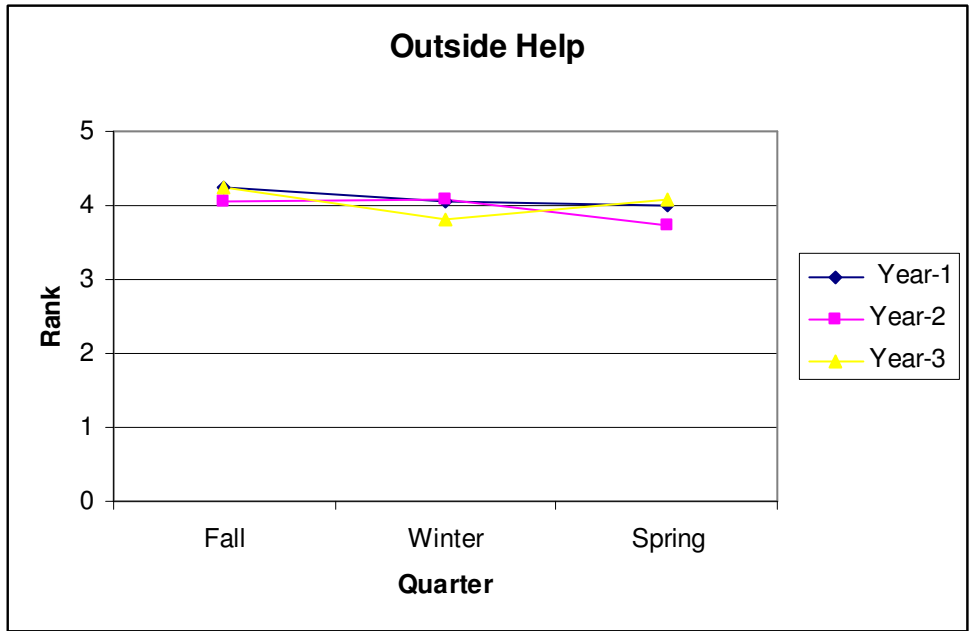


Figure 9: Scaled means for question four by quarter, by year

Willingness to work on teams showed variability between years and quarters, Figure 10. In year 1, the third quarter students felt less positive while in years 2 and 3 they were more positive.

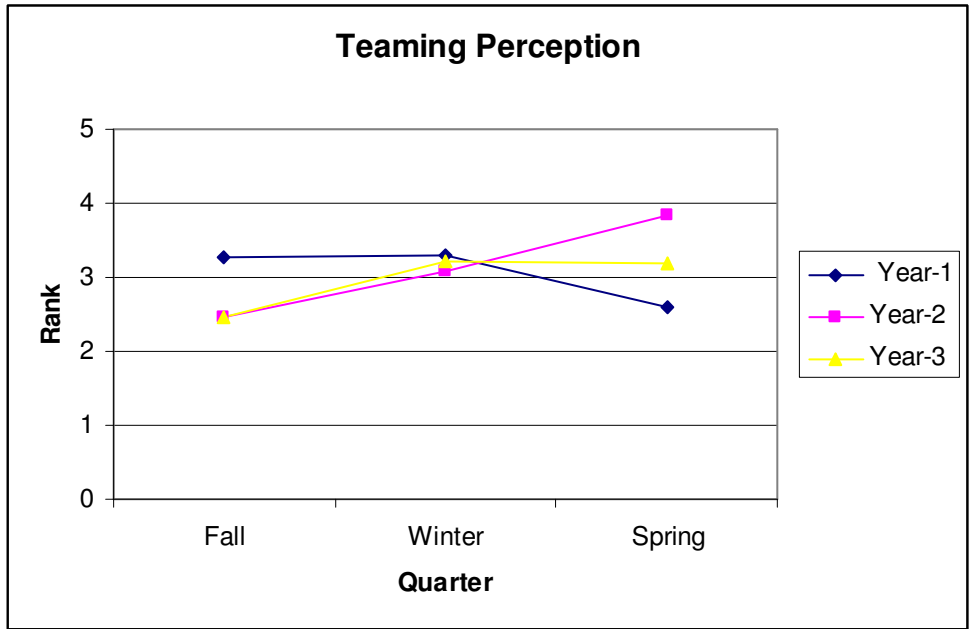


Figure 10: Scaled means for question five by quarter, by year

Correlations were found between questions 4 and 5. Those that answered positive for working in teams also answered positive for seeking outside help. The sum of the five items for question 4, a, b, c, d, and e were computed for each individual. This score represented individuals' attitudes towards seeking help. The sum of the four items for question 5, a, b, c, and d, were computed for each individual. This score represented their attitudes towards working in teams. There was a statistically significant correlation ($r = .25$) between the Attitudes towards Seeking Help scale (question 4) and the Attitudes towards Teamwork scale (question 5). This indicates that individuals that have more favorable attitudes towards seeking help have more favorable attitudes towards working in teams. It also demonstrates that individuals that have less favorable attitudes towards working in teams have less favorable attitudes towards seeking help. We conclude that some individuals that are reticent to work in teams are reticent because they fear asking for help for others. Thus, individuals that may benefit from group work the most (those that won't go to tutoring) may be the least likely to work in groups. This finding has implications for courses that include teamwork as a means for students to help each other.

Conclusions

Overall, this pre-survey on student perceptions has been interesting and informative. There was mixed reaction to how the students perceive their high school preparation for math and science. Most considered it adequate or better but as many as sixteen percent considered it below expectations in math. This fits our observation on the mix of math skills seen in the classroom and supports our teaching at a lower math level as our program is designed to increase retention by encouraging students' continuing progress towards being successful in engineering. This also points out the need to encourage more math and science in pre-college and freshman transition programs. In the college we have recognize the problems that math presents for freshman students and have started offering an innovative engineering math course taught by engineering faculty during the freshman year.⁶ A new engineering math course that addresses the specific needs of those with the lower math skills that we see in the FECS course is in development.

In how the students perceived their own capabilities vs. others they were very positive in terms of self awareness. This involves their drive, leadership, competitiveness, interpersonal and oral communication skills, and self-confidence among others. For the FECS course this is an indicator that the students are willing to tackle challenges. We see this in their response to meeting tasks that have short time frames. They simply dig in and get the job done. Their willingness to accept outside help was above average but their willingness to work on teams was only average. This indicates that there are a number of students who have not learned to team during their high school experience and having a teaming focus in the course is good. This also indicates that the students may benefit from having some lessons on how to team. There was a correlation found that showed that those more favorable to seeking outside help were also more inclined to work in teams. This information can be used to encourage more interaction by the faculty and upperclassmen with freshmen and increase tutoring activities within the college.

References

1. L. Shuman, C. Delaney, M. Besterfield-Sacre, H. Wolfe and A. Scalise, "Engineering Attrition: Student Characteristics and Educational Initiatives", 1999 ASEE Annual Conference & Exposition.
2. C. A. Amenkhienan, L. R. Kogan, "Engineering students' perceptions of academic activities and support services: factors that influence their academic performance", College Student Journal, Dec 2004.
3. M. Besterfield-Sacre, M. Moreno, L. Shuman and C. Atman, "Comparing Entering Freshman Engineers: Institutional Differences in Student Attitudes", 1999 ASEE Annual Conference & Exposition.
4. B. A. Rowley, K. Yelamarthi, and T. L. Bazzoli, "Teaming Activities in a Freshman Engineering and Computer Science Course Aimed Towards Recruitment and Retention", 2006 ASEE Annual Conference & Exposition.
5. J. A. Graham, R. Caso, "Measuring Engineering Freshman Attitudes and Perceptions of Their First Year Academic Experience: The Continuing Development of Two Assessment Instruments", 32nd ASEE/IEEE Frontiers in Education Conference, 2002.
6. N. Klingbeil, et. al., "Redefining Engineering Mathematics Education at Wright State University", 2006 ASEE Annual Conference & Exposition.