AC 2007-86: THOSE THAT LEAVE — ASSESSING WHY STUDENTS LEAVE ENGINEERING

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Those Who Leave—Assessing Why Students Leave Engineering

Abstract

This paper describes the results of a survey designed to uncover the reasons why students choose to leave engineering. The authors collected profile information hypothesized to be factors in retention or attrition (e.g. academic preparation, reasons for choosing engineering, participation in academic support and extracurricular activities) and measured the factors that influenced students' decision to switch out of an engineering degree program. The reported results are from a data collection effort from five institutions in the U.S comprising 120 students who left engineering during the 2003 – 2004 academic year.

Introduction

The latest figures[1, 2, 3] show that attrition rates in the sciences and engineering are still an area of concern. Retention numbers are notoriously hard to pin down, the primary issue being how the data are collected. Cohort studies, in which individual students are tracked for retention, are the most effective but also the most complicated and expensive to mount. Existing cohort studies indicate that engineering students experience relatively high attrition and underrepresented students are retained at a lower rate than majority students.[4] (Women typically are retained at rates similar to white men once they are in the major.[5]) A National Center for Educational Statistics (NCES) longitudinal study of first-year S&E students in 1990 found that fewer than 50 percent had completed an S&E degree within five years.[3] Furthermore, retention of engineering students is a primary goal of Women in Engineering (WIE) and Multicultural Engineering (MEP) programs.

Understanding why some students leave engineering to study another discipline at their university is an important factor in addressing low retention. Studies from Seymour and Hewitt[6] and Brainard and Carlin[7] provided our communities with results essential to developing an understanding of why students from those institutions during that time period chose to leave engineering. However, WIE, MEP, college of engineering administrators and faculty have an ongoing need for these data from their own institutions and the engineering education community has a need for current data to understand what factors precipitate students transferring out of engineering. This paper reports the results of a multi-institution study using a newly developed instrument from the NSF-sponsored AWE project (AWEonline.org) for gathering data from students who have transferred out of engineering about their reasons for doing so. Results are discussed within a framework of retention in general, and in engineering and the sciences in particular.

Background and Related Literature

Figures[1, 2, 3] show that attrition rates in the sciences and engineering are still an area of concern. Retention of engineering students is a primary goal of most WIE and MEP programs. WIE and MEP programs focus primarily on creating support activities to retain students, often implementing career and skills development initiatives. Understanding what influences the decision by students to switch from engineering to another field of study can provide important input into program development. It is important to gather data about who non-persisters are, how they experienced engineering, and what influenced their decision to leave. Identifying the factors that contribute to these decisions to leave is an important focus area for not only WIE and MEP programs but also engineering units in general.

Brainard and Carlin[7] summarize some of the important findings in this area of inquiry. Seymour and Hewitt[6] in their comparative study of science students who persist and those who do not found that there were no real differences in the factors of high school preparation, ability, or effort expended in their coursework between students who remain and those who switch. These results have been confirmed to apply to women science engineering students by other studies[8.9] Seymour and Hewitt also identified two categories of students who leave science / engineering programs: those who become bored or disappointed with the curriculum and those who feel they must leave because of a loss of academic self-confidence in the competitive environment. Further, Seymour and Hewitt found that women and students of color – marginalized populations – were in this second category.

Adelman's[10] ground breaking report of men and women in the engineering path analyzed the path that engineering students followed to both cross an initial "threshold" of studying engineering as well as completing an engineering degree where the "path" is defined in terms of actions and choices as recorded on high school transcripts, test scores and surveys of a nationally representative sample. This research methodology is in contrast to ones, such as Seymour and Hewitt[6] that directly ask students to self-report their experiences and the factors that influenced their decisions. "Migrants" – those students who began an engineering curriculum but left before completion – differed in the following ways:

- Women migrants performed statistically significantly worse than male migrants on the SAT/ACT.
- Women migrants performed statistically significantly worse than women who completed an engineering degree in a constructed measure of academic performance based upon GPA in University-level academic courses and high school class rank.

Overall, Adelman[10] and researchers McIlwee and Robinson[11] observe that for women students in engineering "only the academically strongest are likely to survive" (p. 75).

These studies provide important baseline data regarding this issue however, they do not provide the overall WIE / MEP and engineering education community with a tenable means for collecting similar data for undergraduate students that leave engineering. Although Seymour and Hewitt's[6] interview protocol could be adapted from the original science student audience to engineering students, the feasibility of collecting and doing high quality analysis of such qualitative data is doubtful given the labor intensity and required skills of such analysis – neither of which are likely to be present in WIE, MEP or overall engineering unit staffs.[12]

Additionally, and perhaps more important, all of these studies are somewhat dated. We say this not as a criticism – these studies were and are critically important in our field. However, the students who participated in these studies arguably experienced different high school environments and curricula, different ratios of women to men in science and mathematics pre-college courses, and different social norms and expectations than students – both male and female – do today. And some more recent research reports different findings: Mau,[13] in a six-year study that followed eight graders who professed intent to pursue science and engineering careers, found that the only reliable predictors for persistence across race/ethnicity and gender were academic preparation and math-self efficacy. All point to a continuing need for current data collection using a reliable and valid predominantly quantitative instrument. The AWE Students Leaving Engineering instrument is designed to meet this need. The authors make this instrument (available for download on AWEonline.org) and the initial data available so that MEP, WIE and engineering administrators can use it to design retention programming. More important, such data can be used to create a case for making changes in the engineering education curriculum and extra curricular activities that will alleviate the legitimate problems that students encounter.

Research Questions

We explored the following research questions in our data analysis:

1. What are predominant factors in students' decision to leave engineering? Are there differences by GPA? Gender? Race/ethnicity?
2. Are there relationships between perceived quality of high school preparation and retention? Between level of confidence at entry and decisions to leave?
3. Is there a relationship between students' sense of community and their decision to leave?

Methodology

Subjects

During spring 2004, preliminary data using an online version of the AWE Students Leaving Engineering instrument were collected from 120 students at five institutions: Penn State University (PSU), Georgia Institute of Technology (GT), University of Louisville (U. Louis.), University of Texas Austin (UT-A) and the University of Arizona (U. Ariz.).

Respondents were female students at our five participating institutions (one institution also collected data from males) who had already transferred from engineering or who had stated their intention to transfer from engineering. Table 1 shows the gender distribution of the students who responded.

	Gender		Total
	female	male	
Georgia Institute of Technology	36	0	36
Pennsylvania State University	19	33	52
University of Arizona	8	0	8
University of Louisville	9	0	9
University of Texas-Austin	14	0	14
Total	86	33	119

Table 1: Leaving Engineering Survey Respondents

These programs collectively represent a variety of years of experience for WIE directors and student body characteristics that provide a women engineering student sample that is largely representative of undergraduates studying engineering in the United States. Seventy-two percent (n = 87) of the student sample consisted of women and 28 % (n = 33) were men (all from PSU). There were 21 minorities in the sample, 16 women and 5 men. All but six of the students enrolled in college directly after high school and spent an average of 13 months in engineering before transferring out. Most enrolled between 2000 and 2003 (11 enrolled in 1999).

Procedures

Directors of the WIE programs at each institution identified students who had recently transferred out of engineering. Procedures for identifying these students included the following:

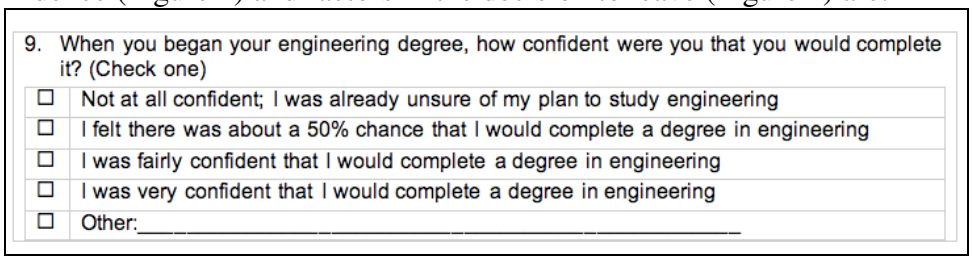
- Accessing data from an institutional office that tracks which students move from one academic unit or college to another.
- Accessing data from an engineering office that collects student requests to move from one academic unit or college to another.
- Manual comparison of lists of students enrolled in a prior year to those enrolled in the current year.

The various institutional methods for identifying students transferring out of engineering did not, in fact, identify *all* leavers. In some cases, institutions did not track students who were leaving the institution all together, or the engineering unit only tracked students transferring to selected colleges (e.g. business or arts and sciences), and clearly only PSU identified male students for this data collection. This is acceptable only because this was a pilot data collection process; these procedures will be made more robust and complete for subsequent data collection efforts.

Once identified, these students received an email explaining that the institution wished to gather data on their decision to transfer out of engineering. The online nature of the instrument allowed respondents to have access to the instrument whether they were on campus or not.

Instrument

The AWE Students Leaving Engineering (SLE) instrument is designed to meet the need for a quantitative instrument to collect data on the reasons engineering students decide to transfer out of engineering. In addition to gathering basic demographic data (e.g. engineering major student intended to complete, University GPA, et.) the instrument gathers data on the following topics: reasons for initially pursuing an engineering major, high school preparation, intended transfer destination (e.g. which college, work, military), career plans, participation in college extracurricular activities, factors that impacted respondents decision to leave engineering including a rating of the significance of each contributing factor. Sample questions related to level of confidence (Figure 1) and factors in the decision to leave (Figure 2) are:


9. When you began your engineering degree, how confident were you that you would complete it? (Check one)

- ☐ Not at all confident; I was already unsure of my plan to study engineering
- ☐ I felt there was about a 50% chance that I would complete a degree in engineering
- ☐ I was fairly confident that I would complete a degree in engineering
- ☐ I was very confident that I would complete a degree in engineering
- ☐ Other:_____

Figure 1. Question asking student to describe level of confidence in completing degree

18. The following is a list of factors that may have influenced your decision to transfer out of engineering. For each factor choose a number between **0** and **4** to indicate the degree to which that factor influenced your decision to leave engineering where **0** = **Not a Factor** and **4** = **A Significant Factor.**

	Not a Factor		A Factor But Not Significant		A Significant Factor
a. Money: loss of scholarship, financial aid, or other financial reasons	0	1	2	3	4
b. A non-engineering career would be more fulfilling to me	0	1	2	3	4
c. Did not feel as if I belonged in engineering	0	1	2	3	4

Figure 2. First part of question related to factors influencing decisions to leave engineering.

To create the instrument, we reviewed existing instruments for students switching majors and the interview protocols that were used in qualitative studies such as Seymour and Hewitt.[6] Other instruments, such as the ACT "Withdrawing / Non-returning Student Survey" [14] is designed to provide "an in-depth look at students' reasons for leaving college before completing a degree or certificate program" rather than for students who persisted in college but not in a specific major. The ACT instrument is not directly appropriate for our target student audience, however the reasons students have for withdrawing from college (e.g. financial, adequacy of departmental and university services) may also be contributing factors that may influence a student's decision to transfer from one college to another. To further inform instrument development we reviewed results of Seymour and Hewitt's[6] study on why students transfer out of science degrees. The resulting instrument incorporates their results and is supplemented by work that has specifically addressed the factors that influence retention in engineering. [10,7,15]

Results and Discussion

The following are the most pertinent results from these AWE-SLE data. We examined data for gender and race/ethnicity differences as well as correlations between factors measured in the instrument that might show behavior patterns for these students who had left (e.g. level of high school preparation and their reasons for leaving).

- 95% of students were "traditional" college students and had just graduated from high school prior to coming to the university.
- Self-reported University GPAs ranged from 1.82 – 4.0. The mode for the distribution was 3.0 with a frequency of six – indicating that many of these students had relatively good grades. There was no significant gender difference on the GPAs ($t(117) = .025$, $p > .05$), nor were their significant differences among institutions ($F(4, 113) = .978$, $p > .05$).

Because high school preparation has been hypothesized to be an important factor in retention,[16,13] we asked students about their perceptions of their own preparation. Most students (n = 69, 58%) reported that their high school coursework had prepared them to be successful in an engineering curriculum and although the male respondents felt more positive about their high school preparation (69% males responding "yes" versus 54% of females) the difference was not statistically significant. It should be noted, however, that a significant number of respondents answered "no" and in an open-ended follow up question, 47 open-ended question respondents (all of whom responded "no" to the prior question) cited poor high school preparation and recognized and articulated a need for better preparation for the rigors of college in general and

engineering specifically as factors in their decisions to leave engineering. Example responses included:

> *I think that it [high school] did not teach me in the reality of college and the difficulties accompanied by it. –Latina*
>
> *Did not reflect the type of work or the amount of work that one encounters in their first year of engineering.—Caucasian Male*

Although these students do not reflect the majority of respondents, it is important for researchers and practitioners alike to give credence to such comments in order to understand the entire set of factors that may be impacting engineering retention.

We further explored their high school preparation by asking respondents about advanced placement (AP) or honors courses completed in high school. In all cases female students had taken significantly more of these courses than male respondents. Chi square tests found significant differences between male and female respondents for computer science ($X_{(1)}$ =8.365, p<.05), chemistry ($X_{(1)}$ =4.681, p<.05), and English ($X_{(1)}$ =8.004, p<.05).

We asked students to reflect back on their level of confidence in completing an engineering degree when they began their study. Paired t-tests showed a statistically significant difference between males and females (t = -3.570, p<.01) with males being *less* confident than females. This significant difference held when we ran the test for only men and women at Penn State (the source of all the male respondents) (t =-2.944, p < .01). In contrast there was no difference between males and females in their responses to their confidence in completing *any degree* at their current institution.

Table 2 shows students' reasons for initially choosing to study engineering. Reasons for majoring in engineering were well distributed over the categories, with being good at math and science and desiring a well-paid job as the most frequently selected. These reasons reflect a similar distribution to those found by Seymour and Hewitt[6]—especially the high frequency of students choosing engineering because of their math/science ability. The relatively low number (women, 18.6%; men 24.2%) who selected "like work that engineers do" is notable. Seymour and Hewitt[6] and Adelman[10] comment on the lack of understanding of what engineers do as being a factor in both poor decisions to study engineering or science initially as well as recruiting potential students into engineering. Male and female responses were much more similar than different with Chi-square tests finding gender differences only for "Like to build and/or fix things, or solve problems" ($x_{(1)}$ = 6.594, p < .05). A higher percentage of males chose this item (women, 46.5; men, 72.7%). These results support the idea that the emphasis on the "tinkering" aspect of engineering found in many brochures and web pages may, in fact, be counterproductive in attracting girls to engineering[17,18].

	Female (86)		Male (33)		Total (119)	
	Frequency	%	Frequency	%	Frequency	%
Good at math or science	65	75.6	27	81.8	92	77.3
Like to build and/or fix things, or solve problems	40	46.5	24	72.7	64	53.8
Participated in engineering camp or workshop that influenced me	9	10.5	2	6.1	11	9.2
High school advisor or teacher suggested it	21	24.4	7	21.2	28	23.5
Wanted to be able to get a well-paying job after I graduate	55	64.0	25	75.8	80	67.2
Not sure	9	10.5	1	3.0	10	8.4
Like work that engineers do	16	18.6	8	24.2	24	20.2
Parents, other relatives or friend is an engineer	24	27.9	13	39.4	37	31.1
Parents, siblings or other relatives recommended it	27	31.4	14	42.4	41	34.5
Attracted by the challenge of a difficult curriculum	30	34.9	7	21.2	37	31.1
Received or anticipated possibility of good college scholarship	8	9.3	2	6.1	10	8.4
Other	9	10.5	1	3.0	10	8.4

Table 2. Reasons for choosing to study engineering

The majors to which students transferred are shown in Table 3. Note that only one respondent was planning to transfer to another institution. While higher percentages of women moved into non-technical majors, when categorized in this way no statistically significant gender or ethnicity-based trends were found in the majors to which students transferred.

Table 4 shows the reported significance of 25 items that may have contributed to the respondents' decision to leave engineering. Students responded to a series of questions on a 4 point scale where "0 = Not a Factor" and "4 = A Significant Factor". Items are organized by the five factors or clusters that emerged from a factor analysis of the results. Reliability figures are shown for each factor in parentheses after the factor title and are in an acceptable range for all but the "belonging" factor.

Overall, there were very few statistically significant differences between males and females or respondents of different ethnicities for the factor responses. ANOVA tests found a gender difference only for the finances factor with males reporting this as a statistically significantly more important factor than females (F (1,115) = 5.203, $p < .05$); however we note that the means for these items for both sexes is quite low – well below 1.0 (on a 0 to 4 scale) in both cases indicating that finances were not much of a factor for either males or females. The finances factor also showed statistically significant different responses by different ethnicities (F (6, 107) = 3.493, $p < .01$) however post hoc analysis tests were not possible due to the small number of respondents in some ethnicity groups. However, simple observation of the means for the finances

factor organized by ethnicity group (see Table 5) shows that the factor was more important to Asian American/ Pacific Islander respondents than other groups.

College/Area of Study	Frequency	%	Male		Female	
			Freq.	%	Freq.	%
STEM						
Agriculture	3	2.5	1	3.0	3	3.5
Science & Technology	25	21.0	10	30.3	15	17.4
Computer / Information Science	15	12.6	7	21.2	8	9.3
Pre Med / Health Professions	3	2.5	-	-	3	3.5
Architecture/Landscape Arch.	5	4.2	-	-	4	4.7
Total	51	42.8	18	54.5	33	38.4
Non-STEM						
Art / Fine Arts	3	2.5	2	6.1	1	1.2
Arts & Science	10	8.4			10	11.6
Business	22	18.5	2	6.1	20	23.3
Education	5	4.2	1	3.0	4	4.7
Liberal Arts / Humanities	23	19.3	8	24.2	15	17.4
Pre Law	1	0.8	-	-	1	1.2
Total	64	53.7	13	39.4	51	59.1
Other						
Transferring to Another Institution	1	0.8	-	-	1	1.2
Undecided	3	2.5	2	6.1	1	1.2
Total	4	3.3	2	6.1	2	2.4

Table 3. “Switchers” Destination Colleges/ Areas of Study

Factors:	Mean (n)	SD	Male Mean (n)	Female Mean (n)
Finances (.75)	.1538	.58891	.3485	.0774
No longer receiving a scholarship	.18	.770	.33	.13
Other financial reasons	.15	.624	.36	.07
Teaching/ Climate (.86)	1.4562	1.11812	1.5931	1.4037
Non-eng teaching better	1.83	1.654	1.64	1.91
Eng curriculum too narrow	1.86	1.536	2.00	1.80
Eng Classes too big	.85	1.319	1.21	.71
Eng teaching poor	1.73	1.609	1.82	1.70
Foreign language accents of teachers	1.66	1.612	1.94	1.56
Poor math / science teaching	1.43	1.565	1.48	1.41
Group projects poor	.83	1.271	1.06	.74
Belonging (.48)	2.0392	.79922	2.00	2.0543
Non eng better fit	3.17	1.223	2.94	3.26
Don't belong in engineering	2.71	1.392	2.48	2.79
No friends in engineering	.24	.701	.58	.12
Workload/ Grades (.85)	1.6250	1.25395	1.7045	1.5941
Not enough time for social life	1.05	1.345	1.39	.92
Unhappy with grades	2.24	1.636	1.85	2.40
Curriculum too difficult or lengthy	1.59	1.429	1.55	1.60
Excessive workload	1.64	1.577	2.03	1.49
Advising / advice (.80)	.6582	1.02621	.7343	.6275
Engineering advisors bad	.88	1.347	.91	.87
Faculty advisors bad	.68	1.235	.70	.67
Discouraged from continuing	.42	1.021	.61	.35

Table 4. Averages for factors for leaving engineering.

Race/Ethnicity groups	N	Finances factor mean
African/Black American	8	.25
Asian American/Pacific Islander	3	1.33
Latino/Hispanic American	10	.25
Caucasian/White American	90	.09
Foreign National on student visa	1	.00
Foreign National/U.S. Resident (green card)	1	.00
Other	1	1.50

Table 5. Finances factor by ethnicity

Two of the factors showed statistically significant correlations with students' self-reported University GPA. The workload factor had a negative correlation with GPA (r = -.231) while the belonging factor showed a positive correlation with GPA (r = .228). To interpret these, one must remember that the higher the score for the factor, the *more* important that factor was in the transfer decision. Thus, the negative correlation for workload is intuitively logical. The more academically competent students were as indicated by their self-report GPA, the less important was the engineering curriculum workload in their decision to leave engineering. If one's GPA is higher, then it is less likely that one may see grades, a difficult of a curriculum or overall curriculum workload as being a contributing factor to a decision to switch from engineering.

In contrast, students who reported higher GPAs indicated that their feeling of not belonging in engineering was more of a factor in their transfer decision. An understanding of this positive correlation is less obvious. It seems to indicate that the more academically competent students perceived a lack of belonging in engineering as a more important factor in their decision to leave engineering. If this is the case, the authors find this to be a disturbing result. Of these non-persisting students, why do the more academically successful feel like they don't belong? Recall that we did not find a statistically significant gender difference for the belonging factor so our data does not support the conclusion that this relationship may be gender based. However, from Table 4 we can see that the belonging factor has the highest overall mean of all the factors, with a "non engineering major would be a better fit", and "don't belong in engineering" having the highest means of all the items (3.17 and 2.71 respectively). Further, even though not statistically different, female means for these items are higher than the male means.

We can gain some additional understanding of these data from the students who provided responses to several open-ended items on the survey. Their open-ended responses to three questions designed to capture the primary factors in their decision to leave engineering, what might have changed that decision and their overall experience in engineering are analyzed. Students' responses were coded into six categories. Since one student often repeats a variation of the same response to two or more questions we applied the categories across the questions and only the first response of an individual respondent was counted. The result was 224 individual responses. All percentages provided below for the qualitative data are based upon the 224 actual responses or the responses by gender (148 women/76 men). The answers to the question about the quality of high school preparation, discussed above, were calculated separately because of the uniformity of students' responses.

In addition, because the students entered data directly, on line, rather than through recorded discussions, we decided to correct spelling in the student quotations we present. Only word misspellings were changed; not grammar, word order, context or meaning. While we recognize this may not be standard qualitative procedure, we felt the presence of misspelled words may bias readers' interpretation of these students' valuable comments.

In response to the open-ended question about the primary factor that influenced their decision to leave engineering, a sub-set of student respondents (8 percent of the total responding), representing both genders and several ethnicities, indicated that they found engineering too narrow or not creative or people oriented enough. The following quotations illustrate this view.

[I left because] I wanted a job dealing with and helping people.—African American Female.

Part of the reason I left engineering was because I was being trained to be machine with no thoughts or ideas of my own. I felt I was being very limited. –Latina

The biggest factor was that I didn't feel that being an engineer allowed me to fit in my artistic and creative abilities. I also felt that I was very different from other engineers. I felt that I got negative reactions from them, because I went to parties and participated in other activities. Even though my grades were usually higher people didn't usually think of my as being as smart as they were. —Caucasian Male.

I did not want to be working in a cubicle for the rest of my life, no matter how much it pays.—Caucasian Female.

The curriculum was extremely narrow . . . There was little to no room for any humanities or city planning or any other type of class. I feel that this is a MAJOR failing of the engineering program . . .—Caucasian Female

These responses, which are consistent with prior work from both Seymour and Hewitt[6] and Brainard[5], indicate that students perceived that they could not work with people, be creative or take other courses if they continued to pursue an S&E career—disturbing in the light of current efforts to present engineering as a broader professional choice[19,20]. The representation of engineering that students perceive through the engineering curriculum is clearly at odds with a new image that the engineering profession is attempting to create and promulgate.

The quantitative data show that the workload/grades factor is the second most important factor in students' decision to transfer (see Table 4). Further analysis is needed to see how these factors plus perceived poor high school preparation correlate to self-reported GPA's at the time of transferring out of engineering and to the types of majors into which they transferred. In qualitative responses 42 of 226 responses indicated that students found engineering, or the workload, too hard or that they were unhappy with their grades. Women voiced this most often (21.62% or 42/148)) as compared to men (12.82% or 10/78 of the men responding):

I was unhappy in the major and felt that no matter how hard I worked, I could not get good enough grades.—Caucasian woman.

The fact that my grades were low and I was on the verge of being asked to leave my field of engineering. —Latina.

The first semester work load was extremely heavy, especially for students coming straight out of high school.—African American female.

It is also interesting to note that in qualitative responses a lack of context for subject matter and lack of adequate information on what engineering is, what engineers do and what the different

majors mean was cited as an obstacle by a subset of students (25/226 or 11 percent), across gender and race:

> *I did not get any sort of orientation that helped me decide which engineering program to pursue; I was simply overwhelmed by which engineering major to choose, so I chose to join a different college.—Caucasian Female*
>
> *I like math/science, what in the world would I do with an optical engineering degree? Would I like my job? I had no answer, so could not risk my future.— Latina*
>
> *A stronger focus to what I would be doing afterward. Everyone I ever asked about what an engineer did had vague answers. — Caucasian Female*

These students' comments indicate that they do not have a good description of what engineers do, how courses in the first part of the curriculum apply to engineering, or do not have enough information to make good choices on majors early enough to succeed. All of these issues are cause for concern if we intend to attract and retain a wide variety of students to meet the demand for engineers.

Conclusions

The results from the first collection of data from the AWE SLE Survey provide preliminary insights into the reasons why students – who by and large showed good academic performance – from a wide range of engineering institutions, choose to leave engineering. Preliminary analysis indicates that more than half of students responding found that high school had adequately prepared them to succeed and reported lack of sense of belonging as a strong factor in their decision to leave.

Other noteworthy results include the following.

- Ninety-five percent were traditional college age students who had started their programs directly after high school, and their self-reported GPAs ranged from 1.82 to 4.0.
- A little over half the sample (59%) felt that high school had adequately prepared them to succeed in an engineering curriculum. In qualitative responses, however, a subset of respondents cited poor preparation as a factor in lack of success.
- The most frequently mentioned reason for initially choosing engineering was "being good at math / science" (see Table 2). The prospect of getting a job with good pay was also frequently mentioned. The choice of "like the work engineers do" had a conspicuously low frequency.
- A much higher percentage of men than women choose "Like to build and/or fix things, or solve problems" as a factor in choosing to study engineering.
- Statistically significant differences emerged regarding the level of confidence in completing an engineering degree when students began their study, males reported being less confident than females. (Penn State results only)
- The factors most often reported as being significant in the respondents' decision to leave engineering focused on "belonging" in engineering, work load and curriculum difficulty, and grades (see Table 4).

- Two of the factors showed statistically significant correlations with students' self-reported GPA:
    - The more academically competent students were as indicated by their self-report GPA, the less important was the engineering curriculum workload in their decision to leave engineering.
    - Students who reported higher GPAs indicated that their feeling of not belonging in engineering was more of a factor in their transfer decision.
- Overall, very few statistically significant differences on factors (Table 4) among males and females and ethnicity race emerged. The only exception was finance: all males and Asian Americans males and females reported finance as a factor in non-persistence. However, overall finances were not a large factor when compared with others.

In order to fully understand or apply these data it will be important to collect comparative data from students who persist in engineering study. As a part of the AWE Project, we are currently testing a "persisters" version of this instrument so that institutions may gather comparative data between those that persist and those who do not. This combination of instruments will help to develop a "composite" of typical persisters and non-persisters that will, in turn, allow engineering educators, administrators and other stake-holders develop more effective retention and development strategies.

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