

(by Bill)

ADDRESSING PROBLEMS IN ENGINEERING EDUCATION [1]

Most engineering faculty who have taught for over ten years have raised a question at some point: “Is it me, or have students changed since I began teaching?”

Using input from university statistics, faculty, staff, and student surveys, published literature, and course grade records over twenty-five years, the author has identified twelve trends and observations regarding current students that impact student success and preparation for engineering careers. While many of these trends are positive and should be encouraged, a few are disturbing and call for being addressed

Positive trends

The authors have found the following positive trends in the entering students.

1. An increased awareness of Engineering and its importance in society.
2. An increased familiarity with the computer and the Internet.
3. Students are more uninhibited than in previous generations.
4. Students are now more used to working in groups.
5. An easy acceptance of other students from varying backgrounds and openness to new and varied ideas.
6. An increased number of female Engineering students.

Negative trends

The following negative trends have been observed.

7. Students have a shorter attention span with an increased incidence of diagnosed ADD.
8. They have less previous “hands-on” experience.
9. There is a decrease in Mathematics ability and familiarity with numbers, so that they have a decreased ability to estimate answers and to do mental arithmetic, and avoid

memorization. There is also an increased reliance on calculators as a “magic box” which gives answers.

10. They have an expectation of high grades without corresponding effort

11. The tendency to cheat is higher.

12. Distractions are more abundant. Internet addiction is a relatively new factor.

Students, in general, have less previous hands-on experience when they enter as freshmen. In comparison with students of the 1970's very few have worked on a car engine or taken apart a radio. There are, of course, exceptions, but as I ask for a show of hands of how many students have siphoned gasoline or water, each succeeding year the response is more meager. I spend a large amount of time interacting with students on a one-to-one basis, and have seen a general decrease of experience with physical interactions with the world. This is, however, replaced by an increase in familiarity with the computer and computer-related gamesmanship. Increasingly with time, our students are living a vicarious life, which is much more exciting and much less realistic than real life. They watch videos, play video games, and even converse through the internet with people they have never met, and the connection between cyberspace and reality is becoming increasingly blurred. This familiarity with instant results, combined with an unfamiliarity with real life, can make studies which require intense concentration seem pretty dull – statistics indicate that a decreasing number of students in the U.S. are pursuing math and science studies, and those who do don't seem to be as apt to continue as before.

1. Attention span

The typical attention span of a college student is about (15) minutes, possibly due to television and video games. In response to this, educators are encouraged to keep their class segments to 15 minutes or shorter, to keep the classes lively, and to use audio-visual media wherever appropriate –all good ideas. However, many detailed derivations, problem solutions, and case studies require far more than 15 minutes. In industry, management presentations and meetings can run several hours. To best help our students, we need to also help to stretch their attention spans, a little at a time.

Students have a shorter attention span now – should we cater to it, or remedy it? Power point presentations can be flashy and exciting, but they are made in a darkened room, conducive to drowsiness. If they are given a handout of the power point presentation, also, they have no incentive to take notes – so, why not just tell them to read the book and skip class?

What benefit comes from coming to class, taking notes and studying them later, anyway? The answer is that, in a good lecture, the book's information has been concentrated. I, (RWG), find it takes me about 8 hours to reduce information to a good one-hour lecture. It is presented in such a way that students can take notes, which keeps them awake and alert, and then they can study the examples given and practice the concepts by doing homework.

The fact that the information is erased away soon is an added incentive to take notes, which aids understanding. Learning must be uncomfortable to be effective. Furthermore, the board can be modified and the class can see a given problem as a whole unit on the board, so that various points can be modified or emphasized when it is complete. Thus students can see the beginning of the problem and link it visually with the result. This provides an excellent medium for interaction with students, and allows spontaneity.

2. Hands-on familiarity

Provide several lab courses and projects for students to develop skills in designing and fabricating projects; some examples are:

- Build and test an amplifier
- Design and present a “Rube Goldberg” project
- Design and build a power supply
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3. Mathematical ability

I give five-minute pop quizzes which require that the students write formulas down from rote memory. I have found a close correlation between the results of these pop quizzes and those results obtained on quizzes on which they are allowed to use their calculators to do problems. In other words, if they don't have the formulas memorized, they can't do the problems, even if they have a calculator.

4. “Grade inflation”

To prevent this, assign daily homework, expect 2 to 3 hours of study/homework for each hour in class, and encourage students to account for their time spent on the topic outside class.

5. Cheating

It is important to have a clear, written and enforced policy to deal with cheating.

6. Distractions

Warn students of the dangers, and encourage them to keep track of the actual time they spend in study without TV or the internet. Whereas students in earlier years went out to the movies on the weekend or rented a video on Friday or Saturday night, many of today’s students will watch a DVD almost any evening. Online video games such as computer chess with players across the country can cause a bright student to lose focus and even fail out.

7. Miscellaneous useful ideas

Give pop quizzes over key concepts, provide supplemental problems, supply links to relevant web sites, encourage students to study in teams, provide various opportunities for design in the curriculum, emphasize the fundamentals, give quizzes without calculators, stretch their attention span, work on estimating numerical answers, to foster “engineering judgment”, and use Power Point, but don’t throw away your chalk.

I had hoped to find a trend in the grade distributions of my students in Circuits I over the past 25 years, since I have been keeping accurate records for at least that long. After having plotted the grade distributions over that period, I found absolutely no trends. Pass rates for that period were constant, in spite of the amount of material covered. I also chose certain problems that I had given over that period of time, and checked the pass rates on those specific problems, given a time span of, in some instances, fifteen years. Still, there were no trends. For this reason, all my observations are anecdotal. Perhaps there are trends which I cannot see because the data samples are too small. I have constantly changed techniques; in particular, I have increased the number of pop quizzes and no-calculator tests to make up for the lack of certain skills in the students, and

the wide variations I have obtained indicate that there are too many variables to determine whether or not there is really a trend here.

Parker Palmer, in *The Courage to Teach*, gives us a stern warning: Don't blame the students for the problems with students-

“The ferocity with which some faculty members insist that today's students are vastly inferior to those of their own generation makes one wonder whether social change alone can account for such dramatic decline. Perhaps the DNA itself has degenerated within the past quarter century!...Criticizing the client is the conventional defense in any embattled profession, and these stereotypes conveniently relieve us of any responsibility for our students' problems-or their resolution....The way we diagnose our students' condition will determine the kind of remedy we offer.” [2]

As educators, we do have a great responsibility to diagnose properly the problems that we see, and to take careful and caring steps to correct them.

Observation:

Many students today live in a “different reality” than I did. Their “reality” has been influenced by so much TV, video, and computer games that some actually think that these things represent real life. It's as if they had grown up in “the Matrix”. They have been immersed in a world in which they have very little experience with reality as dictated by the laws of probability, physical principles, and Murphy's Law. They have learned to expect “miraculous interventions”, superhuman strength, and magic. They have not experienced the laws of probability, because very improbable things have become commonplace to them. When I first saw “Mission Impossible”, having been trained as an engineer, I had to laugh out loud, as a complicated device, built without having been tested, functioned perfectly the first time! My sophomore students have to be retrained in the way they build projects, so that they test each part of the device individually before incorporating it in the overall project. This is now necessary in order to overcome their expectation that everything will work perfectly the first time they try it. In other words, they need to learn, by experience, “Murphy's Law”. One of the projects I assign in lab is to build a Rube Goldberg machine, which is a long string of energy transfers, like the

“Mousetrap Game”. The main purpose is to show them that in real life, something will probably go wrong, since real components follow Murphy’s Law. Simply explained, Murphy’s Law says that” if anything can go wrong, it probably will.

References

1. Adapted from a paper presented at the 2005 ASEE conference, 2005 which appeared in the conference proceedings: “Student Observations over the Last 25 Years” by R. William Graff and Paul R. Leiffer.
2. Palmer, P., The Courage to Teach, Jossey-Bass, 1997.

INTRUSIVE ADVISING

We call advising “intrusive” when the advisor actively seeks to know the student, through questioning, in order to advise him.

Many faculty already do this, and a lot of what follows will seem obvious to you, but some people feel threatened and inadequate to counsel students; this presentation is to help those people.

Your first reaction to this proposal may be "I'm already overloaded. I can't take on more". I agree. The teaching load, plus counselling, is impossible. But, "I can do all things through Christ who strengthens me". If God wants you to do it, He'll make a way for you to. You can't counsel all your students, but you can counsel some. Maybe start with one. There is no organization to be done here; only a technique to be learned.

Procedure:

1. Write your advisees' names down on a list, look at it once or twice a week, and pray through the list at least once a week. At this point, you may not even know what they look like,

and you may know nothing at all about them. Your prayer may simply be, "Lord, please satisfy their spiritual needs". After a few weeks, at least their names will be familiar to you.

2. Next, set some sort of goal for contacts each week, look for opportunities, and keep a deck of 3 x 5 cards handy - when a student comes in to get his schedule signed, or for some other help, give it to him as usual, - but then lean back in your chair and say, "I'm supposed to be your advisor, so what can I advise you about? How's life in the dorms? How's your quiet time? What can I pray for you about?", or, just say, "What's the Lord been teaching you in your quiet time?"

Be on the lookout for opportunities to find out information about your advisees, and when they leave, write it down on your 3 x 5 card (one for each student you get data on). On this card you want to get all the information you can about the person. How many brothers and sisters he has, whether or not he comes from a Christian home, what denomination he comes from, what church he is going to; are all his family saved? How was he saved? How long has he been a Christian, what's his phone number, dorm, roommate, favorite color, dessert, fruit, pets, hobbies, etc. Having the information is important, but getting it is more so - because, as you communicate, you form a bond. People like to talk about themselves; and when they later find out that you actually listened, they're flabbergasted. The greatest amount of counselling is just listening, anyway.

The biggest problem you'll find with students is that they don't even have a quiet time (QT). Probe around to find out if they do, and if they don't, be careful not to put them down by ridiculing their plight - instead, encourage them to set some specific time for prayer and Bible study each day, and don't make it too long. Five minutes a day regularly is better than 30 minutes a day now and then. If you can instill a habit in their lives, you've changed their lives (five minutes a day the rest of their lives will be worth more than all the courses you could possibly teach them in 4-5 years)

For those who already have a QT, and want to bolster it, probe and find if they spend time in prayer, or just read the Bible. Some will spend all their time reading the Bible, and call it a QT - others, just the opposite. I try to guide them to a 2:1 ratio of prayer to BS, (depending on how familiar they already are with the Bible). You might find some ideas about prayer in my article "A Practical Guide for Prayer-Makers."

The most often asked question is "How can I find God's will for my life?" The answer to this is usually their lack of QT -rather than giving them answers you want to teach them how to dig the answers out themselves. Even the most complex counselling problems can usually be resolved by getting the student into a regular QT, because then God gives him the answer directly, rather than through someone else. Avoid being a mediator between God and the student. God wants to answer his problem.

Be on the alert for 3 main problems being propagated by the church today -the wrong definition of faith, 2 pot thinking, and faithlessness. I have papers on each of these if you'd like them.

You don't have to just work with your own advisees, in fact, you just won't "click" with some - your personalities will clash. On the other hand, you don't have to limit your advising to your advisees - you'll find others come, too, and you'll develop relationships with them, instead of your own "official" advisees." That's OK; just let the Holy Spirit lead you.

Once you, begin this procedure, you will find yourself overloaded with counselling opportunities; you will, therefore, need a support base. This is simply one or two prayer partners with whom you should meet every day for five or ten minute's hare prayer requests and get advice. Be careful not to reveal, personal things about your advisees and thereby break the confidence they have put in you. You don't have to mention names. You might say, for instance, "I know a student with a masturbation problem. What scriptures would you give him to show him that it's sin? And do you know any specific procedures we would go through to help him stop?" or, "Mary Fizzbane has a big decision to make; let's pray for her." For some situations you can reveal names and for others you shouldn't, because you know that if you were the counselee, you wouldn't want your specific problem to be passed around to others. Use the Golden Rule to guide you here.

Finally, when you get together with your prayer partner, be very careful with his time. These sessions can become too relaxed, spreading out and eating up time, so that he dreads your approach. Sometimes you may not even get a chance to actually pray together - just lean into his office and say "I need prayer for today". Or, you might just set a time limit for yourselves. The important thing is just a daily touch.