Teaching Statement

Theodore P. Pavlic

Teaching Interests

Facing an audience composed of mostly millennials, classroom teachers compete for attention with various forms of interactive and highly available content. Staying relevant in this atmosphere becomes more difficult as students see less incentive to physically attend classes that cover content that they can find on-line. Some universities have embraced self-paced e-Learning not only as a way to appease these students but also to free up time for faculty to do research. However, rather than competing directly with purely on-line schools, universities can leverage faculty experience to create unique in-person offerings that are complemented by an engaging on-line presence. Along with the opportunity to do research with faculty, instructors can use inquiry-based teaching methods to augment traditional classroom learning with self-paced opportunities that prepare students to do future research. I focus on creating educational experiences tailored to attracting and retaining this new audience. This approach has involved using open-source course content that evolves with student feedback, using inquiry in small-room laboratories to generate synergistic emergent educational experiences, and generating course experiences from novel open-ended short-term problems that students must solve in either classroom or extracurricular settings.

Open-Source Collaborative Course Content

Rather than using textbooks as the primary reference material in the courses I have taught, I have produced hundreds of pages of shorter documents[1] that are not only tailored for each course but provide multiple ways to engage the student. Each document is adequate for printing, but its electronic version also includes hyperlinks that: assist in navigation throughout the document, link to additional third-party sources of information that I have reviewed on the web, and link to other course documents. These electronic versions are fully searchable and include professional-quality graphics that can be used by students in their formal reports. Because undergraduate students may have little experience writing technical reports, each document is written to serve as an example. Hence, these documents simultaneously guide each student through the classroom experience, provide her help finding additional technical resources, and serve as examples of language and format that she should use in her course submissions. Additionally, because the students know that these are living documents that I have contributed to, they are more likely to contact me about questions they have about the content. Moreover, I can easily make adjustments to the living documents based upon the responses I receive from the students.

It is important to me to introduce students to tools that allow them to be successful in their courses but also reduce barriers to entering into other academic pursuits. Consequently, every course document of mine is produced entirely with freely available LaTeX (including graphics, which are produced natively in LaTeX with PSTricks as opposed to using a GUI tool that may be less available) and distributed freely on-line with its source code[2] under an open-source Creative Commons license. Hence, not only are the documents available for the students to learn from, but other instructors can reuse and modify them (e.g., to adapt them to their courses or to correct any mistakes I might have made). I also provide homework and *curriculum vitae* LaTeX templates to assist students in their other work. These templates have received a great deal of attention on the Internet; for example, my LaTeX homework template is the #1 result from a Google search for “latex homework template,” and my other course documents and templates appear as page-1 results for other Google queries like “latex CV template,” “transistor basics,” and “rotary electrodynamics.” I frequently receive positive feedback about these efforts from students, instructors, and engineering professionals.

[1] Samples can be found on any of the course web page mirrors archived at http://www.tedpavlic.com/teaching/osu/.

[2] Mercurial source code repositories for course material available at http://hg.tedpavlic.com/.

Using Laboratory Inquiry to Prove Rules by Exception

The scientific method was not explicitly taught to me as young engineering student, and I viewed engineering as separate from science. Later, it became clear to me that the process of generating knowledge about newly created technology is a science and is subject to scientific inquiry. To experiment with inquiry in the classroom, I took advantage of a one-year graduate fellowship developing inquiry-based scientific instruction curriculum for fourth graders and helped implement that curriculum with teachers from a local inner-city elementary school. Since then, my teaching methods have been greatly influenced by the experimental scientific method. In engineering classes in particular, I work to strengthen students' understanding and appreciation of the abstract mathematical topics by highlighting how experimental deviations from theory follow from violations in model assumptions.

The spontaneous theoretical deviations that occur in the laboratory provide an opportunity to actually validate that theory using scientific inquiry. In the laboratory courses that I have taught, many students either forget or are unaware of the mathematical assumptions taken for granted by the theory being used. When students tell me that observed differences from theory are from "noise" or "parameter variations from the manufacturing process," I work with them to design and execute an experiment to make these blunt statements precise. This process typically leads them to re-examine how few assumptions are actually necessary for common engineering methods and how easy it can be to find which assumptions are violated. Moreover, by testing different hypotheses for why the deviations occur, the students sometimes correct experimental errors and restore the expected results, and they often gain valuable insight into the scientific method itself.

It is not practical to provide a hands-on laboratory experience to every student about every topic. In these cases, I find that simple first-principle-based simulation models can be distributed to students that help them with their own out-of-class inquiry. For example, it is rare that I find younger students who can gain insight from a SPICE circuit schematic. Even if they have SPICE access, there are barriers to opening the schematic and choosing the analyses to run. However, most engineering students have access to tools like MATLAB and are comfortable programming, and so I distribute scripts that implement step-by-step simulations built up from first principles and also demonstrate sample analyses[3]. Students can then examine how simple components introduced in their other classes can be built into complex systems. Furthermore, they can make and test hypotheses about system components.

Learning by Creating

Although guided instruction is an important part of post-secondary education, I believe that engineering students greatly benefit from collaborating with their peers to create new solutions to unsolved problems. As described by Freuler et al. [1], I have spent several years on the instructional staff of a program for first-year engineering students that provides them a cohesive year-long experience that introduces them to basic mechanical, electrical, and computer engineering tools and then requires teams to design, build, and present autonomous robots to complete novel tasks. This kind of tight organization between classroom instructors throughout the academic year is not practical for older students, and so I also served as a team leader in an extracurricular group that challenged these older students with similar but more advanced design and build problems. In both cases, novel design challenges were valuable examples of real engineering and helped students gain exposure to topics that are not easily covered within the classroom.

References

[1] Richard J. Freuler, Michael J. Hoffmann, Theodore P. Pavlic, James M. Beams, Jeffrey P. Radigan, Prabal K. Dutta, John T. Demel, and Erik D. Justen. Experiences with a comprehensive freshman hands-on course – designing, building, and testing small autonomous robots. In *Proceedings of the 2003 American Society for Engineering Education Annual Conference & Exposition*, 2003.

[3] One example is the set of DC–DC boost converter simulation codes and results available at http://www.tedpavlic.com/teaching/osu/ece327/#lab_voltreg. This example was produced at the request of a student.