An Effective Teaching Strategy for Motivation and Retention of Engineering and Technology Freshmen

Zia Razzaq
Department of Civil & Environmental Engineering
Old Dominion University, Norfolk, Virginia 23529

Abstract

The introduction of a pair of new courses titled "Explore Engineering and Technology I and II" at Old Dominion University has yielded dramatic results in both motivating and retaining freshmen. Each course is of two credit hours and is divided into three five-week modules. Each five-week module is taught by a faculty member from civil, environmental, mechanical, electrical or another engineering and technology area. The emphasis is on "hands-on" experience through student group projects coupled with a clear introduction to some related fundamentals. This paper outlines an effective strategy while utilizing as an example the student projects involving structural engineering. A very dramatic increase in the retention rate of the freshmen has been observed ever since these courses have been introduced.

The Logistics

In order to motivate and retain the maximum possible number of students, two courses named "Engineering and Technology I and II" have been introduced at Old Dominion University. Hereinafter, these courses will be referred to as EET I and EET II. Two courses each of 2 credit hours were found to be necessary as opposed to a single one since each department generally has two specialty areas, for example, civil *and* environmental, electrical *and* computer engineering. Thus, a civil project can be covered in EET I and an environmental one in EET II. Each course is divided into three five-week modules or sessions. In a given week, there are two class/laboratory periods each of a 75-minute duration, and one recitation period of 50-minute duration.

Typically, the first class period is used by the instructor to introduce the related engineering or technology area related to a laboratory project. In addition, the instructor briefly explains about the type of professional opportunities available after graduation. The second class period is utilized to explicitly define the overall requirements and constraints for the project. During the third class period, each student group makes a brief presentation about the proposed project before the class followed by an active discussion by the listeners. The remaining class periods are used by the students to actually build and eventually test their models. A typical class of, say, 45 students is divided up into five groups with nine students in each group. Each group acts like a

consulting board which must manage all of its activities in a timely and effective manner. The laboratory work is further facilitated with additional help from a teaching assistant.

There are a variety of approaches for utilizing the recitation periods effectively. The author uses four of these periods for actual engineering numerical problem-solving conceptually related to the project. The fifth period is used by the head of the engineering "co-op" office who teaches them about professional resume preparation and how to develop an effective approach to get jobs in the engineering and technology marketplace.

Students purchase their own materials to construct the models and in a typical group of, say, nine students, the cost of materials amounts to about five or so dollars per person. The direct acquisition of the materials by the students is more effective than the college providing them, for three reasons. First, there is a very wide variety of available engineering materials and it is not feasible for a school to have a storehouse. Second, it is highly desirable for the students to visit commercial materials supply stores and begin to develop knowledge of what is out there for use in real engineering projects. Third, it persuades them to involve themselves in practical decision-making while keeping in mind the functional, aesthetic, and cost factors. The basic tools for fabricating the models, however, are provided by the college since they tend to be far more expensive than the materials. The students are also encouraged to use the campus engineering workshops thus providing added opportunity to familiarize themselves with some of the fabrication equipment used in real life.

By the time a student has completed both ENGN I and II, she or he has completed six different projects in the same number of different engineering and technology areas. This experience also provides an opportunity to the student to re-assess and change, if necessary, her or his plan for specializing in a particular field.

Some Causes of Student Dropout

As soon as a freshman initiates a program of study after high school, she or he is 'bombarded' with a number of courses in English, Chemistry, Mathematics, Humanities, etc. The chemistry and mathematics course instructors are pure scientists and mathematicians who typically have little interest in relating their subjects to even a few applications in engineering. This leads to a confused and discouraged state of mind for the student who can conclude by saying that "if this is engineering, I don't really want it!" The teaching style and philosophy of the chemistry and mathematics instructors is also typically more suited for students specializing in those subjects rather than for engineering students. Their emphasis seems to be more on a high-speed coverage of as many hard-core fundamentals as possible in the purest form. This results in vast numbers of engineering students receiving poor grades who, before even taking any engineering courses, then conclude that they will not succeed in engineering. Furthermore, they drop out of the program when they are given an *unbalanced* perspective of the importance of mathematics and chemistry by the campus community.

Historically, a number of schools have introduced a course typically called "Introduction to Engineering" with one to three credit hours in which up to three instructors team-teach. Old

Dominion University also had a course like that, however, it did not seem to have much effect on student retention rates. This type of a course, as it still exists on a large number of U.S. campuses, is taught in a classroom-lecture mode with little hands-on practical experience. Occasionally, the course requires conceptual engineering design leading to a term-paper-like end product. This type of an approach not only gives a limited exposure to the various branches of engineering to the students but also provides no physical end product and how it may perform. What makes the situation even more deplorable is when instructors unsuited to teach the freshman are given this responsibility.

When the students enter a supposedly engineering program, they have a strong psychological need for a sense of belonging to the school or college of engineering. Instead of spending any time over there, they are taking courses anywhere but in engineering. They feel that the engineering school or college has kind of "orphaned" them. Not being able to see with a lot of clarity "what may lie ahead" for them on the campus, the end result is a sense of inherent restlessness and desperation. Furthermore, although each student is assigned an engineering faculty advisor, that alone gives them the same feeling as watching a poster of a movie outside a cinema hall rather than seeing the actual movie. They can talk to each other all they want but the conversations during the advising sessions are not giving any real engineering knowledge or experience to the student. The freshmen are too eager to get involved in studies directly related to engineering and when that is absent, the urge for so many to drop out of the program increases. These findings are based on extensive interviews with the students during the advising periods.

A Strategy for Motivation and Retention

Several steps can be taken for increasing the motivation and retention levels of engineering freshmen:

1. Assign as freshmen academic advisors only those instructors who are well-known for their effective teaching. These advisors need to spend more time with the freshmen during advising in order to periodically make them aware of the challenges and possible difficulties particularly in chemistry and mathematics courses. They can also suggest concrete ways to improve the study habits of the freshmen.

2. Offer required freshmen engineering and technology courses during their very first two semesters, involving several different hands-on projects in various fields of engineering and technology.

3. Introduce simple principles and formulas for engineering problems to the freshmen without getting carried away with derivation. Instead, for example, explain the physical meaning of the variables present in a given formula and demonstrate its use in a practical engineering problem. During the recitation periods, let the students also solve actual numerical problems using the engineering formulas. This gives them a sense of definite achievement and success before they leave the class.

4. Give the freshmen a sense of belonging to the engineering and technology program from day

one on campus. A lunch or other mode of gathering under the supervision of an engineering freshmen program director is found to be immensely helpful, followed by a well-coordinated registration session. The presence of all of the academic advisors during the freshmen registration sessions has also been found to immensely reduce the stress and anxiety levels in the freshmen. The interaction with these engineering academic advisors also gives the freshmen added sense of belonging to the engineering and technology programs.

An Example of Students' Project

A variety of student projects in various branches of engineering and technology have been assigned with great success in each of the ENGN I and II courses. As a part of the ENGN I course, the author has assigned a number of projects in the field of structural engineering. These included constructing models of suspension bridges, arched bridges, pedestrian bridges, tensegrity structures, transmission structures, and very tall buildings. One particular class of students was assigned scale-model building of one of the World Trade Center towers except that they were allowed to use any construction materials and design configurations of their choice. Five different groups produced their individual models each of which was subjected to an impact load at mid-height attached to a heavy swinging steel pendulum. Figure 1 shows a typical model of the World Trade Center under test. The impact was an approximate simulation of a terrorist plane attack. The freshmen students found the testing of these models as the most exciting and

Figure 1. Model of World Trade center tower about to be impacted at mid-height

enjoyable experience. Upon impact, some towers just toppled off, teaching the students the importance of proper foundation conditions while others developed intriguing structural failure mechanisms. The students took an immense amount of interest in conceiving, constructing, and testing the towers. The entire class 'roared' with excitement each time the heavy pendulum struck a tower!

Retention Rates

The methodology described in this paper was originally introduced at ODU over a six year ago initially on a trial basis with a special section of 35 freshmen. By the end of the semester, only one student had dropped out of the program. Thereafter, the new EET I and II courses were formally introduced for all freshmen. The average retention rate since the introduction of these courses has been in the range from about 85 percent to 95 percent, with an average of over 90 percent. The retention rates for over a decade prior to the introduction of these two courses were in the 40-to-60 percent range with an average of less than 50 percent.

Results and Conclusion

Prior to the introduction of the ENGN I and II freshmen engineering and technology courses, the retention rate of the freshmen students was under 50 percent. After the introduction of these courses and the strategy outlined in this paper, the retention rate went to a level generally exceeding 90 percent. It is concluded that a careful modification of the freshmen curricula with emphasis on hands-on experience increases both freshmen students' motivation and retention levels.

Bibliographical Information

Dr. Zia Razzaq received a Doctor of Science degree from Washington University, St. Louis, in 1974. He is currently a *University* Professor at the Old Dominion University and has previously taught at Arizona State, Southern Illinois, and Notre Dame universities. He has received numerous teaching awards, and has been nominated and listed for four times in "Who's Who Among America's Teachers." He is registered a PE and a Fellow of ASCE.