

Gap Analysis of Educational Web Tools in Engineering and Technology

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<http://www.edtech.vt.edu/dlnet/>

Abstract

A gap analysis of Web tools in Engineering was undertaken as one part of a larger grant entitled Digital Library Network for Engineering and Technology (DLNET) (funded by NSF DUE-00-85849). The DLNET project seeks to build a Web portal and an online review process to archive quality knowledge objects in Engineering and Technology disciplines. The gap analysis purposefully preceded the development of this portal to identify Web tools used or desired by faculty and students to help process Engineering and Technology information in the portal.

Theoretical Framework

The emergence of Web portals to educational content has helped transform traditional links between knowledge developers and users. Where knowledge developers once were required to publish and market their content through publishers, libraries, and bookstores, they may now submit knowledge objects directly to public portals for immediate access and use by peers. One primary gain from Web portals is efficiency of dissemination. Faculty and students can access more information more quickly than before. These gains are positive, but they are not complete. Often, the educational method remains top-down delivery of content to the user (Oliver, 2001). Student processing of information is not necessarily changed, unless a knowledge object happens to be a high-quality interaction or simulation. To fully complement Web portals, it is critical to integrate or recommend educational Web tools that provide the means for students and faculty to process and effectively utilize the growing body of content.

Popular course management systems such as Blackboard and WebCT have found their way onto college campuses. They provide mechanisms for delivery of content, quizzing, and some group communication and file sharing. Additional information processing tools have been developed by educational researchers, however, that are not rapidly disseminated to the general education community by such commercial products. These tools include such features as establishing group project plans via templates (Hung & Wong, 2000), collecting and generating diagrammatic displays of Web searches (Beckman Institute for Advanced Science and Technology, 2001), archiving group-gathered data via Web forms (Means & Coleman, 2000), organizing Web information or links into problem-related or conceptual categories (Slotta & Linn, 2000), integrating or annotating one's notes or thoughts with different Web resources (Berkman Center for Internet & Society, 2000; McHenry, 2000; Weborganic Systems, 2001), and collaboratively editing a Web document (Guzdial, in press) or concept map (Institute for Human and Machine Cognition, 2001). A key goal of this analysis was to extricate and prioritize these types of tools desired by instructors and students in Engineering and Technology disciplines, to raise awareness of gaps between existing and needed Web tools.

Procedure

The gap analysis was divided into three activities. During the Fall of 2000, we identified a panel of Engineering and Technology faculty using Web tools by inviting participation from faculty teaching continuing education courses online with grant partners at the Institute for Electrical and Electronic Engineers (IEEE) and the American Society for Engineering Education (ASEE). We extended the invitation to all faculty in the eight Engineering schools of NSF's SUCCEED Engineering Education Coalition. To generate a more national sample, we also sent e-mail invitations to all Engineering faculty at six additional institutions located in the Midwest, West, and Southwest.

From November 2000 through early January 2001, we collected panelists' registration information and initial recommendations for Web tools via Web forms. Faculty were asked to submit recommendations for existing and hypothetical Web tools that would support both their teaching and their students' learning. We appended other non-represented features to the panelist's recommendations. These additions were based on three factors: 1) existing tool taxonomies (Hannafin, Land, & Oliver, 1999; IEEE Learning Technology Standards Committee, 2000; Landon 2000; Wicks 2000), 2) ongoing discussions with the IMS Global Learning Consortium regarding the standardization of feature specifications in learning management systems (McHenry, 2000), and 3) new tool features and characteristics found in a review of Web course management systems.

Between February and May 2001, the appended master feature list was submitted to the Delphi panelists for a second survey round. Panelists were asked to reflect on and use a Likert scale to agree or disagree with the usefulness of the various features. An online form expedited this ranking. By converting Likert rankings to numeric form, rank-ordered feature lists were derived, describing highest rated tools overall, as well as highest rated tools in specific thematic tool categories (e.g., tools to disseminate or retrieve Web content, tools to process Web content, tools to collaborate or work with others, etc.). One list for all Engineering and Technology faculty was generated, as were several discipline specific lists.

Data Sources

The primary data sources to generate feature lists were participating faculty and educational literature describing Web tool research. The marketing efforts assembled a panel of 66 faculty from over 40 different institutions in the United States and Canada. Each of the 66 panelists submitted their first round recommendations for Web tools, with 56 or 85% of panelists completing their participation by ranking the recommended tools in round two of the gap analysis.

Round One Analysis and Results

To sort the round one recommendations, the following question was asked of each submission: "Who does the tool benefit most?" Three categories emerged during our compilation of the panelists' submissions: tools that benefit the instructor, tools that benefit the student, and tools that benefit both equally. If a tool benefited "both," we asked a second question: "Is there a

situation when the instructor and students would use this tool for different purposes?" If the answer to this question was "Yes," then the tool was sorted twice under "instructor" and "student" categories, because the instructor might rate such tools highly to serve their purposes, but low to serve student purposes, or vice versa.

To help describe the recommendations, we found it useful to ask, "What makes the item described a 'Web' tool?" For instance, some faculty recommended Photoshop to generate images. This software is not a Web tool, but the software or system that allows an instructor to post images online and students to access this information is a Web tool. In such cases, we interpreted the panelists' intent as the latter Web component.

Round Two Analysis and Results

The 51 recommended tools from round one of the gap analysis were rated by each panelist in round two. Each panelist was listed along the left-hand column of an Excel spreadsheet with their Likert scale ratings for the recommended tools listed across the row with their name. The Likert scale ratings were converted to a mathematical scale where 1=strongly disagree, 2=disagree, 3=neutral, 4=agree, and 5=strongly agree. Average ratings were computed for each recommended tool across all panelists, and a comprehensive rank-ordered list was created by value.

Faculty expressed a need for most of the recommended tools in the study by ranking 13 tools with an average value between four and five on the Likert scale (agree to strongly agree that I need the tool), and by ranking 37 of 51 tools with an average value between three and four on the Likert scale (neutral to agree that I need the tool). Only one tool was ranked below a neutral value.

Four engineering discipline areas contained enough panelists to warrant the creation of separate rank-ordered lists: civil and environmental (11 panelists), chemical (9 panelists), electrical and computer (10 panelists), and industrial and systems (7 panelists). For the purpose of statistical analysis, a fifth group was created consisting of "other" panelists not included in the four largest sub-groups.

Statistical comparisons were sought to determine if differences existed between how groups rated individual tools as well as how groups rated tools in the ten thematic categories (e.g., content development tools, information dissemination tools, assessment tools, etc.). Each panelist was sorted into one of the above five groups. An average score, over the tools of each category, was computed for each person. A two-way analysis of variance for repeated measures was ran using SAS software with the ten thematic categories as the repeated measures dependent variable and group as the independent variable. This analysis indicated no significant differences between group averages across the ten categories. This finding indicates for a given category such as communication tools, the average group ratings were similar. A significant difference at the $p < .0001$ level was noted, however, among the ten thematic categories within the groups. This finding indicates within a given group such as civil engineering, the average category ratings were different. A group would place different importance on the tool categories. No interaction effect was noted between groups and the tool categories. Ten one-way anovas were

also ran to determine if the five groups differed on their average ratings of the ten thematic tool categories. As suggested by the one-way anova, no significant differences were found. For each of ten tool categories, the five groups reported similar ratings. Finally, 51 one-way anovas were ran to determine if the five groups differed on their average ratings of any of the 51 recommended tools. Only three tools were found to contain significantly different group ratings at the $p < .05$ level. Out of 51 analyses, however, these three differences could be attributed to chance or error, and thus are not singled out here.

Since differences were noted among the ten thematic tool categories within the groups, table one was generated to illustrate the average rank-order and the average Likert ratings for each tool category. While the category differences are small, it is worth noting their relative order. The most desired Web tool type is faculty tools to create Web content. This tool type is associated with a top-down, didactic approach to teaching. In fact, the top four ranked and rated tool categories are all associated with an instructivist approach to teaching--development of content, delivery of information to learners, and follow-up assessment. It should also be noted that three of the four lowest ranked and rated tool categories are all associated with a more democratic or constructivist teaching style--providing students with activities, interactions, and collaborative opportunities. This analysis provides evidence that the Engineering and Technology panel surveyed places more importance on tools that support traditional teaching practices over tools that would enable different student-centered techniques.

Table 1. Thematic Tool Categories: Most Desired to Least Desired

Tool Categories	Category Codes	Average Category...	
		Rank Order	Likert Rating
Faculty Tools to Create Web Content	CF	10.6	4.138
Assessment Tools for Faculty/Students	AB	18.7	3.911
Faculty/Student Tools to Disseminate or Retrieve Web Content	DB	20.1	3.902
Assessment Tools for Faculty	AF	25.8	3.774
Student Tools to Collaborate or Work w/ Others	WS	28.5	3.712
Course Management Tools for Faculty/Students	MB	30.3	3.688
Student Tools to Process Web Content	PS	31.2	3.650
Faculty/Student Tools to Collaborate or Work w/ Others	WB	31.8	3.576
Faculty Tools to Collaborate or Work w/ Others	WF	37.5	3.573
Student Tools to Create Web Content	CS	42.5	3.293

Table two provides a description of the top ten tools rated by faculty, and presents the tools from highest to lowest ranked overall. The "value" column represents the average Likert rating across the panel from five (strongly agree that I need the tool) to one (strongly disagree that I need the tool). The "code" column indicates to which tool category a specific tool belongs along with a unique number for each tool in that category. Again, it should be noted that the eight top recommended tools fall into the categories of faculty tools to create Web content and faculty and student tools to disseminate or retrieve Web content. These tools represent a traditional or teacher-centered instructional mode of content delivery. They do not reflect more contemporary

learning models that seek to actively involve students in activities and interactions. Additional rankings may be viewed on the project Web site: <http://www.edtech.vt.edu/dlnet/>

Table 2. Specific Tool Rankings: Most Desired to Least Desired

Rank	Value	Code	Description
1	4.661	CF-1	I need a content development tool to create Web-ready documents containing predominantly text and images. Sample software tools in this category include: Adobe Acrobat for creating PDF files; Frontpage, Dreamweaver, Netscape Composer, Word, or an HTML editor for creating standard Web files.
2	4.375	DB-3	I need an information dissemination tool to post my homework assignments, lab assignments, problems, or exercises online, and my students to access, print, or download this information to complete outside of class time. Answers and solutions to the assignments may also be posted online. This category includes such tools as Labview and Mathcad through which the instructor constructs exercises for students to download and run on their computers.
3	4.370	DB-1	I need an information dissemination tool to post my course schedule, calendar, and/or syllabus online. My students will be able to quickly access this information on campus or in their homes.
4	4.304	DB-2	I need an information dissemination tool to post my lecture notes, examples, whiteboard images from class sessions, or Powerpoint slides, online. My students will be able to quickly access this information if they missed class or desire lecture materials for self-study.
4	4.304	CF-2	I need a content development tool to create Web-ready documents with mathematical equations; to write equations and math symbols as fast as writing regular text. Sample tools in this category include LaTeX and MathEQ.
6	4.214	CF-6	I need a content development tool to create Web-readable, static or animated graphics, or 3-dimensional objects. Sample software tools in this category include: Photoshop, Visual Basic for online modeling; Jwave or LiveMath for turning data into 3-D surface images, X-Y plots, polar plots, animations, contours, etc.; Flash, Video Studio, or Ray Dream Studio for creating animated sequences; or virtual reality markup language (VRML).
7	4.164	CF-3	I need a content development tool to scan print-based documents, and save these in Web-readable formats (e.g., HTML, PDF).
8	4.143	DB-4	I need an information dissemination tool to post my learning objectives for exams and quizzes, old print-based exams, and/or solutions to the questions online. My students can access, print, or download this information to practice for upcoming exams.

9	4.130	WB-1	My students and I need an online communication tool to converse in an asynchronous format. Specific tools might include e-mail, listservs, newsgroups, or threaded discussion boards.
10	4.091	AB-3	My students and I need an online gradebook to store their grades. Students should be able to access their individual scores in a secure location. The gradebook should be flexible to allow not only numeric scores, but also statements regarding lab performance, demonstration performance, and general comments about student progress. The gradebook should integrate with the university grade reporting system.

Future Steps: Annotations and Portal Linkages

We recognize the relative unimportance of a simple list, thus have taken steps to create an interactive Web site where panelists and other interested parties may leave their comments and further recommendations. Each list on our site has been integrated with a Web annotation engine, allowing site visitors to embed notes within the body of the documents (see Figure 1).

We have asked site visitors to consider leaving three types of annotations. First, comment on the rankings and let us know if you disagree with the panelists' rank ordering of tools. Second, list specific software programs you are aware of that match a tool description, and leave a Web link to the software if available. Third, describe how you have used specific tools in your classes and suggest lesson ideas for applying a specific tool type.

In addition to the linkages discussed above, we plan to review pertinent knowledge objects deposited into the Engineering content portal and link from the tool lists to those content pieces. These links will suggest mechanisms by which students may process information more actively.

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