An Evaluation Process for Engineering Courseware: The Premier Award for Excellence in Engineering Education Courseware

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Abstract: As the number of digital learning materials developed to support education and learning grows seemingly exponentially, locating these resources and evaluating their quality becomes more and more difficult. NEEDS —The National Engineering Education Delivery System (see www.needs.org) is a web-based resource that provides access to quality instructional learning materials and courseware, and disseminates demonstrated successful educational practices. NEEDS in partnership with John Wiley & Sons developed the *Premier Award for Excellence in Engineering Education Courseware* to identify and recognize outstanding non-commercial courseware designed to enhance engineering education. The key to the *Premier Award* competition is the evaluation criteria coupled with the supporting materials submitted by the author.

Keywords: evaluation criteria, courseware, digital library, technology enhanced teaching and learning

1.0 Introduction

The emergence of the World Wide Web (WWW) as a viable means for national and international sharing and re-use of education materials is fundamentally changing our view of the way education and learning occurs. As the number of materials developed to support education and learning grows seemingly exponentially, locating these resources and evaluating their quality becomes more and more difficult. NEEDS —The National Engineering Education Delivery System (see www.needs.org) is a web-based resource that provides access to quality instructional learning materials and courseware, and disseminates demonstrated successful educational practices.

NEEDS and John Wiley & Sons, Inc. sponsor the *Premier Award for Excellence in Engineering Education Courseware* to identify and recognize outstanding courseware designed to enhance engineering education. Since 1997, the *Premier Award* has recognized nine courseware packages; these packages each have distinctive strengths, representing a breadth of styles, sophistication, pedagogies and use of multimedia, that encourages incorporation of the courseware in learning environments. The *Premier Award* recognizes more than just software, it evaluates the entire educational experience as evidenced through the submission packet.

We will briefly describe the development of the *Premier Award for Excellence in Engineering Education Courseware*. We will highlight past winners of the award and examine the criteria used to evaluate them. Finally we will briefly discuss two related areas for evaluating courseware currently under development.

2.0 Background on NEEDS—The National Engineering Education Delivery System

NEEDS provides a resource where both instructors and learners can search, access, and download digital learning resources over the World Wide Web in science, mathematics, engineering and technology. NEEDS grew out of Synthesis: A National Engineering Education Coalition's determination to share and reuse the instructional technologies developed in support of the coalition's curricular goals [1–2]. NEEDS' services are designed to meet the needs of diverse user groups —some use it to locate resources, others use it to find like-minded educational innovators, while still others simply want to get a glimpse of how to integrate technology and learning [1–2].

3.0 The *Premier Award for Excellence in Engineering Education Courseware*

3.1 Background

NEEDS recognized the importance of quality in our collection very early in our development process. In 1994, NEEDS established a Quality Review of Courseware Committee to develop a review methodology for evaluating courseware. However, developing this methodology was not straightforward since "standard evaluation procedures have not been established for courseware. The literature shows that many different evaluation models for instructional courseware have been proposed based on different philosophical views on education, conceptualization of educational processes and products, and methodological orientations" [3]. The committee performed a literature review and examined both formative and summative evaluation models including checklists, product review and experimental observation.

> "It is essential that a database of courseware set standards and implement a peer-review system in order to establish credibility as a valuable resource for sound educational material. The peer review process will enhance the recognition of courseware-developers for the scholarly and creative effort they have expended in developing the courseware. In addition, the peer review process will create greater exposure of courseware on the NEEDS database to potential users via the peer reviewers. Eventually, an extensive peer review system for courseware will elevate the quality of all courseware developed in the academic community, as reviewers gain innovative ideas to incorporate into their own development efforts and users raise the standard of what they are willing to work with in the classroom."
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> —Pamela Eibeck, NEEDS Founding Editor [3]

NEEDS convened a national workshop of courseware developers, instructional designers, education and learning experts, and publishers at California Polytechnic State University, San Luis Obispo, CA in May of 1995 to further assist us in developing a review procedure for courseware [4]. Participants worked in groups to conduct mock reviews of an assortment of courseware. The outcomes of this workshop included an improved understanding of the criteria for reviewing courseware as well as understanding of a process to be used. Based upon feedback from participants, NEEDS decided to pursue a multi-level review process for its collections, including non-reviewed, endorsed and premier levels.

NEEDS has devoted the majority of its efforts into developing the premier level through the *Premier Award for Excellence in Engineering Education Courseware*. The *Premier Award* was initiated as a national competition 'to recognize high-quality, non-commercial courseware designed to enhance engineering education.' John Wiley & Sons, a long time supporter of NEEDS, graciously agreed to become the founding sponsor of the *Premier Award.* Through their continued support we have been able to grow the *Premier Award* into an annual competition with an awards ceremony at the American Society for Engineering Education/Institute for Electrical and Electronics Engineers Frontiers in Education Conference.

3.2 The Criteria

The key ingredient of this review process was the development of evaluation criteria for engineering education courseware. NEEDS worked with numerous experts to develop and refine this criteria including students, engineering educators, instructional designers, cognitive scientists, and learning theory experts. The initial evaluation criteria consisted of nine primary areas for evaluating courseware: engineering content, engagement, impact on learning, user interface, user interaction, multimedia design, instructional use, technical performance, and accessibility from the NEEDS database. Over the first three competitions we have continued to refine and streamline these criteria [5].

The evaluation criteria (see Table 1) are now organized under three general categories, instructional design, software design, and engineering content. In each sub-category are a series of questions to help the reviewer judge the relative merits of courseware in that area. A copy of the criteria as used in the 1999 competition is available at http://www.needs.org/engineering/premier/2000/1999criteria-final.pdf.

Table 1 – Evaluation Criteria for Engineering Education Courseware

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

3.3 The Premier Award Judging Process

NEEDS has conducted three *Premier Award* competitions since 1997. Through the *Premier Award's* submission guidelines and judging process we attempt to address some of the comments from participants of the May 1995 workshop,

- "Most reviewers are not qualified to review all of these aspects of courseware."
- "No single courseware is going to meet all these criteria."
- "What if some, but not all, criteria are met? It could still be of great value to an instructor other than the author."
- "How can we, as reviewers, evaluate if learning really has been improved?"
- "The effectiveness of the courseware depends on how it is used in the classroom."

NEEDS convenes a judging panel to evaluate courseware for the *Premier Award*. The judging panel is comprised of a diverse set of experts including content area specialists and professors, instructional designers, publishers and students. The judges weigh the strengths and weaknesses of each submission against the evaluation criteria and their own personal experience and expertise. In order to help the judges gauge if learning has been improved and how the courseware is used with students, we ask the submitters to provide a submission packet that includes:

- Description of the impact of the courseware. For example, what topic areas are covered in the courseware? How and where has the courseware been used? In a lab or lecture section? At a different institution? In different departments? How many learners have been impacted by the courseware? A single class? An entire department?
- Description of how the courseware is used by a learner. For example, what are the pedagogical objectives and learning goals? Are there lesson plans, instructor's and user's guides, etc.?
- Description of the evaluation and assessment performed to assess improved student learning through use of the courseware. For example, was student learning was improved? How was student learning measured? Was some process/product (e.g., report writing, test scores, etc.) measurably improved?

3.4 Premier Courseware

Since the inaugural competition, NEEDS has recognized nine outstanding courseware packages.

Premier Courseware of 1997

- *The Electric Drill Stack: Case Study of the Black & Decker CD 2000 Cordless Hand Drill* by Prof. Sheri D. Sheppard, Sian Tan, and Jack Hong. And Bicycle Dissection by Prof. Sheri D. Sheppard and Melissa Regan.
- *Mars Navigator: An Interactive CD Program about Mars, Aerospace Engineering, Astronomy, and JPL Mars Missions* by Prof. Kurt Gramoll, Jason Charlton, Kelvin Raharja, Mike Weaver, Justin Tenisci, and Chet Verigan.
- *The Virtual Disk Drive Design Studio* by David Yu and Prof. Alice M. Agogino.

Premier Courseware of 1998

- *Structural Engineering Visual Encyclopedia– University of New Hampshire* by Robert M. Henry at the University of New Hampshire.
- *MDSolids* by Timothy A. Philpot at Murray State University (now at University of Missouri–Rolla).
- *The Della Steam Plant Case Study* by P.K. Raju and Chetan S. Sankar at Auburn University.

Premier Courseware of 1999

- *Cracking Dams* by Megann V. Polaha and Anthony R. Ingraffea at Cornell University.
- *Engineering Graphics* by Stephen W. Crown at the University of Texas-Pan American.

Copies of the Premier Courseware of 1999 and limited copies of the Premier Courseware of 1997 and 1998 are available. Email premier@needs.org and indicate which courseware package(s) you would like to receive.

4.0 Other Models Under Development For Evaluating Courseware

4.1 Supporting a Community of Learners Discussing Courseware

We feel that community provides the threads to weave content and pedagogy into learning and teaching. The long-term vision of our community building efforts is to facilitate users searching for both content as well as educational concepts (e.g., geometry or problem-based learning). In this process we want to help users answer the questions, "How do I use these learning resources once I've found them?" "How do I know if these materials are good?" This evolution to support communities of learners evaluating uses of courseware and other resources emphasizes interactivity and user-to-user communication. Two steps we have already initiated to facilitate the community of learners evaluating courseware are allowing them to post reviews (i.e., "Amazon.com"-like reviews) and participate in focused discussion groups (e.g., freshman design or using case studies to teach).

4.2 Case Studies by the Institute on Learning with Technology

NEEDS is co-developing workshops to highlight our efforts described above as well as those of the Institute on Learning with Technology's 'Learning Through Technology' (LT^2) Project (see www.wcer.wisc.edu/nise/CL1). The LT^2 will provide in-depth *case studies* of learning technology innovations at a variety of post-secondary institutions, featuring courses in diverse science, mathematics, engineering, and technology disciplines. Personal narratives of faculty and students cover virtually every logistical, technological, interpersonal, and political issue involved in adapting learning technologies into courses or curricula. LT^2 is also developing *vignettes* that provide short, first-person accounts of the learning technology experiences of faculty from around the country. [6]

5.0 Summary

NEEDS has developed the *Premier Award* to recognize the contributions that engineering educators have made to develop outstanding non-commercial courseware. We are also exploring other mechanisms such as threaded dialogue and user comments to further support the evaluation of courseware. Finally we are also developing workshops to help faculty members understand from their peers 'what works' in 'Learning Through Technology.'

6.0 References

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7.0 Acknowledgements