Enhancing Engineering Student Success: A Pedagogy for Changing Behaviors

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INTRODUCTION

Whether we need to bring about greater success on the part of engineering students is not the topic of this paper. The fact that we do is assumed to be self-evident. We only have to consider the anecdotal statements of engineering professors that "students aren't what they used to be," or measure our graduates against the outcomes established by the new ABET Engineering Criteria 2000,[1] or look at the low transfer rates of students who start engineering study in community colleges, or look at the differentially low retention of minority students (African American, Hispanic, and Native American) to convince ourselves that there is lots of room for improvement. If that's not enough, we can always take the TQM view that "no matter how good we are doing, we should always strive to be better."

Unfortunately, when we do strive to do better, we often miss the mark. Most institutional strategies aimed at improving student success are oblique. Examples of approaches taken are: increasing moneys available for scholarships; conducting effective teaching workshops for faculty; improving the quality of academic advising; establishing tutorial programs; revising the curriculum to provide freshman students increased exposure to topics such as computing, engineering design, problem solving, and creativity.

Generally, little consideration is given as to whether these activities and interventions really address those factors that are impeding student success. Consequently, although worthwhile, the types of interventions listed above do not generally have a significant impact on student success. The postulate of this paper is that enhancing engineering student success can best be accomplished by taking a direct approach to changing student <u>attitudes</u> and <u>behaviors</u>.

In Chapter 1 of the author's text *Studying Engineering: A Road Map to a Rewarding Career*,[2] the keys to success in engineering study are described as:

Determination—"Don't give up."

Effort— "Study hard."

Approach—"Study smart."

Approaches for building student commitment to engineering were addressed in a previous paper by the author.[3] Strong commitment is key to students' determination to persist and to their willingness to devote appropriate time and effort to their studies.

This paper will focus on approaches for ensuring that students are "studying smart." Some of the most important attitudes and behaviors required for success in engineering study will be identified. A pedagogy will be presented which has proven highly effective in bringing about substantive behavioral and attitudinal changes on the part of freshman engineering students enrolled in Introduction to Engineering courses having a "student development" focus.

The pedagogy was developed as a means for accomplishing the behavioral and attitudinal objectives developed through an NSF grant "Improving Student Success Through a Model Introduction to Engineering Course."[4]

BEHAVIORS FOR SUCCESS

The first step in ensuring that students "study smart" is to identify those behaviors that will lead to success in engineering study. You can make up your own list, or you can look to the general literature on student retention (e.g. Tinto,[5] Noel-Levitz,[6] and Astin[7]). One warning. In trying to encompass the broad academic context, the general literature on student retention does not, for the most part, address issues unique to success in math/science/engineering disciplines.

I have, nevertheless, found Astin's "student involvement" model[8] to be sufficiently fundamental to the education process to be useful in the engineering education context. Astin proposes that the "quality" of a student's education is directly related to their "involvement" as measured by five metrics:

- Time and energy devoted to studying
- Time spent on campus
- Participation in student organizations
- Interaction with faculty members
- Interaction with other students

Guided by Astin, consider the following behaviors (Note: These are a subset of a broader list of behavioral and attitudinal objectives from Reference 4):

Time on task—Students devote an appropriate amount of time and effort to their studies.

Time Management—Students keep up in their classes by scheduling their study time so as to operate under the principle that they master the material presented in each class meeting before the next class meeting.

Interaction with peers—Students make effective use of their peers by frequent sharing of information and by regularly engaging in group study and collaborative learning.

Interaction with faculty—Students interact regularly with their professors both in the classroom and outside of it, positively and with benefit.

Time on campus—Students are aware of the importance of being immersed in the academic environment so that they can take full advantage of the resources available to them, and therefore spend as much time on campus as possible.

Professional student organizations—Students recognize the value of actively participating in student organizations, particularly those related to their chosen profession and seek to take on leadership roles in those organizations.

I ask you to consider the above behaviors from three perspectives.

1. Are these important behaviors for success in engineering study?
2. Do your current freshman engineering students practice these behaviors to the extent desired?
3. If your answer to #1 is "Yes" and your answer to #2 is "No," do you believe that it would be possible to get students to practice these behaviors?

My answers to these questions are : Yes. No. Yes. If your answer to #1 is "yes," but you don't know the answer to #2, its easy to check it out. Ask your students for a "show of hands" on pairs of questions like:

How many of you would give yourself an A+ on the amount of time and energy your devote to your studies?	How many of you feel you need to increase the time and energy you devote to your studies?
How many of you schedule your study time so as to master the material presented in each class before the next class comes?	How many of you tend to wait until a test is announced and then try to cram for the test?
How many of you study on a regular basis with at least one other student?	How many of you spend virtually 100 percent of your study time studying alone?
How many of you regularly seek advice and one-on-one instruction from your professors during their office hours?	How many of you never go to see you professors during their office hours to seek advice or one-on-one instruction?
How many of you spend as much time on campus as possible and take advantage of the resources available to you here?	How many of you whiz into campus to take classes and leave as soon as you can?
How many of you are actively involved in student organizations and seek to take on leadership roles in those organizations?	How many of you have no involvement with engineering student organizations?

If the survey of your students indicates that they are not practicing the behaviors you believe are essential for success in engineering study, the next question is whether you believe you can do something about it. Changing student behaviors and attitudes is no easy task. I hope I can persuade you that the approach outlined below will work and that you will put it into practice in your classes.

INTRODUCTION TO ENGINEERING COURSE

Although working with engineering students on "success issues" can be accomplished through a variety of structures including summer bridge programs, orientation sessions, and formal and informal one-on-one advising and mentoring, perhaps the most effective structure is an academic year course having a primary focus on student development.

Such a course represents a "tool," and like any tool, it will only accomplish what it is capable of when it is in the hands of a skilled craftsperson. A recent article in ASEE *PRISM* titled "From Sleep 101 to Success 101"[9] points to the capacity of Introduction to Engineering courses to be either ineffective or effective in impacting engineering student success.

The article puts it well:

> "In its most dreaded form, this crucial introduction to the engineering major has relegated freshmen to a seat in row ZZZ of a cavernous lecture hall where they quickly perfected the skill of dozing with both eyes open while a series of departmental chairpersons earnestly extolled the merits of their particular disciplines."

Fortunately, as many engineering programs are revamping their freshman year curriculum, they are reexamining their *Introduction to Engineering* course and many are transforming the course into a powerful tool for boosting student success. Realizing this potential, however, requires engineering faculty who want to learn how to be that "skilled craftsperson."

Being a "skilled craftsperson" in the teaching of such a course requires both a vision and also the capability to deliver on that vision. The vision as I see it is best stated as the following:

> ***If I can have 30 or 40 hours with a group of students, I can create a major "life-changing" experience for those students—one that will significantly enhance their success.***

This is a lofty vision, one that will best be accomplished if the instructor adopts a "student-centered" pedagogy that is designed to provide students with exposure through experiential learning to a "success" behavior. When students experience a behavior that works, there is a good chance that it will become habitual. The following section discusses such a pedagogy.

PEDAGOGY FOR CHANGE

Changing student attitudes and behaviors is a five-step sequential process:

1. <u>Establishing a baseline</u>—Survey students to assess whether or not they are currently practicing the success behavior to the extent desired. This can be as simple as asking for a show of hands ("How many of you visit your professors during their office hours to seek advice or to obtain one-on-one instruction?"), or through more sophisticated methods such as written surveys, personal interviews, etc.

2. <u>Delivering knowledge</u>—Provide students with information and knowledge about why they should put the behavior into practice and how to best go about it (e.g., Discuss human relations principles regarding how one can be effective in approaching someone in a higher position in an organization than them.). Delivering knowledge is what we are best at, so don't hold back. The knowledge can come from reading assignments, from lectures by the instructor, from guest speakers, from videos, from assignments to interview others (upperclass students, faculty, alumni, industry representatives, etc.)

3. <u>Building commitment</u>—Work with students with the goal of gaining their willingness to try out the behavior. Start by having an in-class discussion on what the students think of the knowledge you have brought to them. An important part of building commitment involves working with students on their resistance to putting the behavior into practice (e.g., "Why don't you see your professors during their office hours?")

4. <u>Requiring implementation</u>—Assign the students the task of putting the behavior into practice. (e.g., "Make up a list of questions you can ask one of your professors about herself and visit her during her office hours and ask those questions.")

5. <u>Processing the outcomes</u>—Provide students with an opportunity to "process" what happened, both introspectively (e.g., "Write a one-page critique of what happened.") and/or through class discussions. During class discussion, try to get students talking to each other so they can learn from each others experience.

EXAMPLE—EFFECTIVE USE OF ONE'S PEERS

Let's illustrate this pedagogy with an example. In our Introduction to Engineering class, we decide to determine whether our students are making effective use of their peers by engaging in group study and collaborative learning.

<u>Step 1 - Establishing a baseline</u>

Ask the class, "How many of you spend some fraction of your study time studying with at least one other student?"

Then ask the class, "How many of you spend virtually 100% of your study time studying by yourself?"

If your experience matches mine, you'll find that only a small fraction of freshman engineering students engage in group study with other students. If you verify this to be the case, then you can move to Step 2.

<u>Step 2 - Delivering knowledge</u>

Have students read articles on the efficacy of collaborative learning. Section 3.4 (pp. 78-84) of *Studying Engineering* (Reference 2) would suffice for this purpose. The section there presents the idea that there are only two learning structures: 1) solitary; and 2) collaborative (i.e., either you do it alone or you do it with someone else), and that collaborative learning has three distinct advantages:

- You'll be better prepared for the engineering "work world"

- You'll learn more
- You'll enjoy studying more

Give the class your perspective on the value of collaborative learning. Discuss how to go about it including some of the pitfalls to watch out for. Bring in an upperclass student or recent graduate who studied with other students to give his or her perspectives.

Step 3 - Building commitment

Ask the class what they think of the knowledge you have brought to them. Ask those who indicate they study alone, "Why? Why, don't you study with other students?" Have those students who indicated they engage in group study relate why these reasons have not kept them from doing so. Seek agreement from those who are studying 100% alone that they will try out studying with other students, if only as an experiment.

Step 4 - Requiring implementation

Give the class the following assignment:

1. Identify a study partner in one of your key classes.
2. Within the next two weeks, get together with that person for at least a two-hour study session.
3. Write a one-page critique of what happened.
4. Come to class two weeks from today prepared to share what happened with others in the class.

Step 5 - Processing the outcomes

At the designated class, lead a discussion about what happened. Have several students read their one-page critiques aloud. Ask other students to tell what happened during their collaborative learning session. Seek to find out not only what worked, but what didn't work. Try to get a discussion going among students rather than just from each student to you. Refrain from giving your views on each comment. Turn issues that come up back to the class (e.g., "Does anyone have an idea about that one?")

Collect the one-page critiques and review them. If appropriate, discuss what was learned from them at the next class. If it seems that additional knowledge has been brought forth and the level of resistance has been reduced during Step 5, you may want to return to Step 4 (i.e., assign the class to repeat the assignment).

SUMMARY

Through the pedagogy discussed in this paper, you can bring about significant changes in the attitudes and behaviors of your students. At the end of your *Introduction to Engineering* course, you can check it out. Ask the class questions such as:

How many of you have devoted considerably more time and effort to your studies this term than in previous terms because of what we have done in this class?

How many of you used to cram for tests and are now scheduling your study time and adopting the principle that you master the material presented in each class session before the next class session?

How many of you used to do all of your studying alone and are now studying with other students on a regular basis and that's working for you?

How many of you never went to see your professors outside of class and are now receiving one-on-one instruction from your professors on a regular basis and that's working for you?

How many of you used to come to campus only to attend your classes and are now spending more time on campus and using the resources available to you?

How many of you had no involvement with engineering student organizations and are now actively participating?

When all the hands go up as you ask these questions, I guarantee you will feel good about the fact that you have made a significant difference in the lives of your students and in their success. More than once, I have had students come up to me and say: "I was making a 2.5 GPA, and since I started putting the principles you taught us in ENGR 100 class into effect I'm making straight A's." It could happen to you!

REFERENCES

[1] "Engineering Criteria 2000: Criteria for Accrediting Programs in Engineering in the United States," *ASEE PRISM*, pp. 41-42, March 1997.

[2] Landis, Raymond B., *Studying Engineering: A Road Map to a Rewarding Career*, Discovery Press (see web page at http://www.discovery-press.com), Burbank, CA, 1995 (Available through Legal Books Distributing, 4247 Whiteside St., Los Angeles, CA 90063, Telephone: 1-800-200-7110)

[3] Landis, Raymond B., "Building Student Commitment to Engineering," 1996 ASEE Annual Conference Proceedings, Washington, D.C., June, 1996.

[4] Landis, Raymond B., "Improving Student Success Through a Model *Introduction to Engineering* Course: Dissemination Document for NSF Course and Curriculum Development Project," California State University, Los Angeles, 1995 (Available from the author)

[5] Tinto, Vincent, *Leaving College, Second Edition*, The University of Chicago Press, Chicago, IL, 1993.

[6] Noel, L.,Levitz, R., and Saluri, D., *Increasing Student Retention: Effective Programs and Practices for Reducing Dropout Rate*, Jossey-Bass, Inc., San Francisco, 1985.

[7] Astin, Alexander W., *What Matters in College?: Four Critical Years Revisited*, Jossey-Bass, San Francisco, 1993.

[8] Astin, Alexander W., "Involvement: The Cornerstone of Excellence," *Change*, July/August 1985.

[9] Ercolano, Vincent, "From Sleep 101 to Success 101," ASEE *PRISM*, pp. 25-29, September, 1995

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