Initial Steps in Establishing a Community to Develop Engineering Courseware

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Abstract

Educational courseware modules are beginning to find broader use supplementing traditional engineering lectures as well as distance learning classes. Developing high quality material requires a considerable amount of effort compelling faculty to share modules through digital libraries. Faculty members attempting to create materials for collections of engineering education content in a digital library face several challenges. Lack of training in sound pedagogical practices, a shortage of training in the effective use of educational technology, short supply of required development resources and time to produce completed and tested works, and a lack of emphasis on improving teaching in the university faculty rewards systems are the major obstacles to materials development. To remedy this situation, this project endeavors to create an active, engaged, and sustained virtual community of engineering educators who energetically contribute to and share materials from a common collection of courseware.

New members of the virtual community are first trained in sound pedagogical practices e.g., developing learning goals and assessment techniques. Next, participants are schooled in the effective use of technology in many different teaching/learning situations including: classroom presentation, self-study, distance and distributed learning, experiential learning, etc. Participants are encouraged to use a few existing courseware modules to experience the issues surrounding the adoption process. Finally, faculty begin developing a portion of a collection of courseware modules in their area of expertise. Guidelines are provided so that modules can be integrated with one another from both the standpoint of technology as well as the pedagogical approach being used. Members of the virtual community of contributors subsequently become the testers of the courseware modules with each of the contributors using a subset of modules to conduct courses at their home campuses.   This paper describes the first year of this research effort including the challenges encountered in this difficult enterprise.

Introduction

Courseware modules can be very useful tools for engineering learning environments since well-constructed modules can provide a number of different mechanisms to help students better understand difficult concepts. It is well-known that e-based learning resources can assist students in visualization, communications, skill building, self-assessment, individually tailored lesson pathways, etc. However, well-written and comprehensive presentations take a lot of time and labor to produce and are not yet generally recognized as scholarly work in engineering academic communities. Thus, it requires a very strong personal commitment of individual faculty members to even begin to generate useful and comprehensive courseware. A more efficient scheme for success is to divide the development task among many willing participants with each contributor producing a portion of the whole.

Establishing a community of courseware developers across multiple engineering disciplines and including faculty from different universities is a very challenging undertaking. Toward this end, we have begun a pilot program involving faculty from a number of universities focusing on several widely taught engineering courses. The objective is to learn how this diverse group of faculty members can work together to produce materials in support of courses that each of them teach. Besides analyzing the collaborative development process, we are also studying the process of adoption and adaptation that must be undertaken in order for members of the group to better share their materials.

Topics have been selected based on the interests and needs of the inaugural group of participating faculty members. Initially, we attempt to address needs in basic engineering courses that are attended by large numbers of engineering students – we want to get the biggest bang for the buck. These courses are Statics, Mechanics of Materials, Introduction to Computer Engineering, and Introduction to Circuit Analysis.

In order to make the development process manageable, we choose to address single topics within the individual courses rather than attempting to develop a block of comprehensive materials for an entire course. One of the types of basic modules under development includes computer-based lecture material supplemented with multimedia capabilities (hyperlinked to supplementary text, etc. More sophisticated modules include: visualizations, animation, simulation, etc.; material integrated with large interactive problem sets; and other material deliveries that are able to guide students through resources based on their individual learning styles. In all of these cases, the ability to review the materials at the user's pace is important.

The first problem we set out to solve was to ensure that the materials being developed were of high quality and that they would be beneficial to students increasing the likelihood that they would be adopted by faculty outside of the developers group. In this paper we will describe the steps we took to make certain that the developers were cognizant of the measures of quality and that they were including high-quality features wherever possible in their modules.

Another difficulty we attempt to solve with our development efforts is that of building a common user interface. It is well-known that users are better able to concentrate on the material being

presented (rather than on learning the interface) when the menus, navigation scheme, etc. are easily understood. Understanding comes from experience and commonality across multiple tools. We will discuss our efforts to build a common user interface that incorporates all of the elements required by each of the developers.

A Common Consensus on the Elements of Quality

Factors for evaluating quality in courseware are different than those used to evaluate print media or lecture delivery. This is primarily due to the fact that computer-based materials can do more and these higher expectations must be fully exploited in order for a courseware to be judged high-quality. The authors have developed an awards program, under the auspices of NEEDS, called the Premier Award for Excellence in Engineering Courseware. Over the years the program has produced and refined a set of criteria for judging excellence in engineering courseware. We use these criteria as the basis for training our developers group on how to ensure high quality in their products.

Through the Quality Review of Courseware effort, NEEDS examined existing schemes of software, courseware and paper review. We adopted those aspects that were deemed most appropriate for a rapidly changing environment of courseware creation, in particular, and multimedia technology, in general. To develop these criteria, NEEDS worked with numerous experts including students, engineering educators, instructional designers, cognitive scientists, and learning theory experts. The evaluation criteria focus on an overall evaluation of the resource by balancing its design with use. An outline of the criteria in which courseware is judged under the Quality Review of Courseware is shown in Table 1. Detailed description of each of the criteria elements can be found at www.needs.org/premier/

Table 1 - Evaluation Criteria for Engineering Education Courseware

Instructional Design:	Software Design:	Engineering Content:
• Statement of Goals	• Engagement	• Accuracy of content
• Interactivity	• User interface and navigation	• Organization of content
• Cognition/conceptual change	• Interactivity	• Consistency with learning objectives
• Content	• Multimedia use	
• Multimedia use	• Technical reliability	
• Instructional use/adaptability		

Evaluations will be formative as well as summative. These evaluation criteria will also be used as the basis for a holistic, journal-type, peer review used to evaluate courseware developed in this project and added to the NEEDS or MERLOT digital library collections.

Before beginning the process of courseware development, each developer participated in an exercise to familiarize them with the quality criteria described above. Participants were given three pieces of existing courseware and were asked to review them according to the Premier Award Criteria. In essence, we asked them to go through an exercise similar to, but shorter than, the one performed by the Premier Award judging panel.

For contrast, we used three distinctly different pieces of courseware that were previously rated by a panel of seasoned Premier Award judges. We purposely chose materials that previously rated low, medium and high in order to be able to draw out comments from the participants. This scheme proved to be successful in generating quite a bit of discussion and criticism.

After each of the participants submitted their review data, we brought them all together for a discussion of their scores. We examined the qualitative measures that led them to assign their numerical scores. Through these discussions each participant was able to describe their understanding of each of the quality criteria and how they applied to specific features of courseware products. Opinions were exchanged, personal understandings were altered, and finally the group evolved a common understanding of each individual criterion. The group agreed that this better understanding of quality will allow them to be mindful of the measures that need to be used when deciding on how to produce effective multimedia materials.

Evidence of the use of the quality criteria is seen in the early developments of courseware by the group. Several authors have commented on the scores they would have assigned themselves if they were judging their materials. They also commented on how they revised their materials until they were able to assign themselves a sufficiently high score.

Common User Interface

When using technology-based tools, many of the usage skills such as navigation are dependant on experience with similarly organized/operating packages. The ability for a student to move seamlessly from using one courseware module to another saves the time to learn operational skills and allows the student to focus on learning the subject matter.

We have defined the elements of a common user interface and set of ancillary tools usable in all community developed courseware modules. The interface is flexible and attempts to account for all of the modes of operation developers might like to have, without causing users to have to climb a steep learning curve to effectively utilize the module. A template has been developed for web-based presentations in order to provide developers an easy mechanism to implement the user interface. Flash and HTML source code for the user interface is available to developers so that they may have a foundation for their content material. Developers also benefit since they are relieved of having to produce their own interface code for each module.

The unified user interface proposed here is analogous to the Microsoft Windows model developed back in the 1980s. A basic structure is defined in terms of: menus, screen positions, required basic functions, help, etc. Elements are added to the interface as the specific application dictates, e.g., one-click connection to tools like Mathematica, Matlab, etc. A general design philosophy and style prevails throughout all of the modules designed to this standard making them more "user-friendly".

Not all modules will require all elements of the user interface, and developers are not required to include each element. However, we do encourage the authors to incorporate interface components whenever possible.

After spending some time working with educational specialist and reviewing the needs of engineering online learning environments, we have identified a set of desirable presentation components. When these components are all present, we feel that the student can receive the highest degree of benefit from using the courseware module. These components include:

- Goals Description – students should be succinctly told what they are to learn
- Introduction – background material to provide a common starting point
- Tutorial Presentation – target material is presented and explained
- Mathematical Analysis – includes the math theory required to understand the material
- Examples – sufficiently rich set of examples
- Self-Test – a mechanism to allow students to assess their understanding
- References
- Faculty Feedback – a mechanism for students to communicate with the faculty on the usefulness of a module.

Some of the components may be combined into one or more sections of a presentation. For example, a theoretical presentation of one aspect of a topic may include a quiz in the flow of a presentation. In many cases references to supplemental material will be incorporated into the presentation in a "just-in-time" manner. Certain desirable components may not occur in all presentations. For example, there may be little or no Mathematical Analysis required in some modules. All of the project's authors are working towards including the appropriate desirable components into their presentations.

Conclusions

Testing of development tools has led us to focus on Flash for use in producing web-based animation. Flash allows for easy reference to outside materials and to initiate operations by other ancillary engineering tools like MatLab, AutoCAD, Notes programs, calculator programs, etc. Flash also allows for the playing of several different other formats of digital movies and animations. However, Flash can be somewhat complex for producing simple web pages and for that function we have focused on Dreamweaver.

Several of the development groups are using development tools more closely aligned with the topical material they are targeting in their development. We have done some checking and have found that the products developed by any of the tools are compatible when displayed on appropriate web browser. We will however need to require users to load certain freely available plug-ins in order to view the presentations. Each module or set of modules will document its browser and plug-in requirement.

Each of the current six development groups has used their modules in current course situations. Several modules were used as part of the in-class lecture. Others were used out of class as a self-paced supplement to the lecture and associated notes. Feedback is collected for each module used by asking the students to connect to a web page and score the effectiveness of the module. Developers have used the feedback to improve their presentations in what amounts to second and third iterations of presentation improvements.

Access to the current set of modules can be found at www.ee.vt.edu/~jgtront/CDMELE/ Notice that these modules are actually located at the authors' web site and are maintained and updated by the authors.