Methods for Evaluating Online, Resource-based Learning Environments for Teachers

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Abstract

Online delivery methods offer much promise for anytime, anywhere adult learning. As a method of outreach, and to provide support for just-in-time learning, teacher educators are increasingly deciding to design Web sites that are online, resource-based learning environments for teachers and preservice teachers. Automated evaluation tools and data collection methods can help such Web site designers develop and use online, resource-based learning environments to meet their goals of providing high quality learning opportunities for teachers. This article presents a three-pronged approach for evaluating issues of pedagogical design and user-centered functionality in online, resource-based Web sites. Checklist, Web site traffic analysis, and talk aloud protocols are each described and then illustrated through their application to a site aimed at educating teachers about technology integration. We discuss the relevance for developing effective learning environments when teacher educators apply this evaluation approach to resource-based learning environments.

Teacher educators recognize that online delivery methods offer much promise for anytime, anywhere adult learning. In addition to courses taught partially or entirely online, teacher educators are composing collections of resources in learning environments that are designed to support the professional development needs of teachers for informal learning or just-in-time needs (Dede, 2003; Partnership for 21st Century Skills, 2003). Examples include Web sites designed by staff members of professional organizations (e.g., National Science Teachers Association at http://www.nsta.org), through professional development projects or grants targeting materials to a specific audience (e.g., Learning Point Associate's "enGauge" at http://www.ncrel.org/engauge/), or even by individuals with a special interest (e.g., Kathy Schrock's resources at http://school.discovery.com/schrockguide/).

For teacher educators in the role of Web site designer[1] seeking to create and use such online, resource-based learning environments, finding the answers to the following questions is essential: What Web site characteristics are associated with a quality online learning environment? How can the features and resources of a Web site be designed to support informal, just-in-time learning? Which aspects of the site most engage users? Which users are drawn into the site? We first sought to answer these questions when evaluating the quality and usefulness of eTech (pseudonym[2]), an online, resource-based learning environment for teachers organized around issues of technology integration. The environment was produced as part of a federally funded Preparing Tomorrow's Teachers to Use Technology (PT3) project on which the three authors worked. We developed and piloted a multi-method evaluation approach outlined in this article as a resource to help teacher educators evaluate the quality of the Web sites they draw on as resources, or serve as a resource when designing such sites.

This article first defines and describes resource-based learning. Next, a multi-method approach is described for evaluating online, resource-based learning environments. These methods are illustrated through a review of the eTech Web site. We conclude with a discussion of the possibilities for teacher educators when applying these methods to improve the design and utilization of online, resource-based learning environments for teacher education.

Review of the Literature

Online Resource-based Learning Environments

Unlike online course environments, such as WebCT or Blackboard, sites designed as learning environments that are without a particular instructor, a designated term or assignments, or any particular class list, offer a distinct type of learning referred to in education as resource-based learning. These environments can be an important supplement to teacher education programs (Davis & White, 2001). Resource-based learning operates on the premise that learning can be facilitated with access to information organized around a specific domain that learners can actively explore (Davis & White, 2001). Online, resource-based learning environments are designed for a particular audience and educational purpose. In teacher education, for example, many school districts, higher education outreach efforts, and non-profit organizations are looking to online, resource-based sites to support pre and inservice teachers who are expanding their pedagogical repertoire. Features of such sites may include hypertext links, which enable users to seek and explore information on-demand, (i.e., content area standards or lesson plans), multimedia presentation (i.e., video clips, pictures, spreadsheets, graphs, and sounds), search capabilities, communication tools (i.e., threaded discussion forums or chats), customizable interfaces, and other resources that can potentially support users' active exploration within a particular domain (Davis & White, 2001; Cameron & Spaeth, 2000; Jonassen, 2000). While much has been written about the Web as a resource for learning in higher education, these pieces focus mainly on models or software packages for distance education (Chang, Lin, Hao, Suarez, & St. Lawrence, 1997; Fryer, 1997) or the necessary infrastructure and technical support needed to deploy them, the design of the user interface for online course environments (Kaye, 1996; Descy, 1997), or promise of generating tuition-paying students (Khan, 1997).

[1] We use the term "Web site designer" to refer to individuals, such as the staff of a project or institution, who seek to have educational materials made available to a targeted audience, and in many cases, evaluate and improve upon their use. We distinguish "Web site designer" from the "Web master." Although Web masters may also participate in Web site design, they input and adjust site content, install Web site analysis software, and help troubleshoot.
[2] While the evaluation of eTech was the catalyst for the methods we describe here, in this article it serves mainly as an example of their application.

Purposes of Evaluating Online, Resource-based Learning Environments

The challenge for teacher educators that invest in resource-based learning sites is to assess the site's potential and effectiveness as a learning environment (Barba & Clark, 2002; Swann & Einstein, 2000). If the more traditional process and outcome measures that are used for formal online course environments do not apply, then teacher educators who are designing or evaluating resource-based Web sites must find alternative methods to evaluate such aspects as the quality of design, user characteristics, preferences and behaviors (Trochim, 1996). For example, without an authenticated login, attendance and rate of participation or other process indicators are not collected; without a term limit or assignments and tests teacher educators cannot look to the completion rate or quality of assignments or scores as indicators of the users' learning. While the literature on evaluating educational Web sites is extensive, the vast majority of this has been summative in nature, delivering criteria that instructors and students can use to decide whether or not to use or ignore a Web site as a source of information. Much of this literature provides a set of criteria, including scope, presentation, reliability, and match to curriculum to help people compare sites for appropriateness in a course (Branch, Dohun, & Koenecke, 1999; Wilkinson, Bennett, & Oliver, 1997; Schrock, 1998). Much less has been written on formative approaches to evaluating educational Web sites that provide information to designers in their planning and development of a Web site. These approaches can be divided between situations where the feedback from the intended users is readily available, such as where an instructor develops a Web site for his or her own course, and situations where a teacher educator seeks to provide instruction via an online, resource-based learning environment but will not receive substantial direct feedback from users about it (Hughes, 2001; Rieger & Sturgill, 1999; Weston & Barker, 2001). The evaluation approach we describe here aims to inform the latter situation.

Multi-method Approach to Formative Evaluation of Learning Environments

The evaluation approach we present here is formative and draws heavily on a utilization-focused evaluation model (Patton, 1997) in that it provides information to teacher educators interested in improving Web sites that they are designing or reviewing for use. We do not address the processes implied in utilization-focused evaluation for tailoring the evaluation to the audience's needs, but rather present a set of evaluation methods sufficiently flexible to be adapted to different contexts in which resource-based Web sites are constructed.

Drawing on research on the key dimensions of effective learning environments as summarized by Bransford, Brown, and Cocking (2000), we used these dimensions as a checklist of features desired in an online learning environment and applied the checklist of criteria to the eTech site. This method was complemented by two user-centered research methods: Web site traffic analysis, which draws on data about the length, frequency, and repetition of site visits to infer basic patterns about Web site use and users, and think aloud exercises, which supplement the lack of contextualized information provided by traffic analysis and give examples of how a user may perform and experience tasks in the Web-based environment. These methods were used in a parallel manner, although findings from each method can inform the use of other methods (e.g., pedagogical design shapes the tasks users are asked to do in think aloud exercises).

Evaluating Online Pedagogical Design: Key Dimensions Checklist

Online, resource-based learning environments are most likely to be effective when they are designed and utilized in ways consistent with the research on how people learn. Bransford, Brown, and Cocking (2000) base the following key dimensions of effective learning environments upon current educational and cognitive neuroscience research.

Knowledge-centered environments focus on developing knowledge of the field or discipline and of strategies to develop expertise. They incorporate the language, artifacts, and essential principles on which learning in the discipline is based and model how experts work with those principles to gain increased understanding. In a Web-based environment, this might translate into digital, discipline-specific materials that are up to date, authentic, and accessible to the target audience.

Community-centered environments evolve a community of practice among like-minded professionals where members develop common goals and work toward achieving them. The community-centered environment provides opportunities for active participation and the development of a shared knowledge base. In a Web-based environment, this could be expressed as Internet-based conferencing environments that assist communication over distances, or a repository of artifacts of members' practice.

Assessment-centered environments support learners' testing of ideas by promoting ongoing reflection and feedback on practice. Such environments enable opportunities for metacognition in a sustained, coherent context. Effective Web sites might include Internet-based networking to promote ongoing reflection and feedback on field experiences in a manner that is sustainable, wide reaching, and affordable.

Learner-centered environments focus on learners, building on their strengths, interests, and needs. They take individual learning styles and prior knowledge into account. One of the most promising and underappreciated qualities of new information technologies is their interactive capacity. Effective Web sites might allow users to customize the site according to their preferences and expertise.

The four dimensions or environments outlined here can be visualized as interdependent and overlapping spheres; therefore, we might expect all four dimensions to be present and functioning in a quality learning environment. Referencing research that suggests Web-based technology capabilities can be used as tools to scaffold, motivate, and enhance thinking (Chan, Burtis & Bereiter 1997; Gordin & Pea, 1995; Jonassen, 2000) and referencing Bransford et al's conceptual framework about effective learning environments, we developed a checklist of the desirable features one would want to see in an effective Web-based learning environment (see Table 1). The purpose of applying a checklist is to guide a focused content analysis of the online, resource-based learning environment being evaluated in order to identify its relative strengths and weaknesses. Identifying which items are absent or present is a helpful first step in taking a critical look at how present items support the site's educational purpose and intended audience. This also helps to clarify utilization and development strategies, such as which contexts are most promising for improving the resource-based learning environment. Thus, the purpose for the checklist's use is not about the number of checks that amass, but rather how this systematic review, against established criteria, highlights the support for learning that the Web site provides or does not provide.

The main advantage for teacher educators who use such checklist criteria to guide data collection and analysis is that they link Web site design to a research based on quality instructional practice and they prompt the consideration of facets of the learner's experience not otherwise apparent. Checklists can facilitate a more systematic and efficient approach to collecting and categorizing information, and help teacher educators more readily identify patterns in the data than may be possible with a grounded approach to inquiry.

While the framework we have outlined above is helpful for evaluating the pedagogical design of a Web-based learning environment and its potential for supporting learner's growth, other methods and tools are needed to complete a user-centered analysis of the environment. A

Table 1. Key Dimensions of Online Learning Environments Checklist

Possible Features of a Knowledge-centered, Online Learning Environment
• Hyper-linked resource area (e.g., links to content area standards, current research on Methods and Learning Theory, etc.) • Digital content-area, curriculum or resources focused around specific issues or themes that is up-to-date, authentic, accessible and generative
• Electronic networking forums to support knowledge sharing (e.g., Web-based libraries of: videos of teachers and accompanying descriptions exchanged, reviewed, annotated, and linked to additional resources; lesson plans; journal entries; student work)
• Interactive design tools (e.g., curriculum design tools) with electronic prompts to scaffold thinking • Electronic notebooks encourage reflection in design process • Interactive survey instruments encourage reflection on workplace practices
Possible Features of a Community-centered, Online Learning Environment
• Internet-based conferencing environments that assist communication over distances • Synchronous mechanisms (e.g., via "chat" rooms, multi-user virtual environments or asynchronous e-mail, bulletin boards, threaded discussion forums) • Asynchronous mechanisms (e.g., e-mail, bulletin boards, etc.) that allow anytime-anywhere communication and archiving of discussions to assist the development of a group understanding over time • Coherent human infrastructure (i.e., human facilitators who moderate online conferencing environments) • Repository of artifacts of professional practice (e.g., sites aimed at teacher professional development might have examples of students' work, collaboratively designed lesson plans, electronic records of previous online discussions, URLs to relevant information, etc.) that can be quickly retrieved, distributed, organized, and stored within the online community
Possible Features of an Assessment-centered, Online Learning Environment
• Tools for or tools that encourage self-assessment, reflection, metacognition, feedback such as pop-ups or text boxes to write selected information (e.g., an electronic notepad for recording reflections, pop-up questions prompting self-assessment, electronic feedback forms, etc.)
• Tools for or tools that encourage peer exchange, constructive critique, networking, such as collaborative design tools (e.g., shared online spaces for posting and editing group work, etc.)
Possible Features of a Learner-centered, Online Learning Environment
• Data in graphical, text-based, and multimedia forms, acknowledging diverse learning styles
• Searchable online database through which users can search the site by a topic of interest to support professionals in important aspects of their daily work and let them easily and quickly find what is of interest to them
• Customization according to user's preferences and knowledge (i.e., through Web-based tools such as search engines, databases, conversation tools, simulations, visualizations, and learning environments to give users the ability to initiate discussion strands, import objects, attach files, store work, download software, post notes and published work, or add sound and video to the online workspace)

user-centered analysis that considers user characteristics, preferences, and behaviors will assist Web site designers when they assess the success of the implementation of the above design elements.

Evaluating Learners' Use: Web site Traffic Analysis

Web site traffic analysis is one method that can help designers determine demographic information about site users (from where users come to the site and what learning resources they most often use while there). While this software-driven approach provides a cost-effective and comprehensive means of data collection, it supplies little context for the users' activities at the Web site.

One only has to do a search on the Web for "Web site traffic analysis software" to find the variety of commercial packages available to analyze how and when visitors are accessing a Web site. While a complete listing or review of such software is beyond the scope of this article, we include here some name brands: LiveStats (version 6.2), WebTrends (version 5.0), 123LogAnalyzer (version 2.5), eXTReMe Tracker (version 1.0), and HitBox (version 1.0)[3]. There are also many Web sites that describe how such software packages analyze the statistics that are collected in a database on Web site servers (e.g., Itoh, 2001), and compare and contrast the features of such packages (e.g., Aviram, 1998). The programs differ as to the type and extent of reports they create based on these statistics, but nearly all such software generates similar basic measures, and is designed to provide information about users' activity to Web site designers or server managers.

Most of the reference information on these tools and their use illustrates their application to commercially oriented Web sites (e.g., Lawson, Howard, Kennedy, & Pritchard, 2002; Morris, 1999), to help businesses see what products or information is most interesting to customers. Yet, by substituting learners for customers, and learning resources for products, designers of educational sites can generate insights about how this type of software can assist them. Through automatically generated and continuously collected data, such as that described in more detail below, designers of educational sites can gauge to some degree the "reach" of the site. They can gauge whether actual user profiles match the intended learner audience and identify which learning resources seem most appealing.

Designers can determine whether the site is capturing a return audience by reviewing reports on visitor demographics. While a high number of unique visitors might indicate that the site reaches a large audience, designers of an educational resource very likely expect people to return. Calculating the ratio of onetime visitors to "more-than-one-time" visitors can help designers infer whether the site was compelling or useful enough to convince learners to return.

Data on the average length of visits versus the median length of visits can inform site designers if some users linger over the site. The median represents the mid-point of the data, dividing all users into two equal halves. That the average time spent by users is higher than the median suggests that some users are spending far longer than others at the site, and they are perhaps poring over resources. If the average and median time spent by users at the site are similar, one might infer that learners are uniform in their time spent at the site; of course, the length of time for either measure is also helpful information.

Reports on when those longer visits occur might help site designers make some educated guesses about who is using their site. For example, one might expect that the peak traffic hours for a teacher resource site would be after school during the week. If the traffic analysis report suggests

[3] For further information, see LiveStats: http://www.deepmetrix.com; WebTrends: http://www.webtrends.com; 123LogAnalyzer: http://www.123loganalyzer.com; eXTReMe Tracker: http://www.extreme-dm.com/tracking/; HitBox: http://www.websidestory.com/products/web-analytics/hitbox-professional/. Note: eXTReMe Tracker and Hitbox software companies offered no version numbers at the time we used their software; therefore, we annotated these software packages as their original versions (version 1.0).

otherwise, it should prompt the designer to form questions and collect further information about how the site is being used and by whom.

Data regarding the site resources accessed allows the Web site designer to discern the most and least accessed pages, along with information on the pages where most visitors enter and exit. This is important feedback that might suggest which of the site's learning resources users perceived as most valuable. Such automatically generated data can give teacher educators /designers an idea of how evenly the resources on the site are being utilized, and if resources intended to be most valuable are recognized as such. This information can allow site designers to set priorities as to which content areas should be further developed, and which areas should be minimized. This information can also help the designers of a site decide how to optimize the architecture of the Web site based on where visitors are entering.

Figuring a ratio of page views to unique visitors enables site designers to gauge how encouraged users are to venture into the site, follow links, and check out resources. This ratio also allows designers to infer some things about the visitors' satisfaction with their visits. That is, if a visitor accessed many pages, especially within a particular topic area, she may have found resources helpful enough to look at more.

Finally, data collected on referrers (i.e., links from which visitors come to the site) might suggest other entities with which teacher educators designing the Web site could seek partnership. Data on the keywords used in on-site searches or keyword searches, which led users to the site, helps designers learn what sorts of information users expect or hope to find there. If the things users are looking for are not the sorts of learning resources a site provides, designers might want to add, or link to alternate resources. Of course, data on keyword searches also helps define the meta tags to place on the site's pages, so users who are looking for specific information land at the appropriate page.

In summary, the Web traffic analysis is helpful in that it lays out the facts of a site's use in a cost-efficient and comprehensive way, but it only goes so far to support the designer's ability to make inferences about why site users did what they did. In order to learn why teachers move through the educational resources as they do, another research method is needed. In the following section, we discuss how we used a talk aloud protocol to understand user preferences and behaviors in our resource-based learning environment.

Evaluating Learners' Understanding: Think Aloud Protocol

Think aloud protocol, also known as talk alouds or verbal protocol analysis, is a technique for assessing cognition that involves asking a study participant to report his or her thoughts related to performance of a task. It is associated with a variety of contemporary research methods aimed at capturing thoughts as they occur, such as thought-listing or random-thought sampling (Clark, 1997). The technique typically involves asking participants to undertake a problem-solving task of moderate length while reporting their thoughts as they occur. The participant is urged not to think about what she is going to say before she says it, but rather focus on the task. To this end, the researcher usually sits behind the participant and only speaks to remind her to continue thinking aloud. Outcome measures include a transcript of the think aloud, which can be used in content analysis, and measures of task performance. The main advantage of the talk aloud method is that it can provide a detailed description of how subjects experience the task (in this case, using an educational Web site). The data provided by the think aloud is continuous over time and can be broken up into a number of discrete data points.

Think aloud protocols have been used in educational research to evaluate instructional methods (Grave, Boshuizen, & Schmidt, 1996), assessment methods (Bartolo, Dockrell & Lunt, 2001; Norris, 1990), and the use of instructional technology (Goldman, Zech, Biswas, Noser, et al, 1999; Mathison, Meyer, & Vargas, 1999). Indeed, Goldman and colleagues present a strong case that the assessment functions provided by computer traces are insufficient as assessment tools unless accompanied by process tracing methods such as think alouds. Ericsson and Simon (1993) suggest that there are three levels of thinking aloud affected by the type of instructions given to the subject. These include: (1) spontaneous thinking aloud, such as what one might do naturally in the process of thinking through a problem; (2) intentional thinking aloud with the purpose of simply reporting thoughts but not explaining them to an audience; and (3) intentional thinking aloud with the purpose of communicating one's meaning to others. They recommend the second level as producing the most useful data that engenders the least reactivity to the method. Asking the subject to explain his or her thoughts (level 2) may cause significant changes in what is reported. In conducting think alouds with inservice teachers as opposed to preservice, the distinction between the second and third levels may become especially tenuous as teachers may be quite familiar with talking aloud in problem-solving as a way of communicating content in a classroom setting. Thus, it may be necessary to emphasize that the participant need not explain everything he or she says during a talk aloud.

The main methodological issues regarding the think aloud protocol have focused on whether it truly captures cognitive processes and to what degree it is also measuring subjects' reaction to the think aloud situation. In general, think alouds have their highest validity when capturing conscious thoughts, which are easily verbalized, as they occur. The issue of reactivity calls attention to the importance of the nature of the task undertaken during a think aloud. Ericsson and Simon (1993) suggest that subjects should focus primarily on the task rather than the think aloud, in part so that the subject does not devote too much attention to thinking about what they are saying. In service of this aim, it is common procedure to allow subjects to go through a practice task so that they develop some comfort with thinking aloud. The think aloud should simulate actual tasks to be undertaken by the intended Web site audience and pose a moderate level of difficulty. Our own work in developing tasks for the eTech Web site evaluation described below suggests that the quality of data provided by the think aloud is related to task difficulty in an inverted U pattern. A task that is too easy requires little thinking and is performed quickly. A task that is too difficult constrains the cognitive resources necessary to perform the task and report thoughts at the same time.

eTech Web Site Evaluation

Data and Methods

The multi-method framework outlined above was applied to the eTech Web site approximately two years after its startup and midway through the life of the eTech project. The eTech Project was designed to support preservice teachers during and after their teacher preparation program to use technology in support of instruction in their subject matter. Organized into 11 content areas/teacher licensure programs at our university, the site included: vignettes illustrating added value uses of technology; hardware and software product information; links to external Web sites with teaching resources, lesson plans, and professional organizations; an online discussion area; and case-based interactive exercises for practicing instructional decision making. The site was introduced to preservice teachers during their required technology integration class, utilized throughout its duration, and intended to serve as a resource beyond graduation. The eTech project staff compiled the resources at the eTech Web site.

The first two authors, acting as project coordinator and project director respectively, separately applied the checklist in Table 1 to the eTech Web site, noting what features were present or absent. Afterwards, they met with the third author to compare their checklists and discuss areas for improvement. Data on eTech Web site traffic was collected automatically

by WebTrends software (version.5.0) (1995-2002). Quarterly summaries of Web site traffic from April 1, 2000 through April 1, 2002 were analyzed. Specifically, the authors looked at the following: proportion of returning users out of total users, pages first accessed by users, length of time spent at the site overall, and most frequently accessed pages. The third author, acting as project evaluator, recruited two inservice and four preservice teachers to take part in a think aloud exercise in February and March 2002. These people were enrolled in teacher education courses at the major Midwestern university where the eTech project was based. The six teachers were asked to complete three short tasks while reporting their thoughts about the tasks to the third author. One task asked participants to find an idea for integrating technology into a fourth grade science lesson, while another task asked participants to find an idea to use in an eleventh grade geometry lesson. The other two tasks asked participants to find general advice and resources related to technology integration in the classroom. A brief interview following the exercise asked for the subject's evaluation of the usefulness of the site and what features could be improved. Each think aloud was taped and transcribed for review by the project director and coordinator.

Results of Checklist

Through applying the key dimensions checklist to the eTech Website, we collected information on the range of technology capabilities present in the site, including their intended and potential uses, and categorized them along the knowledge-, learner-, assessment-, and community-centered dimensions. We were quickly able to identify the strengths and weaknesses of the site's design and formulate questions about its content and architecture for further investigation. For example, we determined that eTech incorporated some assessment-centered characteristics, but was weakest in this dimension of quality. Users were invited to send feedback about the site via a comments form on the homepage. In addition, users could link to online, case-based scenarios where they could practice making instructional decisions about technology. They could receive summative feedback on their performances, but the software did not provide formative feedback, such as electronic prompts during performance. It also did not allow opportunities for self-assessment.

Results of Web Site Traffic Analysis

Analyzing WebTrends reports for the eTech site enabled us to make inferences about our users. For example, visitor demographics suggested that about one-third of eTech users were returning users, and that the average visit length was more than 10 minutes. eTech site resource numbers suggested that about a third of our visitors started at the homepage, from which the site branched out into K–12 subject areas. Other data suggested that most visitors moved from home to the beginning pages for these other 11 subject areas. These other 11 starting points were nearly evenly noted as entry pages. A resource page we host for a particular technology course at our university was both a top entry and exit page on our site. About half of our traffic had no referrer noted, and another large percentage came from our college or university Web site. Only a small portion of our audience arrived from a search engine.

Results of Think Aloud Protocol

With the two tasks that asked participants to search for a lesson plan idea, nearly all participants followed a similar path to accomplish the task, although some took less successful paths before this. They went to a subject area (e.g., science or math), clicked on resources, and then clicked on lesson plans. From there, some went to Web sites with which they were already acquainted (e.g., Marco Polo) and conducted searches from those Web sites.

Interestingly, most participants found looking for general information on technology integration difficult. When asked to find a simple guide to technology integration on the eTech site, the six participants were evenly divided among three different search paths before undertaking the task. Two participants gave up after repeated, unsuccessful use of the on-site search engines; two participants found a summary of technology integration principles by going to the site map; and two participants found a brief article on added value by going through an individual content area. For example, looking for a guide on how to integrate technology on the eTech site, a participant read the Web site aloud and commented on how useful they thought a possible guide might be.

> "Technology use provides added value." That sounds kind of like what I'm looking for. "Appropriate to use in a lesson." So "Technology use" I'm going to. No, this is just saying that it does—that technology use provides added value to teaching and learning. It's more of just a statement, not whether or not the technology is appropriate. I'm just reading these things. "Added value summary." I mean I suppose this is kind of related. This is not really a guide to deciding. I guess a guide to me would be something that's more like questions and like a checklist or something.

The post-session interview revealed that some of the difficulties experienced by users were due to incongruence between the users' vocabulary and that used within the eTech Website. This applied especially to the terms "resources" and "tools." One subject remarked during her talk aloud that the eTech Web site's labels did not help her to understand what she might find there:

> To me, when I saw [the label] "Resources" I didn't necessarily automatically go to 'Oh yeah, a lesson plan,' things like that. "Resources," I think of maybe, I thought of what kind of technology could be used, or something, which is kind of included I guess. But, I guess "Resources" is a very general term – and which you may have very well intended since a lot of information is underneath it.

Discussion of Results

The multi-method approach to formative evaluation provided three different yet complementary views of the eTech Web site as an online, resource-based learning environment. Using the checklist criteria as an outline of what a learning environment based on good pedagogical principles should look like, we found the Web site weak on the assessment-centered dimension, especially with respect to formative assessment. The traffic analysis indicated that the intended audience (i.e., preservice teachers learning about instructional technology) was accessing the Web site, but users were not necessarily accessing the material in a linear fashion. Only a minority went through the homepage. The think aloud protocol provided a more nuanced view of Web site use and showed that such use is highly dependent on a clear understanding of the terms employed throughout the Web site. Since the study was conducted midway through the eTech project, the results were used to improve the Web site as a Web-based learning environment. For example, we made changes to the homepage and to the reference page for the technology course. We also reached out to people at our top referring sites, to help them become more aware of our resources and perhaps further build a partnership.

One of the essential characteristics of an "internal" evaluation like this (one that allowed us to make responsive and timely changes to the Web site) is also one of its main limitations. An evaluation of a Web-based learning environment by its designers may bias the results obtained. While using checklist criteria to evaluate the pedagogical design of Web-based learning environments can be useful for generating formative feedback and assisting content analysis, the disadvantages of applying a checklist include the tendency toward oversimplification or inaccurate categoriza-

tion depending on the evaluator's training and knowledge. For example, the categorization of the eTech site's degree of assessment-centeredness by the project director and coordinator may be overly simplified or biased toward intended uses rather than potential uses of Web site features, given that the reviewers were both experienced visitors to the site and familiar with eTech's layout. Where data do not fit into predetermined categories, or categories are loosely defined, reviewers may adhere too closely to a perceived checklist and therefore miss relevant data or opportunities for further clarification of the instrument.

To a certain extent, the use of complementary methods and data sources we describe here can help to overcome this bias. Web site traffic analysis is based on records of actual, rather than intended user behavior. Think alouds provide a close approximation of the user's actual, rather than imagined experience within the learning environment. These latter two methods, in turn, are limited by providing only a description of a user's experience and not a prescription of how a Web-based learning environment might be used successfully. For example, the results of the think aloud techniques are partially dependent on the particular skills and experiences that participants bring to the exercise (including experiences that poorly prepare them to use the eTech Web site). Even during the course of the think aloud, each participant tended to quickly learn the eTech site's structure, such that the third and fourth tasks drew on knowledge they gained in earlier tasks.

Conclusion

The multi-method approach outlined above provides an alternative means for evaluating the pedagogical design and learners' use of online, resource-based learning environments where more traditional process and outcome measures are unavailable. We have illustrated how these methods helped us to evaluate and develop a resource-based Web site as a learning environment for teachers. We learned that applying checklist criteria can provide an efficient means for gathering formative feedback during the site development process and can be useful for comparing the content of our site with an established framework. However, checklist criteria can also be subject to the reviewer's assumptions and preferences. Data collection methods, such as Web site traffic analysis software, can be cost-effective and initially labor saving because they can be employed remotely or automatically. Statistical data can help teacher educators who are designing Web sites learn how the intended audience uses the online, learning environment, how to enhance its appeal, and how to enlarge the user base by partnering with referrer sites. The complementary think aloud protocol, however, can be used to reveal an even more complete picture of what engages users and encourages them to return for additional learning. The think aloud protocol can reveal how easy or difficult and how useful the intended audience finds the typical tasks within the learning environment. While this feedback can be insightful, one must apply the protocol in ways that capture participant's thinking aloud, and consider the influence of their previous skills and experiences. In addition, one must ensure that design tasks are focused and appropriate in their level of difficulty and are representative of actual tasks users are intended to undertake at the Web site. Surveys prior to using the protocol and interviews following its application could help to provide this information.

Online, resource-based learning environments hold tremendous potential for learning in both traditional and nontraditional settings. As networked technologies become increasingly ubiquitous and technology capabilities increasingly sophisticated, organizations and institutions serving preservice and inservice teachers with an educational mission are turning to the Web to provide more affordable, customizable outreach and resources for instruction. Further investigation is needed to develop an established, multi-method approach to gathering formative feedback on the potential and effectiveness of such resource-based Web sites as learning environments. Sustained and concomitant application of data gathering methods would do much to advance the Web site development process because it would help designers refine the environment in ways that more closely align with the ongoing behaviors, expressed needs, and interests of its intended users. Systematic, comprehensive evaluation, however, is usually difficult to accomplish during the initial design, prototyping, and beta-testing phases of Web site development, especially for organizations and public sector institutions with limited resources on time-sensitive grant schedules, or by individuals or groups of volunteers. Automated data gathering software, that can be embedded "behind the scenes" in the learning environment, holds promise for real time feedback, especially where it is part of a comprehensive, predetermined plan for data collection and analysis. Further development of electronic tools and instruments for the evaluation of online, resource-based learning environments and additional examples of their application would help teacher educators as designers meet their goals of providing quality learning opportunities for the intended learners anytime and anywhere.

References

Aviram, M. (1998, February 23). *Top traffic analysis tools*. Retrieved July 9, 2002, from http://builder.cnet.com/webbuilding/pages/Servers/Traffic/ss07.html

Barba, R., & Clark, K. (2002). What's a "hit"? An analysis of a Web-based learning environment. *Journal of Computers in Mathematics and Science Teaching, 21*, 67–77.

Bartolo, P. A., Docrell, J., & Lunt, I. (2001). Naturalistic decision-making task processes in multiprofessional assessment of disability. *Journal of School Psychology, 39*, 499–519.

Branch, R. M., Dohun, K., & Koenecke, L. (1999). Evaluating online educational materials for use in instruction (ERIC Digest EDO-IR-1999-07). Syracuse, NY: ERIC Clearinghouse on Information and Technology. Retrieved April 5, 2006, from the ERIC Database (ERIC No. ED430564).

Bransford, J.D., Brown, A.L., & Cocking, R.R. (2000). *How people learn: Brain, mind, experience and school*. Washington, DC: Committee on Developments in the Science of Learning.

Cameron, S., & Spaeth, D. A. (2000). Computers and resource-based history teaching: A UK perspective. *Computers and Humanities, 34,* 325–343.

Chan, C., Burtis, J., & Bereiter, C. (1997). Knowledge building as a mediator of conflict in conceptual change. *Cognition and Instruction, 15*, 1–40.

Chang, I. F., Lin, L. C., Hao, X., Suarez, H., & St. Lawrence, J. (1997). Cyberspace assisted responsive education implemented on the Internet (I-CARE). *Journal of Asynchronous Learning Networks* 1(1). Retrieved April 5, 2006 from: http://www.sloan-c.org/publications/magazine/v1n1/index.asp

Clark, D. A. (1997). Twenty years of cognitive assessment: Current status and future directions. *Journal of Consulting and Clinical Psychology, 65*, 996-1000.

Davis, H. C., & White, S. (2001). Linking Experiences: Issues Raised Developing Linkservices for resource based learning and teaching (ERIC Digest EDO-IR-2001-02). Syracuse, NY: ERIC Clearinghouse on Information and Technology.

Dede, C. (2003). No cliché left behind: Why education policy is not like the movies [Electronic version]. *Educational Technology, 43*(2), 5–10.

Descy, D.E. (1997). The Internet and education: Some lessons on privacy and pitfalls. *Educational Technology, 37*(3), 48-51.

Ericsson, K. A., & Simon, H. A. (1993). *Protocol analysis: Verbal reports as data*. Cambridge, MA: MIT Press.

eXTReMe Tracker (Version 1.0) [Computer software]. (2003). Amsterdam, The Netherlands: eXTReMe digital.

Fryer, B. (1997). Better WBT: Beating the traffic jam. *Inside Technology Training, 1*(8), 28–32.

Goldman, S. R., Zech, L. K., Biswas, G., Noser, T., & The Cognition and Technology Group at Vanderbilt.(1999). Computer technology and complex problem solving: Issues in the study of complex cognitive activity. *Instructional Sequence, 27*, 235–268.

Gordin, D. N., & Pea, R. D. (1995). Prospects for scientific visualization as an educational technology. *The Journal of the Learning Sciences, 4,* 249–279.

Grave, W. S., Boshuizen, H. P., & Schmidt, H. G. (1996). Problem based learning: Cognitive and metacognitive processes during problem analysis. *Instructional Science*, *24*, 321–341.

HitBox (Version 1.0) [Computer software]. (2003). San Diego, CA: WebSideStory, Inc.

Hughes, R., Jr. (2001). A process evaluation of a Web site for family life educators. *Family Relations*, *50*, 164–170.

International Society for Technology in Education (ISTE). (2000). National Educational Technology Standards for teachers. Retrieved April 5, 2006, from http://cnets.iste.org/teachers/t_stands.html

Itoh, M. (2001, February). *Web site statistics: How, why and what to count*. Retrieved April 5, 2006, from http://www.wisewomen.org/resources/abc/stats/

Jonassen, D. H. (2000). *Computers in the classroom: Mindtools for critical thinking.* Englewood Cliffs, NJ: Prentice-Hall.

Kaye, J. C. (1996, April). *Characteristics of effective networking environments*. Paper presented at the annual meeting of the American Educational Research Association, New York. (ERIC Document Reproduction Service No. ED394502).

Khan, B. H. (1997). Web-based instruction (WBI): What is it and why is it? In B. H. Khan (Ed.), *Web-based instruction* (pp. 5–8). Englewood Cliffs, NJ: Educational Technology Publications.

Lawson, J., Howard, B., Kennedy, D., & Pritchard, L. (2002, February 1). *How do I read a traffic report for my site?* Retrieved April 5, 2006, from http://www.llrx.com/extras/ir27.htm

LiveStats (Version 6.2) [Computer software]. (2004). Hull, Quebec, Canada: Deepmatrix.

Mathison, S., Meyer, T. R., & Vargas, J. D. (1999). Using verbal protocol methodology in the evaluation of software and hardware. *New Directions for Evaluation*, *84*, 73–86.

Morris, C. (1999, August 2). *Mining that data*. Retrieved April 5, 2006, from http://wdvl.internet.com/Internet/Management/mining_data.html

123LogAnalyzer (Version 2.5) [Computer software]. (2002). San Jose, CA: ZY Computing, Inc.

Partnership for 21st Century Skills. (2003). *Learning for the 21st century*. Retrieved April 5, 2006, from http://www.21stcenturyskills.org/images/stories/otherdocs/P21_Report.pdf

Patton, M. Q. (1997). *Utilization-focused evaluation.* (3rd ed.). Thousand Oaks, CA: Sage Publications.

Rieger, R. H., & Sturgill, A. (1999). Evaluating online environments: Tools for observing users and gathering feedback. *New Directions for Evaluation*, *84*, 45–58.

Schrock, K. (1998). *Evaluation of World Wide Web sites: An annotated bibliography* (ERIC Digest EDO-IR-98-02). Syracuse, NY: ERIC Clearinghouse on Information and Technology. Retrieved April 5, 2006, from the ERIC Database (ERIC No. ED436187).

Sonnetag, S. (1998). Expertise in Professional Software Design: A Process Study. *Journal of Applied Psychology, 83,* 703–715.

Swann, D. L., Einstein, M. (2000, October). User analysis and future directions of the web-based aquaculture network information center. *Journal of Extension, 38.* Retrieved August 4, 2002, from http://www.joe.org/joe/2000october/ent-iw.html

Trochim, W. (1996, November). *Evaluating Web sites*. Paper presented at the meeting of the American Evaluation Association, Atlanta, GA.

WebTrends (version.5.0) [Computer software]. (1995-2002). San Jose, CA: netiQ

Weston, T. J., & Barker, L. (2001). Designing, implementing, and evaluating Web-based learning modules for university students. *Educational Technology, 41,* 15–22.

Wilkinson, G. L., Bennett, L. T., & Oliver, K. M. (1997). Evaluation criteria and indicators of quality for net resources. *Educational Technology, 37*(3), 52–59.

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Appendix:
Talk Aloud /Thinking Aloud Protocol

Main instructions

"I'm going to ask you to do several short tasks involving looking through a couple Web sites. The basic idea in the talk aloud exercise is to have you describe everything that you're doing, seeing, and thinking while you go through each task. It's more than just talking aloud to yourself as you might do in other situations, since you'll be reporting all your thoughts while going through this exercise. But, it's not the same thing as being a teacher, either, trying to explain the reasoning behind everything you do with the Web site. Just think, reason in a loud voice, tell me everything that passes through your head while you work through the task. There is no right or wrong way to go through this task."

Reminders

After 20 seconds of silence, the experimenter should say, "What are you thinking about?"

Tasks

Practice Task: From the university's homepage, find the current hours for [name of the main] library.

Task #1: Use the eTech Web site to find one new idea for integrating technology into a science lesson for fourth grade students.

Task #2: Use the eTech Web site to find a simple guide to decide whether technology is appropriate to use in a lesson.

Task #3: Use the eTech Web site to find one new idea for integrating technology into a geometry lesson for eleventh grade students.

Task #4: Use the eTech Web site to find one resource to aid in teaching other preservice teachers about technology integration.

Interview Questions

Is there any topic listed on the Web site that you didn't explore but would have liked to look at?

Did you find it easy or difficult to navigate around the Web site? What made it easy or difficult?

What do you think is most useful about this Web site as a resource for teachers?

What do you think is least useful about this Web site as a resource for teachers?

What improvements, if any, can you see that would make the Web site a better resource for teachers?

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accompanying blog will also be made available so that you can participate by contributing your thoughts.

This Issue

The four articles in this issue provide further rationale for the need for advocacy discussed in this column. Each of these articles suggests some of the exciting affordances of technology to enhance both teacher education and student learning.

In "A Comparison of Teacher Education Faculty and Preservice Teacher Technology Competence" Jim Carroll and Patricia Morrell share results from a study comparing teacher education faculty members and preservice teachers with respect to self-perceptions of technology competence. Findings from this study point to both faculty members and students as having technological expertise and that each group might benefit from the capability of the other. The study presents a positive picture of teacher education faculty members and their abilities to develop student knowledge of meaningful technology applications.

The work of Beverly Ray and Martha Hocutt reported in "Teacher-created, Teacher-centered Weblogs: Perceptions and Practices" provides useful insights for teacher educators interested in exploring the possibilities of Weblogs for classroom teachers. This qualitative study focuses upon determining possible themes that emerge as teachers create and use Weblogs to enhance their professional practice.

Teacher educators and classroom teachers working to design online environments for teacher professional development will find the work of Christine Greenhow, Sara Dexter and Eric Riedel useful as they provide three useful tools for evaluating both the pedagogical design and user-centered functionality of these sites.

Using technology to enhance opportunities for teacher reflection is also the major theme for Lynn Bryan and Art Recesso in their study of the use of a video analysis tool to help enhance science teacher reflective practice. In " Promoting Reflection among Science Student Teachers using a Web-based Video Analysis Tool," the authors explore a user-friendly video analysis tool in helping both preservice and inservice teachers engage in more reflective practice.

All four of the articles in this issue represent innovative approaches to improving our use of technology in teacher education and provide a glimpse of some of the possibilities for future work. The urgent need for legislative advocacy suggested in this column is further reinforced by the forward-looking projects highlighted in this issue.

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posals. We'll post further guidelines for possible SIGTE financial support to graduate student presenters at NECC 2007, as a way of encouraging future teacher educators to get involved in SIGTE activities.

Although recognition of our 2005-2006 SIGTE volunteers took place at the SIGTE business meeting, I want to repeat my thanks to Melissa Pierson for her outstanding service as President from 2004-2006; her gracious and enthusiastic leadership increased active participation of SIGTE members. Thanks also to Karen Grove who was elected to a second term as Treasurer. Finally, at the Business Meeting, we recognized deceased member Bill Halverson's many fine contributions to SIGTE and the educational community. As a community, we have much to be proud of and thankful for in the way of member contributions to the profession, both past and present.