

**AC 2007-2270: INSPIRING STUDENTS — THE KEY TO LEARNING FOR THE FUTURE**

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# Inspiring Students—The Key To Learning For The Future

## Abstract

This paper considers the implications of preparing engineering students to enter, live, and be successful in a “Flat World.” Clearly the exact needs of the future are not known for certain, but we do know that civil engineers of the future will need to be flexible, adaptive, life long learners. All academic institutions and all disciplines aim at preparing students for the future, at our institution the mission statement begins with “To educate, train, and inspire . . .” While the entire mission is specifically geared toward the unique role of our institution and encompasses many areas beyond a traditional undergraduate education, it holds what the authors think is the key to preparing students for the uncertainty and challenges of the future and their current learning—to educate, train and **inspire**. The authors feel that educating and training alone are not enough; it is only with the addition of inspiration that we will create life long learners and ensure their education adequately prepares them for a dynamic and uncertain future.

In considering the changing and increasingly flat world, the role of the traditional educational process, teaching concepts, theories, methodologies, etc. cannot be minimized. In fact, the role of this type of education is increasingly important to their success. In the future, students will certainly need fundamental skills as assuredly as they need them today. However, much more will be required of them than what we teach them today; we must prepare them to not only learn pertinent skills for today but more importantly create in them a yearning for and an ability to become life long learners. The authors propose that the ability to become a life long learner is best achieved through inspiration, which should be a critical part of their undergraduate educational process. This paper considers various educational theories dealing with motivation for learning, recommendations from ABET and The Engineer of 2020 and highlights their calls for what we term “inspiring students.” The paper then analyzes various effects and parts of a civil engineering program to include guest speakers, case studies, field trips, summer enrichment opportunities, ASCE Student Chapter events, and service learning projects that can be used to do more than merely educate and train students, but also to inspire them.

## Introduction

The purpose of any educational endeavor is to impart learning; for engineering education, an additional practical element is included to provide students with the necessary skills and attributes to prepare them for their future applications of engineering. At this point, the exact needs of the future are not known; but we do know that engineers of the future will need to be flexible, adaptive, life long learners. Much has been written about the future our students will encounter, where the “world is flat,” more technologically based, and subject to rapid advances in all fields. All academic institutions and disciplines aim at preparing students for the future, our department’s current mission statement is: “To educate cadets in civil and mechanical engineering, such that each graduate is a commissioned leader of character who can understand, implement, and manage technology; and **to inspire** cadets to a career in the United States Army and a lifetime of personal growth and service.” This mission statement represents an intentional change that took place in August 2004 and was made very deliberately to emphasized the inspire

portion of the mission. Prior to that time our department mission statement mirrored our institutional mission statement, which begins “To educate, train, and inspire the Corps of Cadets...” While the authors’ department statement began with “To educate and inspire the Corps of Cadets in civil engineering, mechanical engineering, and engineering mechanics...” Both then ended in the same way “so that each graduate is a commissioned leader of character committed to the values of Duty, Honor, Country and prepared for a career of professional excellence and service to the Nation as an officer in the United States Army.” While the word inspire was included in both, it is a term that was not separately thought of or emphasized, “educate, train and inspire” was thought of as one entity, and still is at the Academy level. The Authors’ department, however sought to differentiate between the educate and inspire portion, and to suggest that inspire was something beyond the normal education process, something that added to lifetime growth. This aspect holds what the authors think is the key to preparing students for the uncertainty and challenges of the future and their current learning—to ... inspire them. In considering the changing and increasingly flat world, we must prepare our students to enter it. They must understand that the role of the traditional education process, teaching concepts, theories, methodologies, etc. cannot be minimized. In fact the role of this type of education is increasingly important to their success. Students will certainly need fundamental skills to call upon in the future as assuredly as they need them today. However, much more will be required of them than what we teach them today; we must prepare them to not only learn pertinent skills for today but more importantly create in them a yearning for and an ability to become life long learners. The authors feel that education alone is not enough. It is only with the addition of inspiration that our students will want to be life long learners ensuring their education adequately prepares them to face the challenges of an uncertain and dynamic future.

Much has been written about engineering education. In fact, Bruce Seely writes in the NAE report that “Engineering education has been the subject of more studies and reviews, formal and informal, than any other domain of professional education.”<sup>1</sup> We will examine some of the recent reports that call for change in engineering education, chiefly the National Academy of Engineering (NAE) publication Educating the Engineer of 2020 – Adapting Engineering Education to the New Century<sup>1</sup> and the ABET, Inc. “PROPOSED Criteria for Accrediting Engineering Programs.”<sup>2</sup> While none of these reports mention inspiration by name, the authors clearly hear the cry to inspire students as being the key to accomplishing many of the aims addressed in the publications.

### **The Engineer of 2020**

The following statements are recommendations from the NAE Committee on the Engineer of 2020, Phase II,<sup>1</sup> many of which require inspiration of the students to accomplish. The authors find that without that added element of inspiration the likelihood of success is minimal:

1. The baccalaureate degree should be recognized as the “pre-engineering” degree or Bachelor of Arts in engineering degree, depending on the course content and reflecting the career aspirations of the student.
2. ABET should allow accreditation of engineering programs of the same name at the baccalaureate and graduate levels in the same department to recognize that education

through a “professional” master’s degree produces an AME, an accredited “master” engineer.

3. Engineering schools could more vigorously exploit the flexibility inherent in the outcomes-based accreditation approach to experiment with novel models for baccalaureate education. ABET should ensure that evaluators look for innovation and experimentation in the curriculum and not just hold institutions to a strict interpretation of the guidelines as they see them.
4. Whatever other creative approaches are taken in the four-year engineering curriculum, the essence of engineering—the iterative process of designing, predicting performance, building, and testing—should be taught from the earliest stages of the curriculum, including the first year.
5. The engineering education establishment, for example, the Engineering Deans Council, should endorse research in engineering education as a valued and rewarded activity for engineering faculty as a means to enhance and personalize the connection to undergraduate students, to understand how they learn, and to appreciate the pedagogical approaches that excite them.
6. Colleges and universities should develop new standards for faculty qualifications, appointments, and expectations, for example, to require experience as a practicing engineer, and should create or adapt development programs to support the professional growth of engineering faculty.
7. As well as delivering content, engineering schools must teach engineering students how to learn, and must play a continuing role along with professional organizations in facilitating lifelong learning, perhaps through offering “executive” technical degrees similar to executive MBAs.
8. Engineering schools introduce interdisciplinary learning in the undergraduate environment, rather than having it as an exclusive feature of the graduate program.
9. Engineering educators should explore the development of case studies of engineering successes and failures and the use of a case-studies approach in undergraduate and graduate curricula.
10. Four-year engineering schools must accept it as their responsibility to work with their local community colleges to ensure effective articulation, as seamless as possible, with their two-year programs.
11. U.S. engineering schools must develop programs to encourage/reward domestic engineering students to aspire to the M.S. and/or Ph.D. degree.
12. Engineering schools should lend their energies to a national effort to improve math, science, and engineering education at the K-12 level.

13. The engineering education establishment should participate in a coordinated national effort to promote public understanding of engineering and technology literacy of the public.
14. NSF should collect and/or fund collection, perhaps through ASEE or the Engineering Workforce Commission, of comprehensive data by engineering department/school on program philosophy and student outcomes such as, but not exclusively, student retention rates by gender and ethnicity, common reasons why students leave, where they go, percent of entering freshman that graduate, time to degree, and information on jobs and admission to graduate school

Again, while not directly calling for the inspiration of students, the authors firmly believe that this is, in fact, the key to achieving recommendations 1, 3, 4, 6, 7, 9, 11, 12, and 13. It may also be the key to solving the unstated problem alluded to in 14 as well.

Recommendation number 1 and 7 emphasize the continual learning required for professional practice. Number 1 reflects a major paradigm shift indicating that the baccalaureate degree is just the first step in the process of professional development for engineers. As such, students must not view their undergraduate degree as the end of a process, but just the beginning. Similarly, number 7 recognizes that life long learning is required. This is clearly a call for students to do more; if they do not leave the baccalaureate process inspired to continue on, there is little chance to fulfill this recommendation.

In recommendations 3 and 4, the concept of inspiring students is subtly suggested. In number 4, the idea of starting the essence of engineering at the earliest possible time, can only be seen as a way to inspire students. This serves to capture students' imaginations and excites them about the beauty and wonder of engineering. Recommendation 3 is a call for educators to look at teaching methods that are new and different, that go beyond the norm, making the process of learning engineering inspiring or at least more inspiring.

The link to the real world is emphasized in recommendations 6 and 9. By tying education to real world experiences, students will be exposed to the practical world of engineering and the application of what they learn in the classroom. The excitement of facing real world challenges, as opposed to seemingly endless classroom problem sets, cannot help but inspire students and help them link classroom instruction to the real world.

The final recommendations, 11 and 12, and largely 13 as well, are all about inspiration. By providing inspiration, whether at the K-12 age or to students in undergraduate studies, we can hope to attract more students to the profession. By educating the public, as mentioned in 13, we can also hope to garner more support for the profession, from the general population, which will likely have an impact on future students as well. Future students are probably best attracted by planting the seeds of what engineering is and inspiring them to the benefit and wonders of engineering before they ever enter institutions of higher education.

Students, regardless of demographics, are likely not attracted to engineering because of the academic rigor, hard work, and long hours of study required. There is little chance they remain in these programs because of the same factors. A reputation for inspiring students, will likely address the underlying reasons that recommendation 14 is included.

## **ABET**

ABET continues to strive to improve the accreditation process as reflected in the existence of both a criteria for 2006-2007, as well as a proposed criteria for 2007-2008. Complete information is readily available on the ABET website. Of special note in Criterion 3: Program Outcomes and Assessments (in 2006-2007) and Outcomes (in 2007-2008) which states

- (i) a recognition of the need for, and an ability to engage in life-long learning

The importance of life long learning and an ability to engage in it can only be accomplished if students are inspired to continue on in the profession, to recognize its value, demands, changing nature, and joys. An argument can be made that other criteria require inspiration as well to be accomplished. “Extensive research has shown that students learn best when they perceive a clear need to know the material being taught.”<sup>3</sup> Being able to relate what is done in the classroom to skills needed in future courses or better yet in their future careers is a huge motivator to students.<sup>4</sup> If students believe they really do need to master a skill, they will tend to work harder at learning and will do their best.<sup>5,6</sup> Without providing inspiration, the educational connection and desire to accomplish it may be lost. Criteria such as the following fall into this category:

- (e) an ability to identify, formulate, and solve engineering problems
- (f) an understanding of professional and ethical responsibility
- (h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- (j) a knowledge of contemporary issues

## **Inspiring Students**

The ways to inspire students are countless, and probably no two students respond to the same methods. The following is a listing and brief analysis of some of the ways the authors have found to be effective. These include sharing relevant faculty experience, guest speakers, case studies, field trips, summer enrichment opportunities, professional organization student chapter events, and service learning projects. Each of these methods can be used to do more than merely educate and train students, but also to inspire them.

While our school’s unique mission, faculty structure, and role in higher education offers some unique opportunities to share relevant experiences, (a vast majority of our faculty are in the profession that all of our students will enter a upon graduation, and are teaching as a three-year

assignment before returning to the “field”) this is something that clearly is available to other professors as well, especially as we move as a profession to implementing NEA recommendation number 6. The authors have found great benefit to taking 5 minutes from a class periodically to talk about our profession and our experiences. The topic can be related directly to the class, in response to a question about the profession, something unrelated to the subject matter, something the professor thought would be good to share, or a current event. While not requiring much time or effort, the authors have found the payoffs to be great. Countless end-of-course surveys have specifically mentioned this habit, never specifically emphasized in class, as being beneficial, motivating, and very valuable to students. Because this small time investment does not appear as part of the class and is often times unrelated, it attracts and captures the students’ attention. It also aids the professor in developing rapport, a key component to in becoming an exemplar in the classroom and maximizing the learning taking place.<sup>7</sup>

Guest speakers can provide an inspirational element not available from within the university. Putting students in front of engaging speakers is clearly a way to convey to students the “essence of engineering” as well as exposing them to the growing interdisciplinary nature of engineering projects and solutions. Interesting case studies can also be introduced to students and then further explored in individual courses where appropriate. The right speaker can inspire students in a way their normal classroom professors cannot do. They bring the credibility of someone who is out there “doing it” that professors usually lack. They also can provide the reason why the current course of study is applicable and can cause students to consider things in a different light. A young speaker can address challenges faced and overcome and can help students better understand what they will soon face. A seasoned member practitioner can lend the insight of experience that students lack and can often present the material in the form of a case study. The authors have brought in a diverse group of speakers in recent years to include a recent graduate with engineering experience in Afghanistan, the senior Vice President of a real estate development firm, a former CEO of a large internationally know civil engineering and construction firm, and an engineer software developer just to name a few. Each of these, and other speakers, were able to communicate a more diverse and unique view of the profession that professors were not able to bring, as well as to get the students to view the profession in a new and different light.

Internships and enrichment opportunities can also provide large doses of inspiration to students and provide a nice change of pace from the classroom. Often a glimpse of the real world is all that is required to make the classroom seem all the more applicable and important. We have had a successful relationship with the US Army Corps of Engineers for more than 20 years where they have provided summer internships for students on various projects and in labs across the globe. We have also been able to send students to Europe in the summer to look at historic classical structures that provide a link to the past and the foundation for current and future structures.

Independent study and service learning projects have been a key part of our educational program and have often served to inspire our students to achieve great things and to learn much more than they would in a traditional classroom environment. By their very nature, these projects are often out of the ordinary, can provide a tangible physical result, or take a student in directions of their own choosing. Students realize they are responsible for what is getting done and that fact alone

provides a degree of motivation and inspiration that often triggers great learning. In recent years we have had students design and construct foot bridges, study the effects of very high strength concrete, design homeland security training facilities, analyze the effect of runoff and erosion at a local golf course and design a solution to the problems encountered, and investigate the effects of fire on steel buildings in a research setting. Whether practical design-build or scholarly research projects in which students are given a chance to take ownership, the authors have observed students excel almost universally beyond all expectations, due largely we feel to an inspiration they feel from taking on the project. Community service learning projects offer all of the opportunities noted above, and can also be a vehicle to improve math, science and engineering education in the K-12 levels. Service projects often promote public understanding of engineering and technology as the public sees the fruits of the students' labor. These service projects also typically provide a "hands on, learn by doing" experience with project management, team work and leadership.

Student involvement with professional societies, largely through student chapters has been a huge source of inspiration for our students. The student chapter officers benefit from attending national and student conferences and meetings where they gain a much better understanding of the profession. They are also able to communicate this sense of belonging to a larger body to other students. Activities that range from social events, speakers, participation in national competitions, service projects, as well as sessions dealing with ethics and professional licensure are all part of the program. The association and contact with the professional society introduces students to an important part of being a professional after graduation and can help them see beyond the narrow view of an academic university. They are connected to a larger body with a similar purpose and can see the common bond in the profession. Often times, they have faculty and practitioner advisors who are long standing members of the professional organizations as well. Active student groups include most or all of the civil engineering majors in a program and these students participate in the vast majority of activities, such as those listed below.

- Professional meetings: Meetings are held periodically throughout the year that focus on a business or technical presentation, usually given by an outside speaker. Examples of the wide variety of presentations at a meetings include: real world case studies, project management discussions, briefings on engineering projects, technological advances in the discipline, cutting edge research, lessons learned through a career in engineering, introductions to advanced engineering software, business practices, the role of a new engineering graduate in a firm, preparing for job interviews, resume writing and opportunities in the engineering field.
- Giving outside presentations: Student chapter members make engineering presentations to audiences outside of the college or university. These have included presentations at technical conferences, project briefs to local planning boards, classroom presentations to K-12, and presentations about the organization itself to potential sponsors.
- Planning and conducting field trips: Typical field trips take students on-site to see engineering related work, projects, businesses or historical sites.
- Planning and holding social functions: This may well be the most popular activity, but often serves as a catch or spring board for a student's greater involvement, and provides great opportunities for out of class student faculty interaction. These events can be tied to specific milestones in the academic year such as start of the term, end of the term, FE exam, or tied to a holiday, an organization's special project or just an opportunity to get students together.

- Hosting the professional society's meetings: This allows students to interact with local professionals on their home turf and integrates them into professional societies. This also serves as a way for the local societies to see what students are doing and to meet with them.
- Attending professional society's meetings: This provides an introduction to professional society activities.
- Attending or hosting a Student Conference: This provides students an opportunity to compete and interact with students from different universities and also introduces them to the idea of a professional conference. This task provides the host school with an exceptional leadership and project management opportunity in often-times a year long effort. Students must work with budgets, fundraising, scheduling, arrangement of food and lodging, recruiting judges, and administrative and logistical support.
- Participating in student competitions: These competitions provide project management experience in designing and building in accordance with a given set of specifications taking into account economy, efficiency, constructability, and require a high level of teamwork to be successful.
- Publishing a newsletter or website: This provides another opportunity for students to work on communication skills.
- Attending a national professional society event: This usually involves limited numbers of students but provides an opportunity to associate with the larger professional society.
- Organizing and conducting service projects: These projects can vary greatly in scope and range from highway clean up, working with Habitat for Humanity, running food drives, K-12 outreach, judging science fairs, tutoring at-risk students in math and the sciences, to designing and building bridges, play grounds, and simple structures for communities. The larger projects usually involve extensive planning, fundraising, seeking approval from various municipal boards and agencies, team work, leadership and many person hours of work. Even the smaller projects give individual members leadership opportunities and provide students with a chance to give back to the greater community.
- Submitting an annual report: This provides practice in communications skills in a document that is a combination of a technical report and a year book for the organization. The annual reports are often submitted to the national organizations where they are evaluated and judged for awards, with each group receiving direct feedback on both their report and their group's activities over the past year.<sup>8</sup>

In all these activities, students work together, often without credit, only because they are a member of the profession. The authors have seen this as a way to create inspiration both for and from students and often see direct benefits in the class room.

Many perceive the biggest shortcoming of undergraduate engineering education to be its apparent lack of wide-spread appeal, and its inability to retain many who start out in engineering programs. We firmly believe that inspiring students, not just providing them instruction in engineering, will go a long way towards addressing these issues. Further, we strongly suspect that students who are inspired as undergraduates, who are exposed to the full flavor of engineering, and who have opportunities for hands-on activities will be more interested in pursuing advanced engineering degrees.

## Has this worked?

Admittedly the authors have not been rigorously collecting assessment data specifically on inspiration and its role, however, they have noted some data that points to the success in emphasizing inspiring students in addition to, or more accurately as a critical part of, educating students. The institution has a common survey that each student fills out on line each semester for every course. One question posed is; “My motivation to learn and to continue learning has increased because of this course.” Students answer on a scale of 1 to 5, with 5 being strongly agree, 4 agree, 3 neutral, 2 disagree, and 1 strongly disagree. While both the institution wide scores and the civil engineering program scores are relatively high, there is a positive delta, averaging 0.29, for civil engineering courses each semester since the new mission statement was introduced and the increased emphasis on inspiration was given, see Figure 1 below.

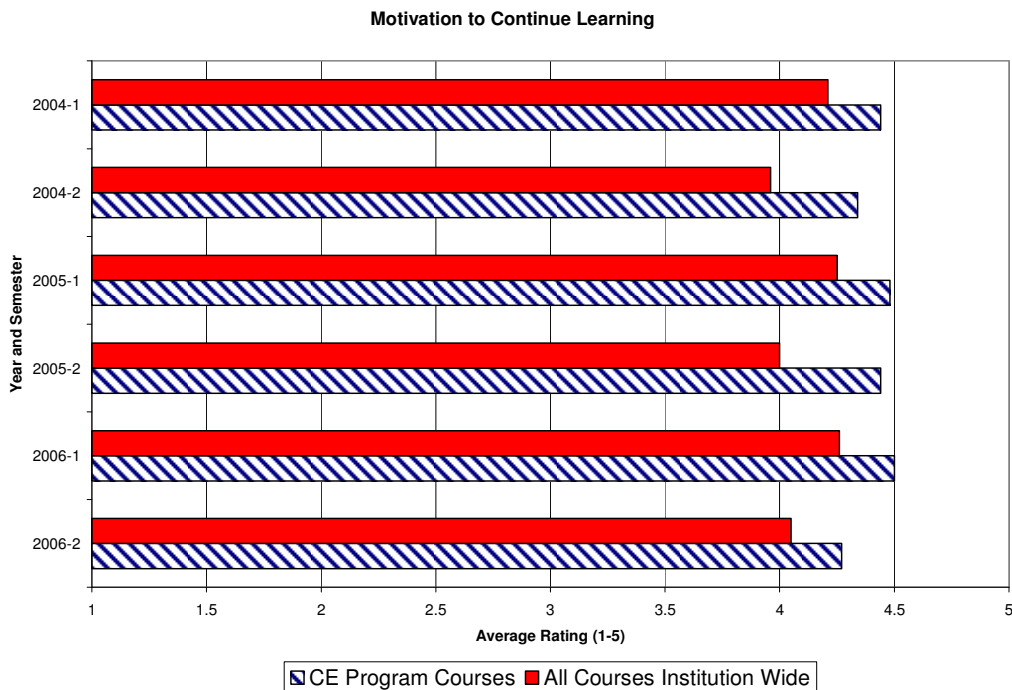


Figure 1

Anecdotally, the ASCE student chapter has been recognized as the best student chapter in the Northeast for each of the past 3 years and has been a finalist for the best chapter in the nation for two of the past three years. The Student Chapter is of course a conduit to many of the activities listed above as ways to inspire students. Chapters are evaluated by ASCE on their programs and activities as provided in an annual report.

As an additional litmus test, examination of student performance on the FE exam since emphasizing the importance of inspiration in the department’s mission statement in 2004 shows an increasing trend, see Figure 2. At the USMA, all ABET engineering majors take the FE exam regardless of their chosen branch in the Army and regardless of whether they will practice engineering upon graduation. The authors like to think that inspiration has played an important role in improving FE exam scores.

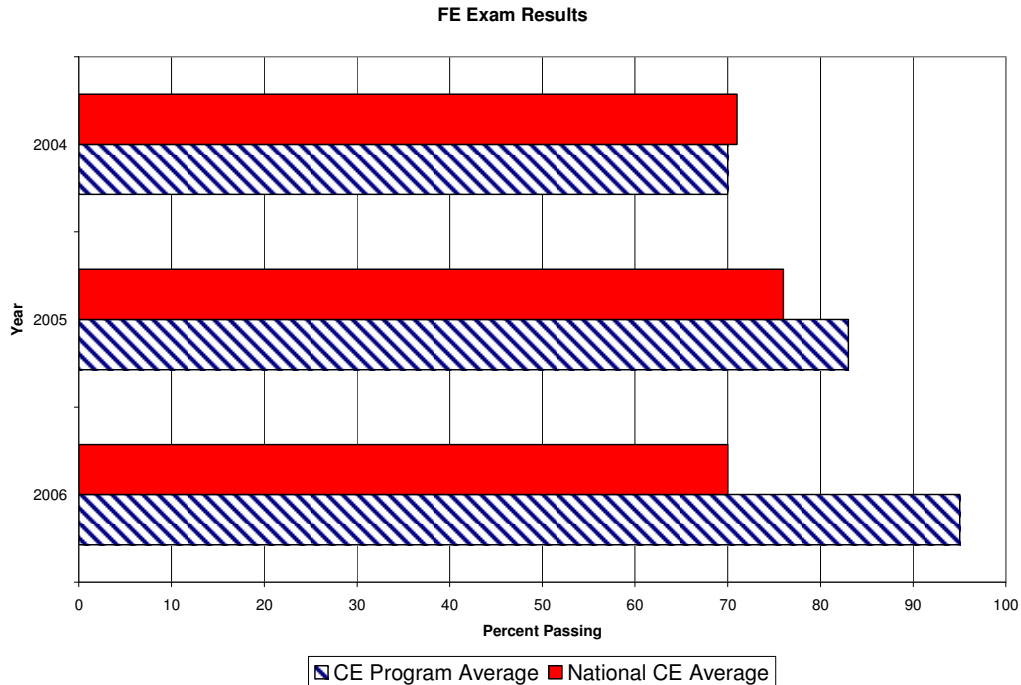


Figure 2

None of these rough assessments alone conclusively prove that inspiration increases learning or creates life long learners. The authors do believe that they are indicators that do show the positive benefits of inspiring students.

### Bibliography

1. Committee on the Engineer of 2020, *Educating the Engineer of 2020 - Adapting Engineering Education to the New Century, Phase II*. 2005, National Academy of Engineering, National Academies Press: Washington, DC.
2. Accreditation Board for Engineering and Technology, *PROPOSED Criteria for Accrediting Engineering Programs*, in *CRITERIA FOR ACCREDITING ENGINEERING PROGRAMS - Effective for Evaluations During the 2006-2007 Accreditation Cycle*. 2005.
3. Felder, R.M., *Changing Times and Paradigms*. *Chemical Engineering Education*, 2004. **38**(1): p. 32-33.
4. Felder, R.M. and R. Brent, *FAQs IV Dealing with Student background Deficiencies and Low Student Motivation*. *Chemical Engineering Education*, 2001. **35**(4): p. 266-267.
5. McKeachie, W.J., *Teaching Tips: Strategies, Research, and Theory for College and University Teachers*. 10th ed. 1999, Boston: Houghton Mifflin.
6. Wankat, P.C. and F.S. Oreovicz, *Teaching Engineering*. 1993, New York: McGraw-Hill, Inc. 370.
7. Lowman, J., *Mastering the Techniques of Teaching*. 2nd ed. 1995, San Francisco: Jossey-Bass. 344.
8. Hamilton, S.R., C. Conley, and D. Hains. *ASCE Student Chapters: A Contributor to Achieving Program Goals*. in *ASCE National Conference & Exposition*. 2006. Chicago, IL.