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by Edward Berger

Podcasting continues to emerge as a popular and flexible medium for content delivery with a projected subscriber base of nearly 50 million by the year 2010 (Gilbert 2005). As instructors have begun to use podcasts more frequently to enhance online courses or supplement traditional classroom courses, institutions have begun to adopt campus-wide initiatives to support such practices. The Duke Digital Initiative arguably ignited this trend a few years ago, and current trends (Apple iTunesU, iTunesU pages at Stanford and Berkeley, Purdue's Boilercast) suggest that podcasting for higher education will happen on a broad scale. Indeed, Educause recently released a podcast about podcasting (Clark 2006).

However, the potential impact of podcasting on higher education is unclear, and our understanding of it is still evolving (Exhibit 1). This is true for all sectors of the academy, but it is particularly true in the disciplines of science, technology, engineering, and mathematics (STEM). While further institutional support can help remedy this situation, models of applied practice and further research into the pedagogical benefits of podcasting is needed to inspire continued innovations with this technology. Further consideration of student perceptions and responses to this technology would also contribute to a better understanding of its effective use in these and other fields of academic study.

This article describes a podcasting pilot study administered in an engineering course at the University of Virginia (UVA) during the spring semester of 2006. The pilot study was designed specifically to assess student attitudes about podcasting, determine who benefits from podcasts, and evaluate which types of educational content provide the greatest benefit to the largest number of students. While this study does not establish links between podcasting and learning outcomes, its results may nevertheless provide some useful insights for instructors who are considering the use of podcasting to support their teaching.

The Rationale for Podcasting

In order to understand the rationale for adopting podcasting technology in this study, it is important to consider the distinctive nature of learning in the engineering sciences, the broader shift in learning styles attributed to today's college students, and the ways in which technological change has led to new ideas about how educational content should be distributed.

First, engineering education by its very nature plays well to students with aptitude for auditory, visual, and tactile learning (see Sarasin 1999). Engineering problem solving requires a mastery of visual diagrams, problem schematics, and free body diagrams; an ability to derive, manipulate, and solve mathematical equations; an analytical thought process; an appreciation for comprehensive case studies; and physical intuition. When we consider the learning styles associated with students of the digital age, this profile of characteristics may be fleshed out further. Millennial students generally favor cooperative problem solving, often employ trial-and-error approaches, and seem to have less affinity for the traditional lecture format. They also tend to multitask and show high competence in all manner of digital media (Dede 2005), which is an important evolution from historically recognized learning patterns (e.g., Gardner 1983). We therefore need educational tools that improve student interaction with and ownership of educational content.

This need may be appreciated further with respect to Hilton's (2006) recent propositions about the challenges of unbundling higher education content and adopting a demand-based approach to the distribution of such content. With regard to unbundling, Hilton's analogy comes from recent changes in the music industry whereby groups of songs previously offered only as part of CD albums are now being offered individually through purchased online downloads. In much the same way, he observes, providers of higher education should consider new ways of segmenting and redistributing their curricular content so that they can serve the needs of students in a more flexible fashion. This goes hand-in-hand with his recommendations for a shift from a "producer-push" to a "demand-pull" approach to education: "In the days of the mainframe, the motto of many technologists was, 'If we build it, they will come'—a classic statement of producer-push philosophy. But today, with distributed computing and the Web, the world is much more demand-pull oriented. In demand pull, users determine for themselves which products, services, and information they are interested in using" ("Demand Pull," ¶ 1).

Podcasting directly addresses the issues above and represents one exciting piece of a future demand-pull STEM curriculum. Its multimedia nature has the potential to positively impact student learning and retention (Valdez et al. 2004), and it can effectively address many of the emerging notions about millennial learning styles (Table 1). Moreover, podcasts that focus on very specific topics allow students to search for and pull the content they want and only the content they want in a discrete package, unbundled from other course content. From this perspective, podcasting has the potential to transform the classroom into a truly student-centered model environment, thereby fueling future innovations in higher education.

But what do students think about podcasting for education? Anecdotal evidence continues to emerge that students like the flexibility and asynchronicity of podcast content. Although quantitative evidence seems to be fairly sparse, a few studies have reported generally high student support for podcasting (e.g., Fryer 2006). The goal of this preliminary study was to provide quantitative evidence about student attitudes toward podcasting in a STEM curriculum, to examine who seems to benefit from podcasting, and to identify the types of content most valued by students.

The Podcasting Pilot Project

The Course

The course chosen for this project was Strength of Materials (CE231), a key engineering fundamentals course at UVA with a typical enrollment of 55-60 students. The course uses a popular textbook (Hibbeler 2005) that currently provides minimal electronic supplements to students—certainly nothing like the content created for this pilot project. The material covered by this course includes concepts like shear and moment diagrams, basic material linear elastic behavior, and statically indeterminate problems, all absolutely fundamental for future success in structural engineering.

The incorporation of podcasts in this course began approximately midway through the semester after some stages of initial planning and preparation. Aside from the key factors previously mentioned, the choice to adopt podcasting technology in this course was determined by its significant advantages over streaming video as well as the relatively low-time investment required to implement it (Exhibit 2).

Podcasting Content

The podcasting content was developed specifically for this course. Three basic classes of content were delivered:

1. Video Problem Solutions (Exhibit 3). In contrast to the static problem solutions typically offered in engineering classes, the author narrated solutions that included commentary and the description of each step in the solution, explaining the why as well as the how of the solution. This moves the solution process from information to knowledge, as those two concepts are described by Hilton (2006). The instructor provided approximately ten podcasts in this category.
2. Roundtable Discussions (Exhibit 4). In a series of office conferences, the author met with up to three students at a time for a 10-15 minute discussion of current class topics, including upcoming homework

assignments or specific questions from recent classes. These discussions were recorded in podcasts and made accessible to all students so they could listen to their peers explaining key ideas in the course. This content included both video and enhanced podcasts, and the instructor provided approximately six podcasts in this category.

3. Exam Review (Exhibit 5). The instructor also employed enhanced podcast technology to provide administrative, content, and scope details for an upcoming exam. The author narrated a summary of the key exam information, including exam time and location, chapter coverage from the textbook, and excluded materials. The instructor provided one podcast in this category.

Assessment Tools

Three assessment instruments were used throughout the course. First, a student survey was administered online through UVA's course management software, the Instructional Toolkit. During the first month of the semester, students answered five questions about their understanding of podcasts and their interest in participating in a podcasting pilot study in the course. Second, another survey was distributed through Toolkit at the end of the semester to collect student feedback about the success of the pilot project and gather specific information about the impact of the podcasts. Third, anecdotal evidence was collected throughout the semester through personal interactions and e-mail.

Survey Results

Two surveys were performed, one before the project was initiated (the preliminary survey) and one at the conclusion of the semester (the feedback survey). Both were administered through UVA's Toolkit, and students were neither compelled to participate in the surveys nor rewarded in any way for their participation. Because Toolkit provides no utility for administering an anonymous instrument, the surveys were not anonymous; however, student names were not associated with survey responses until after final course grades were reported.

Preliminary Survey

The preliminary survey was conducted between January 25 and February 6, 2006; 38 students (over 60% of those enrolled in the class) responded. Five questions were asked. The raw results show modest support for podcasting as well as strong support for the instructor's ongoing use of a Tablet PC in class (Table 2). The survey questions betray some naiveté about podcasting content as they focus essentially on podcasting of lectures. Subsequently, I decided that other types of content may be more beneficial to students, and we never did actually podcast any lecture materials. Nonetheless, the student support for podcasting was lukewarm, and anecdotal feedback from students clearly suggests that many simply were not aware of what a podcast actually was or how it might be useful. This helps explain their lack of participation in the voluntary survey. This anecdotal feedback—that somehow professors could be ahead of students on the technology curve—was a highly unexpected result. We have since developed some approaches to training students on how to access, manage, and interact with the content (Exhibit 6).

Feedback Survey

The feedback survey was conducted online through Toolkit between April 28 and May 5, 2006 before the final exam was administered and before final course grades were submitted to the registrar. However, per my promise, the data were not examined and tabulated until May 16, 2006 after final grades were submitted. Nine questions were asked with 22 students (about 40% of the class) responding. These questions were formulated specifically to assess the usefulness of the three types of content developed for the course and also asked some general questions about how students used the material. The results of the survey were tabulated in the same fashion as in the first survey (Table 3). The data clearly show that the video problem solutions were extremely useful for students (Q2), especially as they attempted to do similar problems for homework (Q8). The notion that tablet technology and video capture software can be deployed successfully for pedagogy has recently been reported by Radosevich and Kahn (2006), and this study certainly supports their conclusions. The general feeling of the respondents is that the podcasting program should be continued and expanded (Q5).

Although no analysis of nonresponse was conducted—and it may very well be that many students who did not think they benefited from podcasts failed to respond—it should be noted that the results from the feedback survey were consistent with the verbal and e-mail feedback provided by students. In all cases, the latter forms of feedback were very positive, especially about the video problem solutions.

Changes and Differences in Student Attitude

The raw survey data can be further reduced, and some interesting patterns emerge when we correlate survey responses with students' final course grades. Student grades were given a numerical value corresponding to the usual grade point average calculation scheme (A = 4.00, A- = 3.67, B+ = 3.33, etc.). In both surveys, respondents' final grades were widely distributed with an average value of 2.73, about a B-.

Comparing student responses to Question 5 on the preliminary survey ("I support the idea of podcasting lectures for Dr. Berger's class") and the corresponding question on the feedback survey (again Question 5, "I support expanding the podcasting program in the future to include more problems, solutions, and other review materials.") reveals a clear, discrete shift in general student attitude towards the potential for podcasting and its utility. The average response on the preliminary survey was 3.54; the average response on the feedback survey was 4.64 (Figure 1).

Deeper analysis, however, reveals another layer to the data. On the preliminary survey, among respondents whose final course grade was either A or A- (11 students), average support was a modest 3.18. For those respondents with a final grade of D+/D/D- (8 students), the average on the preliminary survey was 4.63. It seems clear, and perhaps intuitive, that the better students expected to receive less value from the podcast content while the students most in need of extra help viewed the podcasts as a potential way to get that help. In addition, it seems possible that the better students believed that equal access to these resources would make them stand out less in their overall performance; this was inferred from informal conversations with some of the better students in the class. It seems equally likely that the higher-achieving students may simply support the instructional status quo as an environment they have clearly mastered. Since the better students generally attend class regularly, they may have viewed lecture podcasting as having far more benefit to the students who may not regularly attend class and, in fact, may have believed lecture podcasting would provide a disincentive to attend class.

Limitations of This Study

If weaker students had a larger change in attitude and a larger perceived benefit about the podcasts, why didn't this manifest in their course grade? There are several potential answers to this question. First, this podcast pilot program was limited and experimental. It was introduced in the middle of the semester, so students had a limited time to adjust their study habits to use the content optimally. Indeed, the podcasts were apparently used mostly as a homework and exam preparation tool and consulted mainly when students had difficulties with specific problems (feedback survey, Q1). We therefore expect a correlation between weaker students, who likely need such assistance more often, and the change in attitude. But this program was not comprehensive enough to assess fully how podcasting could positively impact the grades of those struggling students, especially if they have time to work the podcasted content into their general study habits, as opposed to using the content only when a course deadline is approaching.

Clearly there are statistical weaknesses as well. The small sample size, coupled with the self-reported data and no analysis of nonresponse, blunt the impact of the study. However, it seems clear that student acceptance of podcasting as an instructional approach can be cultivated and that certain types of content (i.e., the video problem solutions) can be enthusiastically supported by students. We have subsequently (academic year 2006-2007) expanded this program immensely and will report more comprehensive data in late 2007, including usage of the full range of Web 2.0 technologies (blogs and wikis, for example) (Exhibit 7).

Conclusion

Engineering content—especially in fundamental engineering mechanics—is necessarily visually intensive, requiring photos, schematics, and free body diagrams for physical descriptions. We also require significant mathematics through mathematical equations, numerical procedures, and graphical output from calculations. This requirement for strong visuals separates engineering from other disciplines that may be more suited to strictly audio content (for example, language instruction and other topics in the humanities). It is likely no coincidence that the most visually intensive podcasting content—the video problem solutions—were viewed as most valuable by the students. Moreover, there was a distinct negative correlation of attitude change with course grade, suggesting that the better students derived less value from the podcast content. Although the general level of enthusiasm for continuation of this podcasting program was high, it seems clear this technological course component does not serve all students equally. The obvious next step is to assess podcasting's impact on student understanding and retention, most likely through comparison with a control group. Moreover, podcasting's potential will only be reached when faculty effort to provide content converges with student study habits that routinely integrate podcasts.

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