Students Are Leaving Engineering Curriculums; Can Our Educational Approach Stop This?

Tonya Emerson, Michael Ward

College of Engineering, Computer Science, and Construction Management
California State University, Chico

Abstract

Retention rates in Science, Technology, Engineering, and Math (STEM) majors have been a serious concern nationwide for many years. The Consortium for Student Retention Data Exchange's 2002-2003 STEM Retention Report provides sobering data on our national retention rates. The report shows that retention rates at Carnegie-Masters type institutions for incoming first-year students in STEM majors that continue and graduate in a STEM discipline within six years are less than 28% nationwide. At California State University, Chico, the numbers are less than 23%. These numbers are not consistent with those seen when looking at all disciplines. The same Consortium report found that nationally, retention rates for all majors at Carnegie-Masters schools hovers near 40%, while at CSU, Chico the retention rate for all majors averages 47%.

Why do STEM disciplines lose such a high percentage of students? In the landmark study by Seymour and Hewitt, and reported in their book *Talking About Leaving: Why Undergraduates Leave the Sciences*, many of the common myths about retention were dispelled. Students are not leaving due to a lack of skill or subject matter knowledge. The most common factor influencing their decision to leave was a loss of interest in the subject matter. In addition, poor quality teaching and advising were serious concerns for all students. This data clearly indicates that something in our standard approach to teaching is not working.

The question becomes, what can we do better? This paper reviews current programs nationwide that are targeted at improving student involvement and retention. Changes made in both teaching methodology and curriculum are identified and the resulting effects of these changes are discussed. The intent of this paper is to provide a resource for other engineering educators on effective educational approaches to improve retention.

Introduction

The Consortium for Student Retention Data Exchange's 2002-2003 STEM Retention Report shows that, on average, only 64.5% of incoming, first-year, STEM students at Carnegie-Masters type institutions continue to a second year of study in STEM majors. By the end of their second year, only 46% are still enrolled in STEM disciplines. Within 6 years, only 28% of those first-year students will have graduated with a STEM degree. At California State University, Chico, the retention rate drops an additional 5% to only 23% percent of incoming students in STEM disciplines graduating within six years of entering the university. [1]

"Proceedings of the 2005 American Society for Engineering Education Annual Conference & Exposition"
Copyright © 2005, American Society for Engineering Education

The most frequent explanations provided by faculty and administrators for student fallout tend to focus on “poor preparation” or “lack of discipline” of incoming first-year students. There is sufficient data to support the notion that mathematics and science education in the United States is failing to prepare high school graduates for careers in mathematics and science. Other studies, however, suggest that the loss of majors from mathematics, science, and engineering disciplines came from “a pool a disproportionately able undergraduates”. [2] Data compiled regarding engineering and computer science students at CSU, Chico who left their major during Fall 2000 to Spring 2004 semesters supports this research. During this time period, the mean GPA of students who left their major was 2.38. Of the 1415 students who changed majors during this time period, less than half, 37.5%, where on academic probation or were disqualified while 24% had GPA’s greater than 3.0.

In their groundbreaking study, *Talking About Leaving; Why Undergraduates Leave the Sciences*, Seymour and Hewitt provided valuable insight behind the factors leading to student attrition. [2] Within the engineering disciplines, student’s perceptions of what engineering consists of and what a career in engineering involves had significant influence in students leaving. 50% of students who switched out of engineering degrees cited a loss of interest in engineering as a factor in their decision to leave. Along this same vein, 37% of students who did not persist, henceforth called non-persistors, felt non-STEM majors provided more interest, 31% determined the career options not worth the effort of the degree, and 24% rejected STEM careers and the associated lifestyle. At this time, it is worth recalling that over 50% of student attrition is occurring within the first two years of education. Therefore, students who typically have little to no exposure to engineering courses are leaving the discipline due to a perceived lack of interest in the field. [2]

A second important trend in Seymour and Hewitt’s findings are a reflection of student/teacher interaction. Poor teaching by STEM faculty directly contributed to 41% of students’ decisions to leave, while inadequate advising or help with academic problems was a factor for 26%. In addition, 25% of non-persistors were also motivated to leave due to lost confidence caused by low grades in early classes. While some may attribute poor student performance to lack of student preparation, Seymour and Hewitt limited their sample to students with SAT math scores over 650. This was on the advice of STEM faculty to insure students surveyed had adequate preparation to succeed in STEM degrees. [2]

In addition to determining those issues that students felt were factors directly contributing to their decision to switch fields of study, Seymour and Hewitt also reported issues that were concerns for all engineering students, both non-persistors and students who persisted, henceforth called persistors. The number one concern was poor teaching with over 98% of former engineering students and 86% of persisting students expressing concern with the quality of our teaching. Inadequate advising was also cited as a major concern by 81% of non-persistors and 53% of persistors. Disturbingly, among persisting engineering students, 41% are concerned with their loss of interest in the engineering fields and 52% feel their reasons for choosing an engineering major are now inappropriate. Students are clearly disillusioned with their educational experience and the culture of engineering academia including the practices and attitudes of faculty. [2]

Copyright © 2005, American Society for Engineering Education

How surprising are the retention numbers? No one will argue that engineering is a difficult field of study that requires a serious time commitment and strong study skills. However the overall loss of 35% of incoming students after their first-year indicates that something is significantly wrong. Further, why are students who received A's and B's in high school, suddenly receiving D's and F's in their first semester of college? As noted above, 25% of switching students cited a loss of confidence due to poor grades. A study at the University of Pittsburg found that prior to initiating a first-year program, nearly 29% of their students were on academic probation after just the first semester of the engineering curriculum. Of those, 58% would leave the engineering majors by the end of their first-year. [3] This is not surprising as numerous studies have found that grades received in the first and second semesters of college where the best predictors for perseverance in engineering. [4] This same trend has been found at CSU, Chico.

There continues to be a serious disconnect between student and faculty views of difficult courses and why first-year students are failing. Students believe that through hard work, clarity of teacher instruction, and some faculty assistance they should be able to pass difficult courses. When they devote significant effort to a class and receive failing grades on exams their self-esteem and motivation to continue is severely diminished. [2] While development of proper study skills, which many students didn't master or need in high school, may be an important component of improving student success, faculty attitude also plays an vital role. Many professors tend toward a more fatalistic view in that some material is simply difficult and not accessible to all students. [5][2] Further, the atmosphere of academia exacerbates the educational difficulties faced by our engineering undergraduates as many institutions place little emphasis on quality instruction for faculty promotion and tenure. One must question though if this is adequate reason to not hold faculty responsible for presenting clear and understandable explanations. In the words of one of the greatest physicists and professors of the 20^{th} century, Richard P. Feynman, "If you can't explain it simply, you don't understand it." [6] However, developing simple explanations of difficult topics is typically more challenging than teaching seminars in one's own area of research, and given the low esteem associated with teaching lower division courses, there remains little incentive for faculty to develop appropriate explanations. [7]

In addition to material difficulty, Felder's research on preferred learning styles has shown that many students are unsuccessful in their engineering educations due to a mismatch between learning style preferences and the predominate modes of instruction. The typical lecture format of engineering instruction is well suited to the student who prefers to learn in a verbal, intuitive, deductive, reflective, and sequential manner. [8] Unfortunately, few students exactly match this mold especially with regards to verbal delivery of course material. For example, five semesters worth of learning style tests of civil and mechanical engineering students at CSU, Chico have shown that over 92% of students surveyed prefer visual learning methods to verbal, i.e. straight lecturing. Yet, the typical mode of instruction continues to be the formal lecture format familiar to faculty that does not incorporate models, simulations, and other visual aids.

The above data clearly indicates two key contributors to our failing retention rates. One, we are not engaging our engineering students in the first-years of their education. Two, current teaching methods and student/teacher interaction provide major concerns for our engineering students. The following paper highlights successful curricular and pedagogy changes nationwide to help

Copyright © 2005, American Society for Engineering Education

address these issues.

Curricular Changes
The research indicates the highest number of students are leaving engineering primarily in the first and second years of enrollment and are citing a loss of interest in the field as the major contributor in their decision to leave. However, typical first-year students commonly display a lack of knowledge regarding the disciplines of engineering, computer science, and technology. [9] As such, educators have begun to incorporate programs in the first-year of study with the goal of engaging students in technical majors and, as a result, improving retention. These programs may be a stand-alone first-year engineering course or an integrated first-year curriculum. Both approaches have shown success in increasing student retention, especially when non-engineering aspects including teaming, written and oral communication, and study skills are integrated into the programs. To benefit the reader on the possible programs and approaches, a brief description of a number of programs are provided. Samples of individual, stand-alone, courses are described first. Later, the paper will look at integrated curriculums, which attempt to link key courses students take during their first-year to assist students in relating and integrating the content of these core courses.

First-Year Engineering Courses
CSU, Chico's mechanical engineering department launched an experimental first-year design course in 1990 with the intent to improve persistence in the major by exposing first-year students to fundamental design concepts and to challenging group design competitions. The course used the design of a computer-controlled robot as the teaching vehicle. The course requires students to learn a process for designing mechanical systems and introduces students to the concept of using a computer to control an electro-mechanical system. In addition, the course provides students an opportunity to be creative; encourages the development of teaming skills; and enhances written, oral, and graphical communication skills. The overall goal of the faculty in developing this course was to motivate students to continue studying engineering. Dr. Ron Roth, who proposed and taught the course, compared first-year student persistence in mechanical engineering prior to the existence of the course with persistence of those first-year students taking the course. From 1973 to 1990, only 50% of all first-time mechanical engineering students at CSU, Chico persisted to their 2nd year in the mechanical engineering department. From Fall 1993, when the class became a required course, to Spring 2001, 79% of mechanical engineering first-year students who took the course persisted to the sophomore year.

While the success of the CSU, Chico first-year design course is heartening; one may question the need for implementing a design course at the first-year level. Many schools currently have seminar courses in place for first-year students. Typically, these courses offer a series of seminars regarding engineering professions and require minimal faculty effort as compared to design courses. But are they as effective in retaining first-year students? The following illustrates what the School of Engineering, Technology, and Computer Science (ETCS) at Indiana University – Purdue University Fort Wayne discovered when they asked the same question.

ETCS at Indiana University – Purdue University Fort Wayne faces similar challenges to CSU, Chico with a high number of transfer students and a significant number of students who work 20

Copyright © 2005, American Society for Engineering Education

or more hours in addition to taking full course loads. Although they offered a first-year seminar, ETCS was experiencing retention rates to graduation of less than 50%, with the majority of students leaving by the end of the second year. To improve retention rates, college faculty modified the existing Introduction to Engineering course, which previously followed the historical format of a seminar series about engineering professions. The new high-tech format allows for student development of computer and personal skills necessary to succeed in engineering curriculums. The main focus of the new introduction course is the design and construction of an autonomous mobile robot by student teams, similar to the CSU, Chico model. The project requires students to apply skills from multiple disciplines and provides opportunities to develop both problem-solving and teaming skills. Students are required to develop project journals, final reports, and project websites. ETCS has seen a pronounced increase in student retention after the implementation of this program, with a 30% increase in retention during the pilot year when compared to student of the same first-year class enrolled in a concurrent Introduction to Engineering section taught in the old format. [10]

As first-year design courses continue to show their effectiveness, engineering faculty at University of Colorado, Boulder, have developed a first-year engineering course with an important additional feature. Their student projects all include a service-learning component. As with many first-year courses, students work in teams to solve a multi-disciplinary engineering problem, which allows students to develop teaming and communication skills. Students are required to apply knowledge from a variety of courses and improve their problem-solving skills. The truly unique aspect requires students to work with a specific client that has assistive technology needs. Students determine the different design projects that will be required to meet the client's needs. Student teams then identify the problem they wish to solve, evaluate potential solutions that are compatible with the client's needs and financial constraints, and develop a final project. Student projects are actually implemented by the clients, and students gain an awareness of the positive social aspects engineering provides. Graduation results from students who participated in the initial course offerings in 1994 and 1995 show students who participated in this service-learning, first-year, engineering design course were 13% more likely to graduate within 6 years than students who did not participate; indicating the programs positive effect on retention. [11]

As indicated above, a single first-year design course can be effective in improving student persistence to the sophomore year and to graduation. However, other approaches to first year courses have also shown positive effects. Specifically, the University of Pittsburgh developed two freshmen level courses to deal with high attrition rates. These courses were designed to help students recognize the difference between engineering and its support courses in math and science and to begin early student development of problem-solving skills. The courses, Engineering Analysis and Engineering Computing, were problem-driven courses taught in an active-learning format. In addition, the University of Pittsburgh's existing freshmen seminar course was revised to address perceived needs of first-year students. Instead of following the historic format of guest speakers regarding engineering professions, mentors picked and trained from senior engineering students presented the freshmen seminars to small groups of students. Seminar topics focused on major issues for first-year students such as: time management, coping with stress, familiarity with engineering disciplines, and opportunities and programs available at the university. Implementation of these courses saw a 50% decrease in student attrition. Faculty

Copyright © 2005, American Society for Engineering Education

at University of Pittsburgh are currently working to determine factors affecting those students who are still leaving engineering programs. In addition, faculty advisors note many students express concerns with math and science courses and the lack of relevance of the courses in the first-year of the engineering program. As a result, work is currently underway to pilot an integrated first-year curriculum based on the models developed by the Foundation Coalition discussed later in this paper. [3]

Integrated First-Year Curriculums

As noted above by University of Pittsburgh's faculty, individual first-year courses do not directly address the perceived disconnect between the required math and science courses and engineering. In an attempt to improve the integration of students' education and improve the perceived significance of first-year courses, a number of engineering departments and colleges are developing integrated first-year curriculums, which may include linking a series of courses in an attempt to tie first-year subject matter into a cohesive, meaningful block. The level of integration varies significantly between schools and a number of examples of possible approaches are described below.

Colorado School of Mines piloted an integrated engineering curriculum for first-year students during the 1994-95 and 1995-96 school years. The program, *Connections*, developed a learning community for a small number (49 in 1994-95 and 31 in 1995-96) of average first-year engineering students. Students participating in the program enrolled in specially designated sections of first-year courses that limited enrollment to only those students participating in the program. The limited enrollment's intention was to facilitate camaraderie and community building between program participants. The program included the integration of math, science, humanities, and economics courses with a seminar series that required students to study historical, contemporary, ethical, and social aspects of the sciences and engineering. The seminar also introduced project modules that exposed students to interdisciplinary problems whose solutions required application of knowledge from the students' current coursework in their other classes. Student responses from the 1994-95 trial program resulted in the integration of additional mentoring and social connections for support in the following year. The 1995-96 trial was updated and the positive student response to the program only improved. In a follow-up survey administered in Fall 2000, students still provided favorable comments regarding the program. They felt strongly regarding the positive influence of faculty interaction on their quality of learning. They felt they had strong awareness of the cultural, ethical, historical, and contemporary impacts of engineering. In addition, they felt *Connections* enhanced their ability to think critically and apply their knowledge in a variety of contexts. Significantly, a study of the graduation rates of *Connection* participants shows they graduated at rates 25% higher then other engineering students who entered Colorado School of Mines during the same school years. Complete details of this program can be found in [12].

The *Connections* program offered a highly integrated model that required the collaboration of many faculty across a wide spectrum of courses. While this program is an excellent model of a fully integrated curriculum and showed exceptional results, implementation of similar programs may not be a reasonable first step at many institutions. Fortunately, other universities, such as the University of Tennessee, have found success with first-year curriculums that integrate only the STEM courses.

Copyright © 2005, American Society for Engineering Education

In fall of 1997, the College of Engineering at the University of Tennessee introduced the *Engage* program with 60 participants. The overwhelming success of this program prompted its requirement for all incoming engineering first-year students since the fall of 1999. *Engage* consists of two first-year engineering six-unit semester courses. The first course focuses on teaching basic programming and graphic skills. In addition, problem-solving skills are developed using non-calculus based statics and dynamics problems. The second semester uses team projects and active learning to teach calculus-based statics and dynamics. In both classes, team assignments require students to design and build skill-level appropriate projects like foam-core chairs in the first course and egg-bungee and catapults in the second course. Course objectives include the development of skills in written and oral communication, teaming, project planning, idea generation, determining appropriate problem specifications, basic experimentation, and performance prediction. The two six-unit courses replace separate first-year engineering, computer graphics, and physics courses seen in typical engineering curriculums and integrates them into the described two course active-learning series. The courses also include homework laboratories where students perform simple experiments to reinforce fundamental scientific ideas. Finally, sophomore through senior students act as facilitators for first-year teams to assist them in their transition to college life, provide mentoring, and assistance with teaming skills. Although the typical time to graduation for engineering students at University of Tennessee is 6 years, including a year-long internship program, results from the initial *Engage* program showed significant increase in both 4 year and 5 year graduation rates for *Engage* participants. Six-year graduation rates were not yet available. In addition, grade comparisons were made in second year courses between students who participated in *Engage* and those in the control group. Both Fall 1997 and Fall 1998 freshmen *Engage* participants consistently earned grade point averages at least 15% higher than their peers who completed the traditional engineering first-year curriculum. [13]

As the previous models indicate, curriculum integration, primarily in the first-year, has become a popular trend in curriculum reform. Departments and universities that dedicate the time and resources to integrate the first-year experience are likely to find their efforts justified as the literature reports notable increases in student retention and performance. The integration may include only science, math, and engineering courses or can incorporate English and social science courses with the technical classes. Integration may be as simple as linking course sections together to allow students to attend the same sections and develop strong student relationships or can include the interaction of multi-disciplinary faculty to insure topics covered each course are complementary and notation and jargon match across the curriculum. At the 1998 Frontiers in Education Conference, Al-Holou, et. al. presented a description of ten different integrated curriculum efforts at various institution types ranging from large research institutions to community colleges. [14] As with the previously reported efforts, longitudinal studies of student participants suggest that students enrolled in these integrated curriculums demonstrate higher retention rates and equivalent or higher GPAs than comparable students at the same institutions who did not participate in the new curriculums. The Al-Holou, et. al. paper describes the efforts at Rose-Hulman Technical Institute, University of Florida, Texas A&M University–Kingsville, The Ohio State University, Texas A&M University, North Carolina State University, Arizona State University, University of Alabama, Maricopa Community College District, and Drexel University. As details of the ten unique integrated curriculum programs are provided in

Copyright © 2005, American Society for Engineering Education

the Al-Holou, et. al paper, they are not described here-in. Al-Halou, et. al. provide significant insight on the numerous pedagogical models that an integrated curriculum can follow and offer sage advice for developing a successful program. As such, their paper provides an important resource for any department considering developing an integrated curriculum, and can be found at the Foundation Coalition's website, www.foundationcoalition.org along with numerous resources for developing integrated curriculums for both first and second year programs.

Teaching Pedagogy

In the curricular changes noted above, one important similarity in all the programs can be identified. The classroom delivery of the course content has moved away from the traditional formal lecture. As a result, students are engaged in the learning process, students are working collaboratively toward design solutions, multiple learning styles are accommodated, and student/faculty interaction is increased. Can these same pedagogical changes be incorporated into an individual course and still provide benefits to retention? Educational research supports the positive effect of each of these changes on student attitude and performance. Considering the importance of student attitudes, confidence, and engagement in the curriculum on their decisions to stay in engineering curriculums, it becomes apparent that a positive experience with even one faculty member or engineering course can make the difference in whether or not a student leaves engineering.

Further evidence of the importance of student/faculty interaction can be seen in the results of a two-year study on the effectiveness of a first-year engineering course in the Penn State system. As part of the study, researchers looked at the effects of faculty interaction on student achievement and student attitudes. Using the Classroom Activities and Outcomes questionnaire developed by the Center for the Study of Higher Education (CSHE) at Penn State, correlations were made between external factors that could affect a student's ability to make positive progression toward achieving the course objectives in the following four areas: group communication, problem solving skills, occupational awareness, and engineering competence. Researchers compared a number of factors, including gender, SAT scores, year in school, expected grade, collaborative learning, instructor interaction and feedback, and peer climate, to determine their affect on student performance. Data gathered from over 1500 students indicated that only "instructor interaction and feedback" showed strong correlation with positive progression toward each of the four areas of the course objectives described above. This study highlights the need for improved student/instructor interaction, as supported by Seymour and Hewitt's work. Student/instructor interaction can occur both inside and outside the classroom. Design projects and active learning/teaching methods both provide increased opportunities for faculty to connect with students. [15]

When considering the need to teach to multiple learning styles, Richard Felder is a leader in assessing and teaching to the diverse learning styles of our students. Felder completed an experiment to measure the effects of personality type on engineering students' academic performance. Felder purposefully modified his instructional approach in a five course series to favor learning styles that are typically neglected in a formal lecture. For this study, Felder applied the Myers-Briggs Type Indicator (MBTI) personality assessment and required all participating students to complete the Myers-Brigg test. Within the Myers-Briggs

Copyright © 2005, American Society for Engineering Education

classifications, introverts, thinkers, judgers, and intuitors typically outperform their extrovert, feeling, perceiving, and sensing classmates when instructional delivery follows the historical lecture format. An important objective of Felder's study was to determine if active and cooperative learning models would allow extraverts and feelers, who are typically disadvantaged when student interaction is discouraged, to improve their expected classroom performance. In addition, Felder used experimental course instruction, which possessed an inductive nature beneficial to sensing learners. Sensors are typically disadvantaged in comparison to intuitors when theories are presented abstractly without relation to concrete concepts or real-world experiences. At the end of the five course series, Felder found that extroverts, while not performing at the same level as their introvert counterparts in other engineering courses taught using formal lectures, performed at statistically identical grade levels as introverts in his active-learning environment. This is with the exception of weaker students who began the program with lower high school GPAs or admission scores. The "weak" extroverts outperformed their "weak" introvert counterparts in the active and collaborative learning environment. Feelers were not seen to gain any benefit from the active and cooperative learning and consistently performed at levels below their thinker counterparts. However, sensors experienced improved performance due to the inductive learning in Felder's courses and, with the exception of weaker students, performed at identical levels to their intuitive classmates. By showing that utilizing a different teaching style can alter the expected student performance, Felder's work illustrates that no single teaching style will benefit all of our students equally. As such, it is important for faculty to "teach around the learning cycle" to provide learning opportunities for our entire diverse student population. [16]

So how do we do "teach around the learning cycle" and how do we increase student/teacher interaction? For faculty looking to incorporate new teaching pedagogies into their classrooms, the amount of literature available can not only be overwhelming but also misleading. There are a number of alternative teaching methods to lecturing and not all have proven to be effective in improving student learning and attitude. Many faculty will also face resistance from their colleagues who still view active learning as the most recent in a series of teaching fads that do little to improve student performance and attitudes. However, a recent study is now available that sifts through the educational research to not only provide clear definitions of alternative approaches but critically examines the core of each approach and its reported effectiveness. As described in [17] active learning is generally defined as any teaching method that actively engages students in the learning process. Professors who simply break up their traditional lecture every 15 to 20 minutes with two-minute activities, which could include various activities such as discussing a question, solving part of an example problem, or to telling an anecdotal story, will find improved student retention in the course material. More advanced techniques of active learning include collaborative learning, cooperative learning and problem-based learning as defined in detail in [17]. Collaborative learning describes any form of instruction where students are working together toward a common goal. Cooperative learning also involves students working together toward a common goal. However, it distinguishes itself from collaborative learning in that its definition requires each student to be assessed individually. Finally, problem-based learning uses a problem presented at the beginning of the material content to provide motivation and example for the development of new topics. Each of these methods has been shown to promote academic achievement and positive student attitudes, which

Copyright © 2005, American Society for Engineering Education

we now know is correlated with student retention. This study provides a valuable resource to anyone incorporating active learning into his or her teaching approach for the first or 100th time.

Reflections

The problem of retention of engineering students has been the focus of discussion since the 1980's. However, it was not until the landmark study of Seymour and Hewitt that many of us developed any understanding why students were leaving. Unfortunately, too few faculty are aware of this report or have the time to devote to reading it. Sitting in on most department meetings will reinforce that the apparent mismatch between student and faculty perceptions on course difficulty and course instruction, which was reported in Carter and Brickhouse's [5] study in 1986, can still be found today. As a result, this paper attempts to provide an overview of those factors negatively effecting student retention. In addition, a review of a number of curricular and pedagogical changes that have proved successful in improving retention are highlighted. While this literature study does not and cannot include all efforts occurring nationally, it does show that faculty have found methods that are working. Further, models are now available for others who are looking to increase retention at their own universities. The literature shows that changes do not have to be all encompassing to influence retention rates. A single instructor improving student engagement and student/teacher interaction can improve student attitudes and performance, and on a smaller scale, have a positive effect on student retention, which in the end should be a goal for us all.

References

[1] Consortium for Student Retention Data Exchange, July 2003, "2002-03 STEM Retention Report – The Retention and Graduation Rates of 1995-2001 Freshman Cohorts Entering in Science, Technology, Engineering and Mathematics Majors in 211 Colleges and Universities," Center for Institutional Data Exchange and Analysis, Norman, OK

[2] Seymour, E. and Hewitt, N., 1997, *Talking About Leaving: Why Undergraduates Leave the Sciences*, West View Press, Boulder, CO

[3] Shuman, L., et. al., 1999, "Matching Assessment Methods To Outcomes: Definitions And Research Questions", *Proceedings of the 1999 ASEE Annual Conference,* Charlotte, NC

[4] Zhang, G., et. al., 2004, "Identifying Factors Influencing Engineering Student Graduation: A Longitudinal and Cross-Institutional Study", *Journal of Engineering Education*, Vol. 93, No.4 pp 313 – 320

[5] Carter, C.S., and Brickhouse, N.W., 1989, "What Makes Chemistry Difficult? Alternative Perceptions", *Journal of Chemical Education*, Vol. 66, pp. 223 – 225

[6] Feynman, R. P., 1984, *Surely You're Joking, Mr. Feynman!: Adventures of a Curious Character",* WW Norton & Co, New York, NY

[7] Perlmutter, D. D., 2004, "Teaching the 101, A Tenured Professor Makes a Case for Why Introductory Courses Should Not Be Left to Adjuncts and TA's", *The Chronicle of Higher Education*, September 10, 2004, pp C1

[8] Felder, R.M., 1996, "Matter of Style", *ASEE Prism*, Vol. 6, No. 4, pp 18-23

Copyright © 2005, American Society for Engineering Education

[9] Mullins, C.A., et. al., 1995, "Freshman Expectations of an Engineering Program", *Proceedings of the 1995 ASEE Annual Conference,* Anaheim, CA, Vol. 1, pp 173 – 178

[10] Pomalaza-Ráez, C. and Groff, B., 2003, "Retention 101: Where Robots Go… Students Follow", *Journal of Engineering Education*, Vol. 92, No. 1, pp 85 – 90

[11] Picket-May, M., and Avery, J., 2001, "Service Learning First-year Design Retention Results", *Proceedings of the 31st Frontiers in Education Conference*, Reno, NV, Oct. 2001

[12] Olds, B.M and Miller, R.L, 2004, "The Effect of a First-Year Integrated Engineering Curriculum on Graduation Rates and Student Satisfaction: A Longitudinal Study", *Journal of Engineering Education*, Vol. 93, No. 1, pp 23 – 35

[13] Parsons, J. R., et. al., 2002, "The Engage Program: Implementing and Assessing a New First-year Experience at the University of Tennessee", *Journal of Engineering Education*, Vol. 91, No. 4, pp 441 – 446

[14] Al-Holou, N., et. al., 1998, "First-Year Integrated Curricula Across Engineering Education Coalitions," *Proceedings of the Frontiers in Education Conference*.

[15] Bjorkland, S.A., et. al., 2004, "Effects of Faculty Interaction and Feedback on Gains in Student Skills", *Journal of Engineering Education*, Vol. 93, No. 2, pp 153 - 160

[16] Felder, R.M., et. al., 2002, "The Effects of Personality Type on Engineering Student Performance and Attitudes", *Journal of Engineering Education*, Vol. 91, No. 1, pp 3 – 18

[17] Prince, M., 2004, "Does Active Learning Work? A Review of the Research", *Journal of Engineering Education,* Vol. 93, No. 3, pp 223 - 232

TONYA L. EMERSON, Ph.D., P.E., Assistant Professor of Civil Engineering, Director – First-Year Experience
Dr. Emerson is in her 4th year at CSU, Chico where she is the faculty advisor to SWE, ASCE and Minds in Motion. She is the newly appointed 1st-Year Experience Director for a program dedicated to improving student engagement for all 1st year students. Dr. Emerson received the 2002 ASEE's Glen L. Martin Best Paper Award and the 2003 ASEE Gerald R. Seeley Fellowship. She recently received a Professional Achievement Award from CSU, Chico.

MICHAEL WARD, Ph.D., P.E., Professor of Mechanical Engineering, Associate Dean
Dr. Michael Ward is Associate Dean of the College of Engineering, Computer Science and Construction Management at CSU, Chico. He previously served as department chair and faculty in Mechanical Engineering. He earned his PhD in ME from Stanford in 1983. Dr. Ward recently completed a current assessment for CSU, Chico of persistence rates in computer science and engineering for Fall 00 to Spring 04, which provided data for this paper.

Copyright © 2005, American Society for Engineering Education