High Expectations: A Passport to Student Success

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Motivation: Why Do I Need a Passport?

Why would a student need a passport to enhance learning, success, and satisfaction? What does a passport imply? Obviously, it implies travel from one place to another—often, to a place very different from where the student started.

Now, for successful travel to a new and different place, what do you need besides a passport? It helps to have a good map of where you're going. A solid foundation in the basic customs of the people is a good thing. And of course, as every traveler knows, you should be prepared for a little discomfort along the way.

This discussion will examine WPI's first-year curriculum in Electrical and Computer Engineering. We will consider two broad aspects in light of the "travel" theme:

What we do: This is the curriculum itself, a "map" that provides an overview of the field and an introduction to the many aspects of the electrical and computer engineering profession.

How we do it: Essential to the success of our program is setting very high expectations for our students. This causes many students to experience some discomfort. In the end, however, students welcome and indeed thrive on the challenge we set before them. This is shown repeatedly in student evaluation results which will be presented.

What we do: The courses

The educational philosophy underlying our first-year introductory curriculum emphasizes a hands-on, project-oriented introduction to the field of electrical and computer engineering. The students are encouraged to think at a system level: what kind of problems are addressed by electrical and computer engineers? Once students encounter this overview of the engineering profession, they are better motivated to learn the underlying principles and inner workings of the systems they have seen. Subsequent courses follow a "spiral curriculum:" knowledge is built up in successive levels of detail, while continuing to revisit the system-level issues that underlie the engineering design process. Following is the introductory sequence, typically taken by students in the second half of their first year:

EE2011 Introduction to Electrical and Computer Engineering: A broad introduction in which students build projects and learn basic ideas of electrical engineering. The focus is on concepts and process rather than content and calculation.

EE2022 Introduction to Digital Circuits and Computer Engineering: An introduction to the concepts underlying computers and their use in engineering. The concepts introduced range from circuit-level (internal construction of logic gates) to system-level (computer organization). This helps students begin the process of understanding systems at several levels of detail.

This sequence contrasts sharply with the approach of traditional introductory courses, which begin by emphasizing detail without providing a motivating overview. Retention often suffers under the traditional approach, since most first-year students know little about electrical and computer engineering, and an overly detailed approach is unappealing, boring, and actually quite removed from engineering practice.

How We Do It: The Atmosphere

In an increasingly competitive global marketplace, there is little room for the mediocre performer. For our graduates to succeed, they must have a broad set of skills:

- high personal motivation
- flexibility and breadth
- critical thinking
- creativity and experimentation
- ability to work in teams
- ability to communicate effectively, verbally and in writing
- ability to learn independently
To prepare our students for this environment, WPI offers a rigorous array of upperclass courses, and requires substantive technical and interdisciplinary group project work of upperclass students. Yet our first year students are often poorly prepared for this journey. In too many American high schools, very little is expected of students, and often the brighter students need not work hard to excel. How are students to make the transition from high school to college, where the challenges and atmosphere will be foreign to them?

One might be tempted to make the transition gradual, easing the students into a heavier workload and higher challenges. In our experience, this is a mistake. If students' first impression is that college isn't much different than high school, the opportunity to communicate the difference has been lost. The transition to college, in combination with the introduction to a new and strange discipline, provides the perfect "checkpoint" at which to raise students' expectations of themselves.

In accordance with our "travel" theme, we believe the key to eventual student success and satisfaction is passage through what may be for many a difficult and disorienting experience very different from high school. In the 2011/2012 sequence, we set very high expectations and make substantial demands of the students, including:

- extensive homework sets, featuring calculation, computation and written expression
- weekly labs, with preparatory assignments and written lab reports
- independent learning of software tools
- computation projects with written and oral reports
- challenging tests requiring critical thinking beyond "what was covered in class"

Of course, like any good travel guides, we also must provide the appropriate support services! The faculty, graduate students, and undergraduate peer tutors associated with the courses are available for consultation on a regular basis. Students quickly learn that they can benefit greatly from this resource, as long as they are putting in the effort to do so.

Even though students often are initially taken aback by the work load and high expectations, evaluations indicate that most students rise to, and appreciate, these challenges. By setting high standards, we send a message to students that we believe they are capable of meeting those standards. They are empowered by their accomplishiments, just as international travelers who overcome fear of the unfamiliar are emboldened for further adventures by thriving in a new setting.

Benefits

Based on student performance and student evaluations compiled over several offerings of this new sequence of courses, we perceive a number of benefits for students willing to commit themselves to the challenges put forth. We find that the students:

- are more knowledgeable about the engineering profession, and thus more enthusiastic about their future careers;
- see the relevance of their freshman math and science coursework to the engineering profession;
- have a better idea what their capabilities in engineering are;
- learn to work hard and see the benefits;
- learn to think critically about the fundamental meaning of the concepts they encounter;
- learn to learn on their own;
- become part of the electrical and computer engineering "community" from early on in their education.

By taking on the challenges of this first venture into unfamiliar territory, they prepare themselves for the more exotic educational voyages ahead. They see that their "Passport to Success" will be issued internally, by their own motivation and abilities.

Conclusions and Discussion

In our talk, we will share details of student evaluations and comments for these courses, and attempt to link these and other outcomes to specific pedagogical strategies as described above. We will then engage the audience in a dialogue regarding their experiences in helping first year students make the transition to a collegiate learning environment.