Engineering Attrition: Student Characteristics and Educational Initiatives

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Abstract

Roughly fifty percent of the students who begin in engineering leave the field before receiving their engineering degree. Typically half of this attrition occurs during the first year. Its causes may vary widely from student to student (e.g. disinterest in the field of engineering, lack of fundamental preparation, lack of confidence to succeed). However, before we can develop more effective initiatives to reduce this high rate of attrition, we must first determine its underlying causes. As a result of an in-depth analysis of the attrition and retention issues at one school, several curricular and evaluation-based efforts have been introduced that are aimed at improving retention not only at the freshman level, but also at the sophomore and junior levels. This paper discusses results from the in-depth analysis and provides an overview of the curricula and evaluation changes made. We also suggest additional methods to examine.

Introduction

The problem of engineering student retention has received considerable national attention. At the University of Pittsburgh, we have been addressing the retention issue from several perspectives for the past six years. Our efforts have been augmented by three research grants[a], which have enabled us to focus on the retention of freshman engineering students. As a result, we have developed several tools, which are being implemented both by us and by colleagues at other universities. We also have introduced a number of promising initiatives.

While our efforts offer the potential of reducing attrition, in the long run we believe that we must do much better in fulfilling the expectations and needs of our students. To do this means seriously addressing the "structure" and "culture" of the engineering educational experience, and developing additional creative solutions that will facilitate the desired structural and cultural changes. Seymour and Hewitt most emphatically documented the need for such changes [1] in their comprehensive six-university study of students who switched out of science, mathematics and engineering programs. They concluded that those problems arising from the structure of the educational experience, and the culture of the discipline (as objectified in the attitudes and practices of faculty) have a far greater impact upon attrition than do problems of personal inadequacy, aptitude for other disciplines or the appeal of other majors.

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In a very broad national study of attrition, Astin and Astin [2] reported that engineering education loses more than half of its undergraduate students (53%) with 40% switching into non-science fields. The Astins observed that majoring in engineering has negative effects on students' satisfaction with faculty, quality of instruction, student life, and overall college environment. It also has negative effects on a variety of academic outcomes including GPA; growth in foreign language skills, writing and listening skills; and cultural awareness. They concluded: "Clearly, it would appear that some of the problems that engineering programs have in retaining students may be associated with these negative outcomes." Hence, it is not surprising that the innovative EC-2000 accreditation criteria [3] explicitly focus on changing certain of these "negative outcomes."

This paper discusses certain aspects of our ongoing, in-depth analysis of engineering retention. We provide an overview of the curricula and evaluation changes made and present some of these results to date. We also discuss other, more innovative changes that promise an even greater impact.

Defining and Tracking Attrition

We have divided engineering attrition into five main areas – two at the freshman level and three at the upper-departmental level. Specifically:

Freshman Level

- Students who transfer out of or resign from a formal engineering program in "good academic standing"[b] within the first twelve months of their college education (before beginning the second year). Students who resign before they complete the first semester are considered to leave in good academic standing.
- Students who are placed on academic probation during either the first or second semester of a formal engineering program and subsequently leave that program within the first twelve months while still on probation.

Departmental Level

- Students who transfer out in "good academic standing," after beginning the second year of their engineering education.
- Students who transfer out after the start of the second year who are no longer in "good academic standing."
- Students who are considered "inactive" after electing not to return to college; such students may be in "good academic standing."

In this paper we are particularly interested in the freshmen that are placed on probation at the end of their first term. As shown below, these students account for half of the freshmen attrition and a substantial portion of the second and third year attrition.

As noted above, here first year attrition includes all freshmen that leave the University of Pittsburgh School of Engineering during their first academic year. Of these students who transfer

[b] We define "good academic standing" as having a GPA of 2.00 or better on a four-point scale.

to another unit within the University, roughly half did so in "good academic standing." That is, a number of our transfers are, in fact, our better students.

Table 1 displays this data for a seven-year period. In addition, to transfers, certain students are dismissed or resign (sometimes before they are dismissed). In fact, 45% of the students who leave, either resign or are dismissed.[c] We know from other studies, that the first semester is critical [4]. At the end of the 1992 Fall Term, 28.9% of the freshman class was placed on probation, a disturbingly high percentage. The following year, a major structural change was made in the two-course freshman engineering sequence. Subsequently, several other retention initiatives have been introduced which collectively have contributed to a lower proportion (15.4 to 22.2%) of freshmen being placed on probation for the succeeding six years. In addition, the first year attrition rate appears to have dropped substantially from a high of 29.9% for the 1992-93 academic year to 19.6% and 22.1% for the past two academic years. When attrition is combined with those "held" in the freshman program for a third term due to poor academic performance, a similar, encouraging pattern is observed, especially for the past two years.

In order to get a clearer picture of the percent of entering freshmen that actually earn their engineering degree, a six-year period is required. For the academic years 1989-90, 1990-91, and 1991-92 (the most recent period for which six-year graduation rates can be calculated, 54% of the entering engineering freshmen obtained an engineering degree. Another 16% transferred out of engineering but received a non-engineering degree from the University of Pittsburgh.

Table 1 School of Engineering Attrition Summary

Academic Year	**'92-'93**	**'93-'94**	**'94-'95**	**'95-'96**	**'96-'97**	**'97-'98**	**'98-'99**
Entering Freshmen (Fall)	284	271	235	261	326	362	391
First Term Probation	82	42	48	58	68	57	76
Percent First-Term Probation	28.9%	15.4%	20.4%	22.2%	20.9%	15.7%	19.4%
Resigned or Dismissed	39	29	26	31	31	37	NA
Transferred out (other)	46	38	34	38	33	43	NA
Percent First Year Attrition	29.9%	24.7%	25.5%	26.4%	19.6%	22.1%	NA
Third Term Freshmen	34	15	26	31	36	26	NA
Percent Third Term Freshmen	12.0%	5.5%	11.1%	11.9%	11.0%	7.2%	NA
Third Term and Transfer Out (%)	41.9%	30.2%	36.6%	38.3%	30.6%	29.3%	NA

[c] Freshmen must have obtained a cumulative GPA of 2.0 or better by the end of their first year to matriculate into a department. Those who have less than a 1.5 cumulative GPA at the end of their first year are subject to dismissal; those that have at least a 1.5 but less than a 2.0 GPA are considered to be "third term" freshmen and are given up to an additional year to reach the 2.0 level.

First Term Probation

As noted, we are particularly interested in the ultimate success of freshman engineering students who are placed on probation (GPA less than 2.00 on a 4.00 scale) at the end of their first semester. Table 2 summarizes the experience of these students. For the most recent six-year period, an average of 58% of those students placed on first term probation leave engineering during their freshman year. These students account for approximately half of the freshman engineering first-year attrition. Further, almost two-thirds of these students (62%) either resign or are dismissed. Approximately half of those that remain in engineering are considered "third term" freshmen (on probation) and are not permitted to matriculate into a department.

Table 2. Status of Engineering Freshmen Placed on Academic Probation after Their First Term

Academic Year	**'92-'93**	**'93-'94**	**'94-'95**	**'95-'96**	**'96-'97**	**'97-'98**	**'98-'99**
First Term Probation	82	42	48	58	68	57	76
Resigned or Dismissed	23	16	18	21	20	28	NA
Transferred out (other)	23	13	8	13	12	9	NA
Percent Left – First Term Prob.	56.1%	69.0%	54.2%	58.6%	47.1%	64.9%	NA
Percent of First Year Attrition	54.4%	43.3%	43.3%	49.3%	50.0%	46.3%	NA
Third Term Freshmen	17	4	9	11	18	12	NA
Percent Third Term Freshmen	20.7%	9.5%	18.8%	19.0%	26.5%	21.1%	NA
Third Term and Transfer Out (%)	75.1%	78.5%	73.0%	77.6%	73.6%	86.0%	NA

An analysis of a sample of students placed on "first term probation" indicates that there is no clear trend with respect to SAT scores. Though these students had lower than average SAT scores[d], they were not found to be significantly different from students who were not placed on first term probation. Clearly, the first semester is critical to student success, as other researchers have also observed [5].

Table 3 further examines this population of students who are placed on probation at the end of their first semester. For this group, the Table shows that approximately 4/5ths of the attrition occurs during the first year. Further, a number of these students who remain in engineering eventually become "inactive." They no longer register for classes, and hence do not complete their engineering program. Only small proportions (ranging between 10 to 25%) are able to return to "good academic standing" and eventually graduate (or are track to graduate) in

[d] Average SAT scores for entering freshmen are approximately 1220; all but seven percent of entering freshmen are calculus ready.

engineering. In brief, this data confirms our belief about the importance of doing well the first semester, and documents the disturbing fact that typically no more than one in five freshmen engineering students placed on academic probation at the end of the first semester will graduate in engineering.

Table 3. Subsequent Academic Performance of Freshman Engineering Students Placed on First Term Probation

Academic Year	'92-'93	'93-'94	'94-'95	'95-'96	'96-'97	'97-'98	'98-'99
First Term Probation	82	42	48	58	68	57	76
Attrition during First Year	46	39	26	34	32	36	NA
Attrition after First Year	13	8	12	11	9	4	
Inactive Engineering	7	1	9	3	8	1	
Engineering – Probation	0	1	1	2	4	4	
Engineering – Good Standing	3	0	9	8	14	10	
Engineering Graduated	14	4	3				
Good Standing or Graduated (%)	20.7%	9.5%	25.0%	13.8%	20.6%	17.5%	

Reasons for Leaving Engineering

In order to investigate the reasons behind engineering attrition, we have developed a structured series of questions that are administered to every student who transfers out of the School of Engineering. The survey is administered by one of the freshman academic advisers and includes opportunities for open-ended responses. This data is displayed in Table 4 and is divided into two populations of exiting students – freshmen and sophomores through seniors.

Table 4. Primary Reasons for Students Leaving Engineering

Reason for Leaving	Freshman n = 115	Soph – Senior n = 61	Total n = 203
Came to dislike engineering/studying engineering	76 (66%)	35 (57%)	128 (63%)
Lost interest/developed new interests	83 (72%)	48 (79%)	148 (73%)
Academic Problem	29 (25%)	20 (33%)	54 (24%)
Personal and Financial Reasons	2 (2%)	0 (0%)	2 (1%)

This data suggests that over half of the students who left engineering, came to dislike either studying it, or lost interest in what they felt the profession offered. A fourth of the freshmen and a third of the upper class students indicated that academics were a primary reason for leaving. Only two students cited personal or financial reasons as the cause of their leaving engineering.

In addition to asking students their reasons for leaving engineering, we also presented them with a series of yes/no questions. Each was followed by an opportunity for an open-ended response. Table 5 summarizes the responses to these questions for freshmen and upper class students.

Table 5. Survey of 203 Students Transferring Out of Engineering Program[e]

Question	**Yes**		**No**	
	Freshman n = 115	Soph. – Sr. n = 61	Freshman n = 115	Soph. – Sr. n = 61
1. Did your perceptions of engineering match your experiences as a student?	55 (48%)	33 (54%)	56 (49%)	25 (41%)
2. Were you influenced study in engineering by parents, high school counselor, or other influential person?	57 (50%)	25 (41%)	57 (50%)	34 (56%)
3. Were you misled in choosing engineering?	19 (17%)	6 (10%)	88 (77%)	52 (85%)
4. When you entered the university, did you know that you might not stay in engineering?	65 (57%)	28 (46%)	50 (44%)	32 (53%)
5. Would you recommend the School of Engineering to other students?	101 (88%)	53 (87%)	8 (7%)	5 (8%)
6. Before deciding to leave engineering, did you talk to someone about the engineering profession and your desire to leave?	89 (77%)	45 (74%)	25 (22%)	14 (23%)
7. Do you feel that enough assistance was given to you from the School?	99 (86%)	50 (82%)	11 (10%)	9 (15%)
8. Have you been to career counseling at the University?	7 (6%)	4 (7%)	106 (92%)	55 (90%)
9. Were you provided enough academic support from professors?	82 (71%)	50 (82%)	25 (22%)	9 (15%)
10. Were you aware of the workload involved in studying engineering?	89 (77%)	51 (84%)	19 (17%)	8 (13%)
11. Were you academically prepared in high school?	60 (52%)	47 (77%)	50 (44%)	10 (16%)
12. Were you emotionally prepared for the stress of the curriculum?	63 (55%)	42 (69%)	42 (37%)	16 (26%)

Although students were generally positive about the School of Engineering, 57% of the freshmen and 46% of the upper class students admitted that they were not sure about their completing the engineering program when they entered the School (Question 4). In addition, approximately half felt that their perceptions of engineering did not match their experiences (Question 1). Surprisingly, while most discussed their decision to leave engineering with an advisor or parent (Questions 6, 7 and 9), very few sought out career counseling services even though such services available at the University (Question 8). As a consequence, we are now working with career counselors to ensure that our students, especially those leaving engineering, will be better

[e] Percentages for each item are not adjusted for "no response."

informed about academic and career alternatives. Most were aware of the workload (Question 10) and academically (Question 11) and emotionally prepared (Question 12) for studying engineering, although less so for the freshmen. It is gratifying to observe that almost 90% of the students transferring out of the University of Pittsburgh School of Engineering would recommend it to a friend (Question 5)!

An Overview of Attrition Interventions

The University of Pittsburgh does not appear to differ substantially from the national "norms" relative to its attrition problems. Our recent graduation (54%) rate for students who enter engineering as freshmen is slightly above the national average (47%). However, with slightly less than half of our freshmen transferring out of engineering, we felt that there is much room for improvement. In response to these concerns about attrition, we have introduced a number of initiatives geared at improving learning and retention.

At the Freshman Level

With funding from the National Science Foundation, the freshman engineering curriculum was substantially revised. We felt that most entering engineering students had little idea what engineering is about, knew what engineers do, nor appreciate how engineering differs from science and mathematics. As a result, too many students were becoming impatient, or drawing improper generalizations from their introductory course material, and thus possibly leaving engineering. We viewed the freshman engineering curricula as doing little to address these issues. If we could better identify incoming students' expectations, and then develop ways of satisfying those expectations as part of the educational process, we would not only increase the retention of talented students in engineering, but equally as important, we would increase the heterogeneity of engineering students and the engineering profession. As a result of this funding, two major changes came about in addressing the attrition problem: one curricular-based and the other evaluation-based.

Curricular Changes: We developed two problem-based learning courses, *Engineering Analysis* and *Engineering Computing,* that are taught in an active learning environment and are required by all freshman engineering students. With the re-designed courses, we reduced student attrition *from these introductory engineering courses* substantially from twenty-four percent to twelve percent [6]. This suggests that the continued attrition from the freshman year may not primarily be attributable to these engineering courses. Our new method of instruction and course content also has led to improved faculty and student satisfaction. (The above have been confirmed by our attitudinal surveys that indicate more dissatisfaction with math and science courses compared to the engineering sequence.)

In addition to the two new courses, the *Freshman Engineering Seminar* was substantially redesigned in an effort directed at reducing attrition. The central theme of this non-credit, mandatory experience was a compilation of Murphy's [7] five models of freshmen seminar. Tailored to fit the perceived needs of freshmen engineering students, sessions focused on major issues such as [8]:

- Adjustment to college life,
- Time and stress management,
- Overview of the different fields of engineering,
- Special opportunities (e.g., co-op, international studies, undergraduate research, etc.).

In an effort to ensure seminar material was delivered in a more effective manner than that of the large group format, mentor driven cooperative learning groups were chosen as the new vehicle to deliver academic and professional development topics [9]. The class was divided into small discussion groups of approximately 20 students. Each group was led by a specially selected and trained undergraduate Freshman Engineering Leadership Team mentor. Previous research has indicated that using peer mentors, encourages confident personal identity development through the interactions freshmen have with those who recently successfully negotiated the transition from high school to college [10]. Our impetus for moving freshman seminar in this direction was to increase retention by linking new students with peers who would act as cultural coaches to the School of Engineering.

We quickly learned that the sessions should be interactive in nature and limited in scope. Over time we learned that each mentor group needs to progress at its own pace, and the mentors need to be given flexibility to respond to the group's concerns and needs. With appropriate experience in team building and small group intervention, the mentors have proven to be extremely valuable. Pitt's seminar experiences and subsequent benefits are consistent with that of Tinto's [11] learning communities and their benefits. Although the weekly fifty-minute meetings were a modest attempt at reconstructing a new learning environment, the program has proven itself to be successful to both freshman students and the upper class engineering student mentors in the following ways:

- Supportive peer groups were formed that extended beyond the classroom. The levels in which this experience was recognized within freshmen to freshmen, freshmen to mentor, and mentor to mentor interactions. Through sharing the engineering curricular experiences, all groups appeared to spend more time together inside and outside of the classroom [12; 13]. Thus, the relationships the shared experiences cultivated also appeared to perpetuate an excitement and a desire to learn and succeed. These relationships have been defined as integral components of an environment that fosters student achievement [14].
- Support systems created through peer relationships were especially effective with students whose "life-tasks" make attending college a difficult experience [15]. Commuters, students who must work to pay for college, as well as under-represented populations appear to positively respond to the interactions freshman seminar creates [16].
- An additional academic community developed when student services staff and faculty collaborated in supporting the freshman seminar activities. Although the relationship between faculty and staff was not a primary driver in implementing the new seminar, an additional benefit was realized within the positive examples that were set through such productive interactions.

A freshman engineering weekly planner for use in the mentor sessions was created and implemented for the 98-99 academic year. The specially designed planner provides freshman with a system for organizing their time and contains pertinent information about University support resources, as well as information about each of the different engineering programs. This enables students to make a more informed departmental choice in the spring. Preliminary results for the 1998-99 academic year indicate that the number of first term freshmen transferring out of engineering in “good standing” the first semester to decreased below five percent.

As noted, a relatively large number of freshmen are placed on probation after the Fall term. We have been contacting those students who remain in engineering and invite them to attend a specially designed program of three weekly-sessions that focused on improving student’s study and time-management skills. We try to have the students focus on the reasons for their poor academic performance. Each session is designed to be interactive and small group based. The initial session is comprised of participants creating and signing a “Success Contract” designed to commit each student to a series of action points that will eventually lead to academic improvement. Students then brainstorm a list of choices that they felt contributed to low grade point average, followed by a list of different choices that could be made to contribute to their success in the new upcoming term. The second session is devoted to time management methods, such as how to organize large projects and reverse time lines. Students learn to develop master time and study schedules and later adjusted their schedules once they are properly taught how to monitor their time. At the third session students discuss left brain and right brain thinking and its effects on learning, and the different types of learning: visual, auditory and kinesthetic. This discussion leads to a discussion of how one should organize themselves to study and how to take notes in class given their individual learning styles, as well as varied teaching styles. The session ends with a talk on the use of alcohol in school. The final session is an open reward session with pizza served and where students can seek further group and individual assistance.

For the initial implementation of the program, 23 of the 42 of the students responded positively that they would attend, and 15 attended all sessions. As this probation program is relatively new, we are still investigating the long-term performance of how these 15 students changed compared to the 28 students who chose not to participate. Note, based on the data presented previously, we would expect that only three of these students would be expected to graduate if no interventions were tried. If the pilot proves successful, we will expand the program to include “provisional admit” students during the first term.

<u>Evaluation</u>: We have been investigating attributes of students most likely to transfer out of engineering, specifically in good academic standing [17]. In doing this, we developed a closed-form questionnaire that captures students’ attitudes towards the profession, confidence in ability, and reasons for studying engineering [18,19]. Approximately 20 engineering schools in the US as part of a cross-institutional retention study have adopted this instrument.

A model to better identify those students who are most likely to leave engineering in good standing was developed and implemented at the University of Pittsburgh in 1995. Such students typically have very high school class ranking, but lack confidence in their math and science ability, and are not completely committed to an engineering education. Further, there may have been some parental pressure to enter engineering. As a result, when this type of student begins to have academic difficulty or finds the coursework to be too burdensome, he/she seriously considers transferring to a less demanding major. We also are using our instrument to assess the change in student attitudes during the freshman year. We have found that those students who transferred out in good academic standing demonstrated statistically significant decreases in their general impressions of engineering, enjoyment of math and science courses; confidence in chemistry; and perception of the engineering profession. In contrast, they reported increases in family pressure to study engineering. These results have also been used to improve the freshman engineering seminar structure and content. We intend to make our freshman advisors aware of those students who the model had identified as most likely to transfer out, with the intent of making sure that these "at risk" students understand the options available in engineering.

In addition, we have measured students' expectations when they began the freshman year and how well those expectations were being met during the first year [20]. This also has guided us in revising our freshman seminar and designing our mentoring programs, as well as supporting the revision of our two freshman engineering courses.

The freshman attrition model is currently being updated to reflect changes in the program, as well as students who leave after their freshman year. In addition, models to predict students who leave in poor standing are also being developed. With funding to conduct a cross-institutional study, we plan to build prediction models for other schools seek to develop attrition models, and thus identify factors that contribute most to attrition at the freshman level.

<u>At the Department Level</u>

We believe the next step is to address attrition at the upper levels. At the freshman level, we saw how effective active learning can be in the classroom. In using this format, we are more closely matching our teaching styles to the students' learning styles. It is important to learn student names, maintain office hours, assist students in solving their problems, and be supportive. A similar commitment is needed from staff. Though the retention issue at the upper levels is primarily left to the individual departments, there are two area in which a School wide effort may address retention issues: cooperative education and ABET accreditation.

<u>Cooperative Education Program</u>: Approximately half of the School's graduates enter as transfers. These students have a graduate rate of 85 percent. The Co-op Program, which was re-established in 1988, also appears to be a major factor in reducing attrition. For the first 501 students who co-oped for at least one rotation, only 26 (5%) failed to graduate from Pitt. For the 391 students who completed all three rotations, only two (0.5%) failed to graduate. For the approximately 450 students currently in the program, only three (0.67%) have left engineering. These data suggest that approximately 95 percent of students who begin the co-op program will remain in engineering and graduate. With almost 50 percent of our eligible students now co-oping, this should result in improved freshman graduation rates due to reduced attrition during the sophomore and junior years.

<u>Evaluation</u>: As the School of Engineering prepares for accreditation under EC 2000, several evaluation efforts are being taken to identify areas for improvement within each department and at the School level; thus improving retention in the long-term. As part of these evaluation efforts, we are moving our study of student attitudes and their relationship to attrition into the sophomore

and junior years where the second half of the attrition occurs. Companion instruments to our freshman engineering instrument are currently being piloted at three institutions.

A realistic goal is to graduate 65 percent of students who start as freshmen. By achieving this goal, we would increase the size of our student body by 125 (or approximately 10 percent, with no increase in admissions. However, much additional effort needs to be done in order to achieve this goal. In particular, our extensive surveys of freshmen continue to indicate dissatisfaction with their science courses. Further, we have become concerned by the deterioration in student attitudes over the course of the freshman year, and the relatively large number of complaints that our advisers receive from freshmen about their math and science courses. In addition, we are concerned about the students' perceived lack of relevance of much of their course work. As a result, we are designing a pilot integrated freshman engineering curriculum as a mechanism to both improve learning and reduce attrition. We plan to implement the pilot program next year, based primarily on the coursework developed by members of the Foundation Coalition. As part of that pilot we are also planning to test the concept of inclusive learning communities to better support our students outside of class[21].

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References

1 Seymour E. and NM Hewitt, *Talking About Leaving : Why Undergraduates Leave the Sciences, Westview Press*, January 1997.
2 Astin, AW and Astin, HS (1992). Final Report: Undergraduate Science Education: The Impact of Different College Environments on the Educational Pipeline in the Sciences, Higher Education Research Institute, Graduate School of Education, UCLA.
3 Engineering Criteria 2000 Third Edition: *Criteria for Accrediting Programs in Engineering in the United States* (1997). Published by The Accreditation Board for Engineering and Technology (ABET), Baltimore, Maryland. http://www.abet.org/EAC/eac2000.html.
4 Budny, D., LeBold, W and Bjedov, G., "Assessment of the Impact of Freshman Engineering Courses," *Journal of Engineering Education*, Vol. 87, No. 4, 1998.
5 Budny, D., LeBold, W and Bjedov, G., ibid.
6 Setliff, DE, Gottfried, BS and Patzer, JF. "Enhancing Introductory Engineering Courses Through an Active Learning Format," *1995 ASEE Annual Conference Proceedings*, Anaheim, CA.
7 Murphy, RO, "The Freshman Year Enhancement in American Higher Education," *Journal of the Freshman Year Experience*, vol. 1, no. 2, 1989, pp. 91-100.
8 Bishop, SL and Besterfield-Sacre, M. (1996). "Freshman Engineering Leadership Team: Student Mentors for Recruitment and Retention," *ASEE Annual Conference Proceedings*, Washington, D.C.
9 Johnson, CA. and Orr, CL, "The Professional Development Course as a Natural Extension of the Postsecondary Freshman Seminar," *Journal of Education for Business*, vol. 72, no. 2, Nov/Dec 1996, pp. 120-124.
10 Johnson, DW, Johnson, RT and Smith, KA, "Cooperative Learning Returns to College," *Change*, vol. 30, no. 4, Jul/Aug 1998, pp.26-36.
11 Tinto, V, "Colleges as Communities: Taking Research on Student Persistence Seriously," *The Review of Higher Education*, vol. 21, no.2, 1998, pp. 167-177.

12 Tinto, ibid.
13 Johnson, Johnson and Smith, op. sit.
14 Johnson, Johnson and Smith, op. sit.
15 Tinto, op. sit.
16 Johnson and Orr, ibid.
17 Besterfield-Sacre, ME, Atman, CJ and Shuman, LJ, "Characteristics of Freshman Engineering Students: Models to Predict Student Performance and Retention," *Journal of Engineering Education*, Vol. No. 1996.
18 Besterfield-Sacre, ME and Atman, CJ (1994). "Survey Design Methodology: Measuring Freshman Attitudes About Engineering," *Proceedings*, 1994 ASEE Annual Conference, Edmonton.
19 Besterfield-Sacre, ME, Atman, CJ and Shuman, LJ, (1995). "How Freshman Attitudes Change in the First Year," *1995 ASEE Annual Conference Proceedings*, Anaheim, CA.
20 Mullins, CA, Atman, CJ, Shuman LJ, and Gottfried, BS, (1995). "Freshman Expectations of an Engineering Program," *1995 ASEE Annual Conference Proceedings,* Anaheim, CA.
21 See http://www.foundation.ua.edu/ for more information of the Foundation Coalition and a number of their activities.

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