Unique Metadata Schemas: A Model for User-Centric Design of a Performance Support System

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Learning object technology is viewed as a method for fast retrieval. This effort is on developing unique schemas for a targeted group to aid efficient retrieval. In this article, I study a user-centric model for developing tags for K–12 educators that is based on user needs, expectations, and problems. I use a combination of techniques from human performance technology and Sensemaking® to gather and analyze data from potential users. The resultant tag set is simple enough that researchers may envision a performance support system where users may quickly and easily tag and add objects to the system. This opens the door to the creation of systems designed for groups with homogenous information needs, with unique metatags, populated largely with objects and information brought into the system by the users.

Learning objects have stirred great controversy in the educational community over the past few years. Some embrace the idea as a new wave in education, allowing customization of instruction on the fly. Others flatly reject the concept of objects. If learning is constructed (either internally or socially—Burton, Brown, & Fischer, 1999; Hogan & Tudge, 1999; Rogoff, 1990; Rogoff & Lave, 1984), then the idea of objectified learning contradicts more than two decades of research (even more if one goes back to the writings of Dewey and Vygotsky's original writings). Instead of the widely accepted notions of constructivist learning environments, learning objects seem to be a throwback to programmed instruction. However, learning objects themselves are not the problem. The problem lies in the claims that tagging objects will result in the facility for instantly customized and targeted instruction. This tension may be a result of the inherent tension between those futurists who have done so much toward making learning objects function and those focused on instruction. This tension can be portrayed as Can we get these objects tagged and retrieved? versus Can I use objects to teach? These two very different views may give rise to an evolution in the theory that guides the development of the tagging sets that underlie the search and retrieval of learning objects. Although the current state of the theory is thin, continued interest in learning objects and other tagging applications (such as the Semantic Web), may encourage study to develop a richer understanding.

In this research, a look at new theoretical assumptions for the development of tags is contrasted with the existent assumptions. A model, derived from the new assumptions, that devel-

ops tags based on user needs (user centric) instead of using an object-centric approach to development, is studied. The process of developing tags is examined, and the possible implications of using the model are considered. A single case of using this model is studied.

BACKGROUND

What Is a Learning Object?

The bane and blessing of learning objects is that the term seems self-explanatory. However, there are many different definitions of various degrees of vagueness in play. The IEEE defined learning objects as "Any entity, digital or non-digital, which can be used, re-used or referenced during technology supported learning" (IEEE_LOM, 2002 para.1). Wiley (2001) said, "Learning objects are elements of a new type of computer-based instruction grounded in the object-oriented paradigm of computer science" (p .3). Cisco systems said, "a learning object is based on a single learning or performance objective, built from a collection of static or interactive content and instructional practice activities" (Ying, 2002, para.3).

A tension exists between technicians, who are interested in questions of can learning objects be tagged and used interoperably between learning systems, and practitioners, who are concerned with how to effectively use learning objects within their instruction. McGee summed up this tension at the 2003 E-Learn conference:

> The power of learning objects is that they can be decontextualized. This is what allows them to be used in different places. As educators, we know that context is everything. So, there is a fundamental tension between the power of learning objects and their use. (McGee, 2003, p. 63)

If the teacher or instructional designer provides the context, the learning object is merely a tool, a bit of information. The pedagogic problem lies in the claim that objects may somehow be strung together *automatically,* based on some criteria. The problem is with the intended *use*, not with the object—just as information in a book or a journal article is the tool, and locating the information is its use.

If the problem with learning objects is with intended use, it is helpful to find a more useful, perhaps less explosive definition, defining by form rather than by use: A learning object (or information object) is an object that may be accessed on line by means of some kind of tags. The learning is directed by the learner and the instructor. The distinguishing feature of an information object intended to support performance or learning is that someone has added some kind of information (metatags or metadata—data about data—a description of the object) to aid in the search and retrieval of the object. In other words, if one removes the pipe dream of automatic construction of instruction, the efforts surrounding learning objects are to one end—making it faster and easier to find and retrieve useful materials that can support instruction. This in no way demeans the efforts toward developing metatags and tagging objects. Anyone who has tried to find useful information via search engines knows the frustration of information overload. If designers' spending time and energy on adding metadata to objects results in reducing the time required to sift through the chaff of a Web search, they can provide a great service.

If a learning object is an object that someone has tagged to make it easier to find and be used by educators, then all learning object initiatives are efforts to make it easier to find and use information available. If the focus is on form, with the end of enhancing finding and retrieving, then it behooves designers to explore different methods of tagging objects to this end, continually seeking to improve this search and retrieval function. To expand on this, a brief explanation of metatags, metadata, key words, and searching follows.

A Brief Introduction to Searching

Educators spend a great deal of time searching for information, but give little thought to the "mechanics" underlying the search tools they use. From the advent of libraries, it became necessary to develop methods for search and retrieval. Imagine going to a library that only contained random piles of books: "Have you

any information on constructivism?" "I don't know, feel free to look."

Fortunately, libraries have metadata systems—these used to be card catalogs and now are usually online catalogs. The catalog has data about data—in this case information about the materials in the library. There is also standardization in metadata. You know what information will be on a card in the catalog—it will have the title, author, date, call number (also standard), some keywords, and a brief description. This way, if you can find a book in one library, you can find it in most libraries. There are two common standards in libraries—the MARC system (Machine Readable Cataloging from the Library of Congress) and the Dewey Decimal system (owned by OCLC—the online computer library center, which also develops the Dublin Core metadata schema). In neither case, in searching the system or the physical card catalog, is the actual information (the book) read. Instead, it is the metadata that is accessed: the information on the physical or the online card (title, date, author, publisher, a description, and keywords). Keywords are a challenge. There must be uniformity in how keywords are assigned to books, but they are assigned by a person making a judgment call. In order to promote uniformity, there are reference volumes of accepted keywords, and training available. Even with these supports, uniformity is a challenge. I once participated in a seminar of graduate students in library and information science where each person assigned metadata to the same set of objects. It was rare when there was more than 50% agreement on keywords, even after discussions.

Web search engines use a different approach from searching metadata. Because of the enormous and growing number of objects online (Web pages, animations, PDF files, documents, etc.), it is impossible to have a bank of master librarians continually looking at new material, assessing it, and cataloging it. Instead, search engines use text searching. A Web search engine (such as Alta Vista, Google, or Yahoo) has a tool called a crawler that is constantly searching the Web, "reading" pages. It creates an index of words, noting which documents contain each word. If you are searching for *horse,* the engine will look at its index under horse, and return all documents that are listed. It is not going out and searching the Web; it is searching its index. Next, the engine ranks the results and returns them in the order calculated to be most relevant to your search. Each search engine uses different methods for deciding ranking, which is why you will get different results if you enter the same search terms in different search engines.

There have been attempts to encourage users to add keywords to Web-based documents. HTML introduced a tag, the metatag, which was placed in the header of the document. It was not displayed on the Web page, but search engines could read the metatag and index those words as well. However, this tag was problematic for two reasons. (a) Marketers would add extensive lists of words in the metatag field to increase the likelihood of their page being displayed by search engines. (b) The other problem was one of uniformity. Because tags are added by the author, and there is no control or indexing expertise for Web page authors, there was no uniformity in keywords or their use. The result was that metatags served little useful function in narrowing a search.

There are two approaches taken by those attempting to make it easier for educators to find information. (a) Some groups, such as the Gateway to Education Materials (GEM) and Marco Polo, have developed repositories of objects (pages, documents, etc.). These are databases containing uniform information about objects. Usually, this information is not a part of the actual object—it is not a metatag in the header of the object. It is more like a field in a database or a card in a card catalog, listing information about the object and referencing its location. These objects are tagged uniformly by specialists and use defined keywords. (b) The second approach focuses on the creation of specifications, or uniform tag sets, called schema. These either can be located directly in the object (in the HTML header), or can be used for repositories (such as those described above). Currently, the most well know of these specifications is developed by the IMS Global Learning Consortium (www.imsproject.org), but there are dozens of specifications. Some are focused on learning (such as the IMS and IEEE LOM); others are

more general (Dublin Core—www.dublincore.org); others are for different focused groups (such as MARC for library materials).

If the object is in a database, with each tag as a field, it is possible to introduce a very different kind of search. Text search engines work by matching words the user enters with words associated with the document (be it in the header, a field, or the text of the object—depending on the structure of the set of documents). If you type nothing in the search box, the engine matches nothing . . . no documents are returned. However, if a document set has been tagged, a tag-based search engine can be built. In a tag-based search engine, the tags that are selected act as filters. For example, in a tag-based search engine for educators, one of the tags is Lesson Plan. (See Figure 1). If a user selects that tag, then only objects that have been tagged as a lesson plan will be retrieved. If the user does not select any tags to filter (focus) the search, a tag-based search tool will return all the documents in the document set. One is reminded of the old joke: How do you carve an elephant? Get a block of marble and chip away everything that doesn't look like an elephant.

In summary, efforts by groups such as IMS are designed to help educators more efficiently find information (with less extraneous detritus) by encouraging uniform labeling (or tagging) of information. These tags are called metatags whether they are located as part of the object or in a database that references the object. In either case, the focus is on the tags as referents to the information, as opposed to text searching.

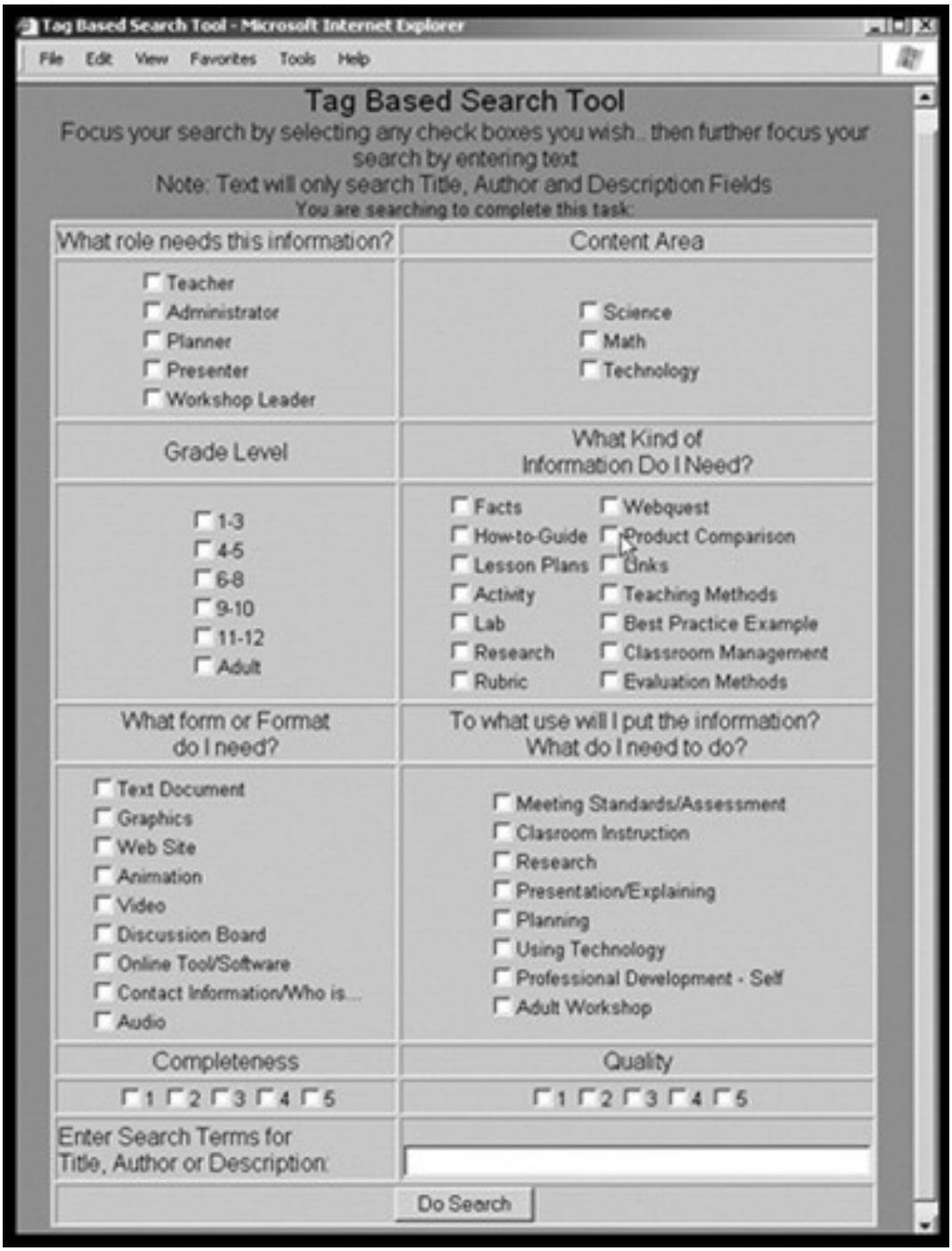
Two Problems

The work of those involved in promoting the use of tagging schemas is a great boon to those in education. They have provided a means to cope with the tsunami of online information. However, two problems threaten the usability, and so, the implementation, of tagging as a general practice. (a) The first is an *object orientation* for tags. The development schema (what tags should be included) is usually focused on describing the objects that will be tagged in many different ways—the title, author, media, order of use, and so forth. The focus is on objects—what problems a user may want to solve—not on use. The problem with attempting to describe an object is that there are so many different features of an object; the result is often a very elaborate schema with a great number of tags. This requires time and money. Each tag takes time to add and a judgment call by someone who is knowledgeable enough to be able to do it. Each tag decreases uniformity, because each person will make different tagging judgments. In other words, the more tags, the greater the cost, the more time it takes, and the fewer the number of people who have the expertise to be able to tag. Tagging, then, becomes a specialized pursuit, accomplished by experts rather than a common task, generally done by everyone who adds an object to a repository. It certainly limits the number of tagged objects available.

(b) The second problem is compromise. A driving goal with most efforts is to provide a single, universal specification to facilitate easy exchange of information (*interoperability*). Several schemas are already in use, and more are being created. Most of these schemas can "map" to each other—sharing some similar tags. Previous attempts to create universal standards for tagging failed. In the current effort, most schemas are either variants of or make an effort to map to the IMS specifications, an outgrowth of the IEEE LOM. In order to become universal, a specification must meet the needs of a great many people and groups. To encourage groups to sign on to supporting a certain specification, the developing group must take note of (if not reflect) the needs, vocabulary, and agendas of key players.

For example, one of the key players in the development of metadata standards is ADLnet (www.adlnet.org), a group that brought together software developers, content providers, and content consumers to develop its shared content object reusability model (SCORM). SCORM uses IMS specifications. Software developers and content providers wanted to be able to declare their products "SCORM compliant." They wanted a simple, stable tag set. Because of this, suggestions of developing means to incorporate unique tag sets focused on smaller groups were initially decried. There

Figure 1 ☐ Tag-based search tool.



likely will be ongoing tension between groups that have adopted specifications, do not want to be constantly changing their products, and do not want continuously to invest time and money training their staff to stay abreast of a moving target, and the evolution of a relatively new

technology that must change as it meets and adapts to new needs and challenges.

Two additional tensions continue to shape the evolution of metadata specifications, requiring continuing compromises. (a) The first is how many tags should be included in the schema. The Dublin Core schema is the only tag set that has been adopted as a standard (a "notch above" a specification) The Dublin Core is a very simple tag set, with fewer than 20 tags. A tension exists between how simple, but generic, a tag set should be versus how specific, but complex, is useful. This tension cannot be easily or universally answered. For example, consider a Web site on which there is a photograph of a famous statue. Who is the author—the sculptor, the photographer, the Web site designer, the site owner? A simple tag set opens the door to such questions, but a more elaborate tag set that includes tags for "created by," "original creator," and the like adds to the cost and complexity of tagging, reducing the likelihood that objects will be tagged at all.

(b) The final tension considered here is between universality and uniqueness. The previous tension concerns the degree of specificity—the number of tags in the set. This tension considers the *nature* of the tags. If one builds a tag set for a specific group, such as teachers, perhaps one can create a tag set that more closely answers the needs of the target population. It may also be possible to limit some of the tags to a certain list of words—a controlled vocabulary. This would certainly increase uniformity in tagging. However, such a thing would not be possible for a tag set that tried to be all things to all people, even with a great number of tags. The tension is between a more targeted approach, with much more limited appeal, versus a more generic approach, with broad application. For example, including a tag for pedagogy would make sense in a schema designed for teachers, but would have no place in a universal schema. Dublin Core is a very generic, simple, universal tag set. It is used for learning objects, museum pieces, Web documents, and more. The IMS specification is a more targeted tag set, with more specific, detailed tags, aimed at tagging objects that focus in some way on learning.

THE CURRENT RESEARCH

Most of the work done with metatags has focused on tags that serve a large target population. In this research, I have continued the move toward specificity started by the IMS, when they developed a specification focused on learning objects. I address the question, What kind of tag set would be useful for a group with a relatively homogenous information need—in this case, K–12 science and math educators?

Developing metatags has been largely atheoretical. The method for developing tags has typically involved discussions by a group of experts (sometimes experts in tagging, sometimes experts in the target field). This process has not been guided explicitly by theory. However, the methods and results indicate the following implicit theoretical assumptions:

1. *Object-oriented tags.* The best way to develop tags is by considering possible objects and developing tags that can describe all possible objects for all possible users in all possible situations.
2. *Tag sets developed by experts.* The tags are developed by committees of experts in tagging, who are not necessarily end users. It is the judgment of these experts that decide which tags are necessary, useful, and good.
3. *Relatively generic tags within a broad targeted population are preferred.* In order to offer the greatest interoperability, one must develop sets that may be used by a broad section of an industry.
4. *Detail is more important than abbreviated tag schemas.* Tied to the first assumption and the process of developing tags by group decisions, most tagging schemas tend to err on the side of completeness rather than brevity. The sole exception is the Dublin Core, which relies on a relatively small number of tags.

One can view each of the tags in a schema as a theoretical construct that is an outgrowth of these foundational assumptions. With this view, each schema is a theoretical statement that the best way of describing a set of documents is this set of constructs (the schema).

Many of the problems with schemas previously detailed can be attributed to the founda-

tional assumptions that are rarely explicitly recognized and so are never considered or justified. In this study, I propose a new set of theoretical assumptions and investigate the resultant new model for developing tags. My focus is on using the model and explicating the application of the model in the development of a set of tags. It is premature to attempt quantified comparisons between methods using the traditional theoretical assumptions and methods using these new assumptions. The question now is one of exploration of alternate foundational assumptions. If these new methods result in schemas that show promise, then researchers must work to understand the implications of these new theoretical assumptions and to become proficient with the resultant methods. Only then will it be appropriate to ask whether one method is superior to the other, or results in superior schema—either in specific cases or generally. At this point, those developing schemas have one method, reliant on theoretical assumptions no one recognizes. In this study, I offer new assumptions and explore the resultant method.

The new assumptions investigated in this study involve:

1. *Task- or problem-oriented tags.* The best way to develop tags is to explore the information-seeking behavior of the target population and make tags that will support the tasks for which the tags are used.
2. *User-centric design.* Tags are to be developed based on extensive interviews with the target population.
3. *Evolution.* Tag schemas are only a best guess of potential use. Continued input by users based on use will indicate necessary revisions.
4. *Unique tag sets.* Tags may contain generic tags, but the most important tags must be developed based on the information-seeking behavior and needs of the target population.
5. *Brevity.* In the balance between detail and ease of tagging, there is a high value in keeping the schema simple enough to reasonably consider the tagging of objects by users.

In this research, I study a model for developing tags that describe possible user needs (user centric) instead of using an object-centric approach to development. I examine the process of developing tags and consider the possible implications of using the model. This research demonstrates one instance of using this model. While I did collect data from multiple potential users (including teachers, administrators, and technology leaders), using a variety of methods (including onsite structured interviews, unstructured interviews, observation, and telephone interviews), I did not test the efficacy of the tags developed. Of course, one would prefer to be able to develop the model, use the model, and also test the effectiveness of the tags developed. However, man's reach must exceed his grasp, else what's a heaven for? It is simply too much for one research project. Researchers must proceed in stages. This research examines the development of tags. None of the tagging schemas currently are tested for efficacy. They are debated, explained, and promoted; however, different possible iterations are not compared for effectiveness. This is because the state of underlying evaluation theory for evaluation of information retrieval systems is so thin that comparative studies are of questionable merit. I have spent the past year developing and studying new measures for evaluation. As that research is completed and reported, it will be possible to turn to the question of comparative studies that can examine unique tags developed using this or other methods.

However, it is now common for groups to use some unique tags to customize more generic schemas. This trend will almost certainly continue with the growth of the semantic web. Currently, there is no explicit method for the development of unique schemas. This method offers a starting point for future discussion and research.

A MODEL FOR DEVELOPING USER-CENTRIC TAGS

In order to develop tags for the purpose of aiding search and retrieval of documents and objects to answer questions or problems posited by a group with homogeneous information needs, I used human performance technology and sensemaking for theoretical guidance.

Human Performance Technology (HPT)

HPT is a field within instructional design that offers guidance in developing interventions that increase performance. When there is a *performance gap*—a difference between targeted performance and actual performance—a traditional instructional-systems approach will suggest that the solution lies in a training intervention. However, HPT looks to other possible causes for the gap. For example, when one considers the problem of drivers exceeding the speed limit, the problem is not one of training. Drivers know how to read the signs (one hopes) and know how to operate a vehicle at different speeds. This is a problem of motivation.

Rossett classified causes of performance problems into four areas: (a) lack of skill and/or knowledge, (b) lack of motivation, (c) flawed incentives, and (d) flawed environment (Rossett, 1996). Gilbert highlighted the importance of the supporting environment in seeking ways to improve performance.(Gilbert, 1996). Gilbert looked at information, instrumentation, and motivation in the environment and in a person's repertory of behavior.

In order to study persons, their performance, and their environment, HPT practitioners have developed a rich set of methods and tools. These include observation, interviews, focus groups, questionnaires, brainstorming, and more (Hackos & Redish, 1998; Jonassen, Tessmer, & Hannum, 1999).

The use of HPT techniques within this model grounds the data in users, their tasks, and their environment. This shifts the focus from trying to describe the specifics of an object to gathering information about user needs. Developing tags must start with users—interviewing them about the problems they have as well as observing them in the environments in which they work.

Sensemaking

Sensemaking is a theoretical perspective emphasizing examination of the cognitive processes undertaken by individuals and groups when faced with a situation or information that does not fit into expectations—a jolt. Sensemaking has been used to explore organizational management interprets their environment and how this interpretation process influences strategic behavior (Schneider, 1997), the behavior of airplane pilots during events preceeding a crash (Weick, 2001), and the process of creativity, both individually and organizationally (Drazin, Glynn, & Kazanijian, 1999). "The sensemaking process both draws on cognitive schemas as a guide for action and updates these cognitive schemas in making sense of experience" (Morrison, 2002, p. 1). The emphasis in sensemaking is on understanding the processes through which individuals and organizations develop systems of meaning about creative action (Drazin et al., 1999) Weick identified seven attributes of the sensemaking process: (a) grounded in identity construction, (b) retrospective, (c) enactive of sensible environments, (d) social, (e) ongoing, (f) focused on and by extracted cues, (g) driven by plausibility rather than accuracy (Weick, 1995 p. 17).

Using sensemaking as a theoretical lens to both gather and analyze data roots the activity in examining the purpose the user has for seeking information, as well as the type of information the user wants and expects. My work centers on performance support systems—systems that provide answers to problems—as opposed to generalized searches for information. While one occasionally has time to "cast a wide net" to find tangential information about a topic, one more often searches for objects because of a need or a problem. This type of searching may be viewed as a sensemaking activity—finding information and using it to develop the user's frame of reference to be able to solve the problem or fill the need that initially stopped the smooth flow of performance. For example, a teacher tasked with teaching a lesson in the phases of the moon may not have a ready explanation or may need supporting illustrations. The teacher has a need, has a perception of what is wanted, and begins to search to find those objects that can provide information to make sense of the task—filling in the gaps in understanding. The teacher is engaged in a process that includes "placement of items into frameworks, comprehending, redressing surprise, [and] constructing meaning"(Weick, 1995, p. 6).

What problems bring the target population to search for information? What types of information do they believe they need? To what use wil they put that information? If researchers develop tags that support this process, the search may be more direct and more effective.

Specifics of the Model

Using HPT methods (observation, interviews, document analysis, and task analysis) I attempted to understand the population, the environment, and usual tasks. I used sensemaking to guide data collection and analysis in order to bridge the gap between the user-environment-task and the problems or reasons a user might come to the site. Sensemaking begins with a jolt. During the course of activity, the jolt enacts sensemaking behaviors. I tried to clearly explicate the frame of reference of users when they came to the site. What was their problem? What was their need? What did they want? How would the site support their sensemaking activities?

Once the data on the users and needs had been collected, I used sensemaking to guide analysis. I used several poster-sized sheets topped with Weick's seven attributes of sensemaking and the question, Who Am I? As data was analyzed, I entered specific statements of needs, purposes, problems, and/or desires, always attempting to be clear and concrete.

When all the data had been entered, I looked for clusters—similar types of information needs. I have done this with three very different target populations now and in each case most of the types of information needs lent themselves to clustering. There were often be some outliers, and a decision had to be made (dependent on the specific case) as to whether they should be imperfectly classed in another group, discarded, or remain as independent categories. Each category then becames a tag. In appropriate categories, the specific summaries within the category became the controlled vocabulary for the tag. Specific examples will be provided in the results section.

THE CASE

In 2001–2002, I undertook a project with a regional educational laboratory that wanted to provide easier access to their extensive collection of Web-based objects. After discussions, I agreed to develop a set of metadata that would include tags from established schemas (Dublin Core—www.dublincore.org and IMS—www.imsproject.org/) but also would include tags unique to their organization. What I wanted to study was whether the model detailed above could be used in the development of these tags.

The specific research question was: Can a model combining HPT and sensemaking as a theoretic basis be used to inform the development of unique metadata schema for performance objects in a performance space?

Based in an objectivist epistemology and a postpositivist methodology (Crotty, 1998; Phillips & Burbules, 2000), in this study I use a case study (Yin, 1989) to explore the application of a design model to provide a richer understanding of the model. It may be hoped that with continued research and reflection on the application of the model, theoretical assumptions may be developed.

METHODS

Interviews were conducted in two phases: (a) The first phase consisted of 13 on-site visits, combining observation of the work setting with an interview. (b) The second phase comprised nine telephone interviews. The researcher used the model to both gather and analyze data and developed a set of unique tags. The tag set will be discussed in the results section.

Phase One Interviews

In Phase One, the client organization wanted to better understand teachers' needs and problems, as well as finding ways to both increase site usage and make search and retrieval easier through unique metatags. The researcher proposed carrying out in-person interviews in order to identify (a) why the users might come to the site, (b) problems and challenges encountered in

their job for which the site might hold an answer, (c) current uses for the Web, and (d) other sites that were useful. I thought it was important to have a series of face-to-face interviews not only to gain a feeling for the environment, but also to help the developers identify more closely with the daily work of the users. The client specified interviewing between 9 and 12 teachers, 2 university researchers and 1 or 2 administrators. Further, it was decided to attempt to recruit respondents largely from poor, rural schools, because the educational lab had a vested interest in developing ways to bridge the gap between rich, urban districts and poor, rural districts. Because of time and cost considerations, respondents would be recruited only within driving distance of the researcher's location (a convenience sample). Respondents were recruited through e-mail solicitations to known teachers and computer coordinators.

Thirteen interviews were conducted with teachers, administrators, tech coordinators, a preservice teacher, and a researcher. Of that 13, 2 were administrators and 7 respondents were in rural schools. All interviews were conducted face-to-face. All respondents were computer users and were comfortable with technology. Questions included brief demographics and usage, identification of current uses of computers, identification of problems in their work, and possible solutions. In addition, in order to provide a richer understanding of needs, rather than asking What kinds of services would you like? a list of potential services was presented and respondents were asked to identify services they would value.

Phase Two Interviews

After the first phase of interviews, the client organization decided that it was not in a position to consider new services, nor was it ready to prioritize outreach to a new user population. They wanted to focus on improving the user experience and ease of search and retrieval for existing users. This brought the project to exclusive concentration on the development of unique metatags. The interviews for current users were focused on how they used the site, what problems they were trying to solve when they used the site, search techniques, aspects of other sites they liked, and which aspects of the site they liked and did not like. Nine interviews were conducted by telephone. The subjects were identified by the client organization as administrators or trainers and current users of the site. Two telephone interviews with client managers were conducted and detailed interviews and observation of one manager, who was the main contact for the project, extended over several sessions.

RESULTS

Phase One Interviews

In the first phase of interviews, the needs expressed were far reaching. However, most respondents asked for information objects that they could "get and go." Some wanted online tools such as grade books, rubric makers, and test generators. Nearly all wanted lesson plans, but written by teachers, with annotations by teachers of what worked and what did not.

> I look for lesson plans by other teachers, notes from other teachers for presenting a topic, feedback from other teachers, and stories from other teachers to see if they are going through the same things. I found the journal of one guy who is teaching in Japan. (Bill. First-year science teacher.)

Another need expressed was the sharing of information both between teachers and from "above" on such hot topics as assessment and standards. Again, the desire was for very practical application. Said another teacher about assessment,

> That's in the back of my head all the time . . . where are we going and will I be able to do it. How are they assessing how we are meeting those standards? I would like to talk to other teachers. Are we the only ones going through this? I don't think we are. (Jean. Third grade teacher.)

Another common request was for guides or answers to applying technology in the classroom, again with a regular preference stated that these guides and experiences be from actual classroom teachers, not experts. Suggestions included,

"How I used a color printer to help my teaching"; "How to use hand held computers and probes in teaching science"; and "How to use specific technology to teach specific standards."

First-year teachers had extra concerns. What of all the required paperwork was important? How long does a lesson take to present and how should one proceed if it takes longer or less time than expected? Discipline was a concern for all preservice and new teachers interviewed. A first-year teacher echoed the concerns of other new teachers, not knowing what was important to test and really wanting the guidance that comes, not from teacher training, but from experience:

> I'd like to hear about how to go about evaluating tests. Do I make good tests? I hate writing multiple choice tests. (Joyce. First-year teacher.)

A high school science teacher who had just been assigned a new class was overwhelmed with trying to find useful information for the class and said:

> Right now, I need anything that will make a lesson relevant. I don't like the text book, but they have to have some kind of resources . . . written resources . . . web sites they can go to. (Hannah. High school science teacher.)

A math teacher-coach who complained about the time he spent grading, not teaching, also wanted more specific lessons to share.

> Most of the sites I see are very general. I would like to see a site that says, "Here's an idea . . . now use it this way." Show me how to do it. I need new ideas. I can come up with some, but it comes more natural for other people. (John. Junior high math teacher.)

Finally, a common need expressed was help in sorting through the plethora of information available. Lesson plan sites abound; however, getting a good lesson plan that can be effective with little additional work is still a rarity.

> The lesson plans sites are getting hard to get through. You click on 6th grade, then social studies and you get 150 lessons. Some are complete, some don't work . . . anyone can submit the lessons . . . so they aren't consistently listed. (Adele. Tech coordinator.)

In order to develop a richer understanding of user needs, respondents were asked to value a list of services. They were asked to choose five, rank them, and to note if there were any on the list that they would either definitely never use or might consider using.

I assigned a value of 1 to 6 (1 for *no response*) to each response, then calculated mean and mode. Table 1 shows the list of services and rankings. Most notable were the items ranked by mode (5 services tied for highest ranking) that were also low when ranked by mean. Discussion boards (ranked #11 by mean, but #1 by mode) and grant resources (ranked #12 by mean, but #1 by mode) both rated as services teachers often said they wanted, but never rated as high need. However, the low placement in ranking by mean coupled with the relatively high cost of participation (both activities are time consuming) make me believe that, at least for this group, discussion boards and grant resources would be relatively unused in practice. It is also interesting to note that the top four items when ranked by mean scores (lesson plans, articles, pictures, guidelines for standards) are all discrete objects, things that a teacher can find, evaluate, and download in a relatively short time. Although suggested functions were not adopted by the client organization, the information gleaned from this exercise was very useful in understanding users and user needs.

Phase Two Interviews

The interviews completed during the second phase were shorter and more directly linked to user needs during search and retrieval. The researcher tried to understand if this user group had different needs, came with different problems, and had different expectations for making sense of the results than the teachers interviewed in phase one. The questions were intended to expose the reasons the respondents came to the site. Questions included: "Consider a recent time you went to the site. What were you looking for? Why did you need that information? How did you look (what search words)? Did you find it?" The client manager interviews were an effort to make sure that the work was in line with the perceived needs of the

client organization, both in the present and in the future.

The most common reflection voiced by these users was that the information available was fine, but getting to the information was a challenge. The site has a number of different project sites cobbled together. Most useful information was not found without knowing beforehand that it was there. Illustrative comments include:

There is no indication of what is new. I DO know there's a lot that is old.

The site has enough information, but it's getting at it. When I go to (the site), I usually know what I want. (Gene, District Technology Coordinator)

Another common suggestion was to have information accessible by the purpose or topic sought by the visitor to the site. Administrators often come with a specific purpose and would like to be able to request answers for a specific need. Common needs mentioned were guides, facts, models, and diagrams to explain or justify new directions in technology or pedagogy.

I think you have to think about how you will present all this to the community and to parents. Why are we doing this? Why will teachers and science do it different. We have to make it so they understand. They may come home with different homework. Its not that they aren't learning. They do more with hands on.

Parents HAVE to be considered. It's one group we forget about. They will back you if you show that you want to show them. (Ellen. Director of technology training for a large museum.)

Jane (Consultant-trainer for several districts): Things should be accessible by topic or purpose.

Interviewer: What's an example of purpose?

Jane: I'm a principal and I need to explain how technology can be used to help us meet standards. I want research, models, applications.

There were many positive comments about the site and the utility of the information it contained. Users noted the wealth of research, the links to other sites (though many were outdated) and the reliability of the information. Information on the site has been screened, impartially screened and copyright cleared. This was mentioned as very important.

The APM (a library of copyright free graphic images) is the only graphics site that our screening software will allow teachers and students to access. We installed the screening software and suddenly teachers had no access to pictures. No other site screens for improper pictures. (Jim. Tech coordinator for 25 schools)

The best thing about—is that they are not commercialized. . . . So their stuff has more validity, for me and people I'm showing it to. If you show stuff from other sites, even sites that are not product sites, but that do accept ads, they will say it's sponsored.—has no special interest. (Jill. Training coordinator for science research center.)

Summary of Phase Two Interviews

As with phase one, the interviews conducted during phase two provided information about the types of problems users sought to solve through a search. Questions asking about the last search completed were designed to move the participant from hypothetical interactions to responses rooted in practice. These users tended to seek more general information about a topic instead of the very direct how-do-I . . .-type questions common in the first group.

Applying the Model

Having used HPT and sensemaking to guide data gathering, I now analyzed the data using a sensemaking lens. We wrote Weick's seven properties (Weick, 1995) on a poster-sized paper. On several more pages, I wrote, Who Am I? Going through the data, I listed explicit reasons users would come to the site—what problems they faced and what needs they had. Table 2 is the list generated.

I then began to cluster the list—removing duplicates and listing similar needs together. I had always assumed that adding unique tags to existing standard tag sets (Dublin Core or IMS) would significantly increase the number of metatags necessary to label an object. Indeed, it had been a worry for future development. How could I hope to have users bring objects into the system themselves if doing so meant an arduous process of adding many tags, both standard and unique? However, on examination of what tags were necessary to answer the needs of someone coming to the site with a problem, the result was

Table 1 ☐ User ratings of proposed functions.

Function	*Mean rank*	*Mode rank*
Discussion boards to talk with other teachers, administrators, or tech coordinators	11	1*
Web casts with experts—educational, or from the department of education	8*	5*
Research reports on the latest teaching techniques (Inquiry, multiple intelligences, etc.)	4	1*
Lesson plans	1	1*
Pictures for download	2*	5*
Video for download	10*	4*
Tutorials on software and hardware	6*	4*
Reports on what happened at educational conferences	7	6*
"Ask an Expert" columns	5	5*
Online encyclopedias	9	3
Articles on using technology in support of teaching	2*	2
Guidelines on applying standards	3	1*
Ask the Board of Education column	10*	6*
Discussions on discipline	6*	6*
Resources for getting and writing grants	12	1*
Links to other web sites	8*	5*

* = multiple

significantly fewer tags, not significantly more. In the beta version of the metatag schema, there were a few general housekeeping tags (location, short name, description, etc.) that mapped to both Dublin Core and IMS tags, but to get from "I have this problem." to "Here are a list of probably useful objects." took only five tags plus a text field. These were refined during a daylong meeting with the client, but the number remained the same. None of the tags is required for either searching or adding an object into the system, but I believe that using even one can make a search more effective. The five unique tags developed were:

1. Who am I (what role, such as teacher, administrator, researcher)?
2. Content area (for an object that applies to math, science, literacy, etc.).
3. Type (What kind of a thing are you looking for?—a model, an article, a video, a tool for analysis?)
4. Usage (What are you going to do with it?—plan a professional development day? — present to the PTA?)
5. Grade level (Some objects, such as lesson plans, are grade specific).

Since completing this research, based on user tests and feedback, I have added two additional tags.

6. Quality (a subjective rating 1–5 of the quality of the object).
7. Completeness (a 1–5 rating, because many Web resources lack significant parts or contain bad links).

The simplicity of this schema is an extremely important result. If it proves useful for search and retrieval (which must be explored in a future study), it means that a group of users might regularly add their own objects to a performance system. I have created a tagging tool based on this schema, as well as a tag-based search tool (see Figure 1). I recently tagged more than 500 objects. Each object took about 30 sec to

Table 2 ☐ List of user-centric reasons for using the performance system.

Who Am I?
I am an administrator or principal.
I need to justify a decision to use technology.
I need numbers, quote and reference.
I'm a trainer doing professional development on how to use technology.
I want to know links for other information and research.
I'm trying to find people.
I'm trying to find references.
I write grants to fund technology and need statistics.
I defend technology to the school board.
I am *busy!*
How do I keep up with technology?
How does technology help me meet standards?
How does technology help me do assessment?
I need to do a PTA presentation.
I want to use technology to help literacy.
Can I use technology for assessments?
I'm a principal who wants to set preparation guidelines for teachers for technology . . . what should they learn?
What have other districts tried?
Best practices—What works
I need to draw up a technology plan for my school . . . district.
I need a fast bit of information—where is . . . . who is . . . what?
I am developing a literacy program.
I am evaluating a literacy program.
I have to show an administrator what I'm talking about . . . I need models of technology in the classroom . . . a video would be good.
I have to teach a worship on engaged learning.
I want to explain engaged learning.

tag. Figure 2 is a screen shot of the search and retrieval tool. Although tag searching has some fundamental differences from text searching (see the section on A Brief Introduction to Searching), users were able to understand and use the search tool with only online instructions.

Notice that many of the areas of the tool have check boxes. These tags have controlled vocabulary—only these selections may be added. As with the tags, the vocabulary was derived from user data. The advantage of such controlled vocabulary is that tagging is both fast and uniform. As the system is used, new vocabulary probably will be suggested and implemented by users. In the planning stage is research that probes the evolution of controlled vocabulary with usage.

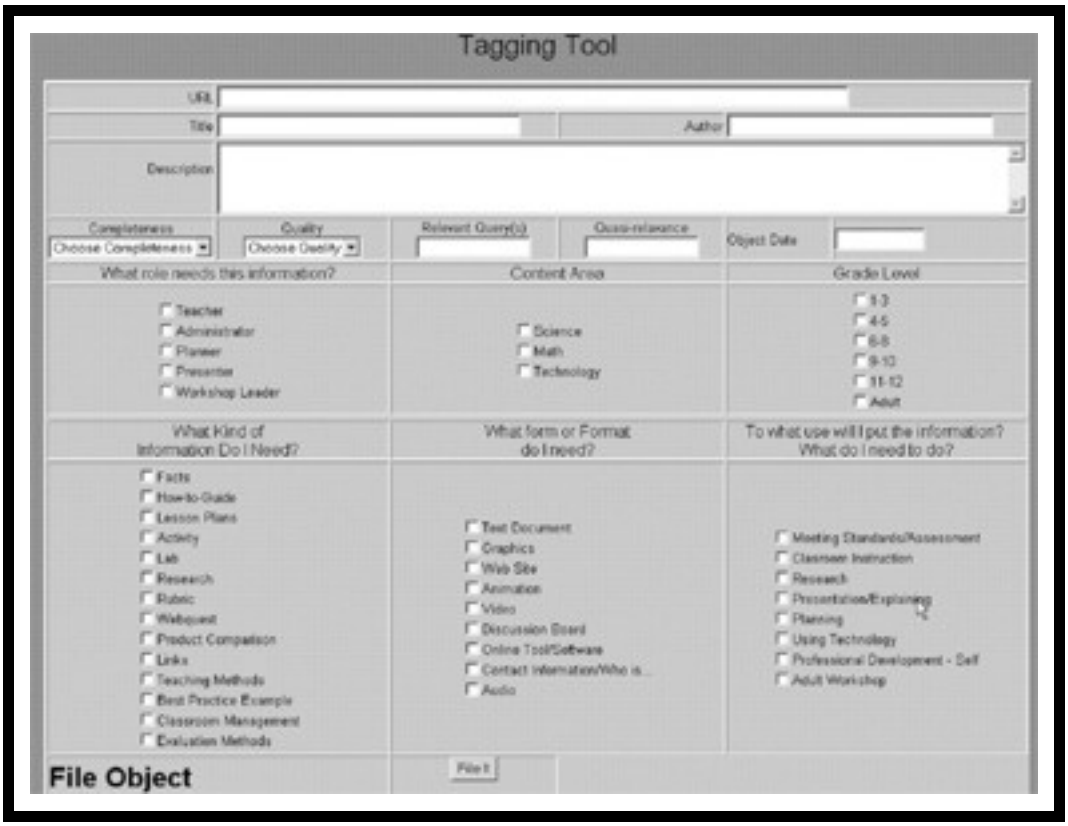
IMPLICATIONS

As stated earlier, the focus of this study was to offer a new set of explicit theoretical assumptions for developing tags that offer a clear alternative to the largely unstated assumptions that underlie current development of tags. The model that arose from these new assumptions has been applied to develop a unique set of tags. The new theoretical assumptions were detailed in the section on Current Research.

Having gathered data from three different potential user groups as well as content providers, using different methods, a rich view of the application of the model emerged. This may not be the only model that will be developed from these new assumptions. However, this model provides a clear difference from the models and schemas derived from the traditional, largely unstated assumptions.

Additionally, in this case, the set of unique tags that can describe an object from the perspective of how a user will attempt to find it is so very simple, that an important possibility arises. With a simple set, such as the one developed in this case, researchers may reasonably hope that users will be willing to tag and add objects into a system themselves. This is very significant. If researchers can develop systems where users tag and add objects, then systems can be dynamic—growing not only by the efforts of the administrators, but also by the efforts of all users. Allowing users to publish is the power that pushed the Web to grow exponentially. Such unique, simple schemas have the potential to put learning and sharing of information into the hands of the learners. This model is an important step along that path.

Figure 2 □ Tagging tool for unique teacher-centric tags.



It is not possible to be sure that the schema developed will be effective for search, retrieval, and tagging without further study. As stated earlier, researchers must explore these new assumptions and their resultant models before attempting a direct comparison. In addition, the existing theoretical basis for the evaluation of information retrieval systems is not rich enough adequately to evaluate a performance support system. Methods for evaluation that may be used with performance systems are currently being investigated. The schema has been coded into a database structure and is being used in a comparative evaluation research project. I will report the findings of that study as they become available. Although I cannot generalize from this study to a wider application of the model for developing unique tags, in this case, this model was very useful in informing the development of the schema.

The combination of HPT and sensemaking provided direction throughout the data collection and analysis. HPT encouraged a look toward the environment to see how to most easily affect performance. Gilbert talked of the importance of looking at accomplishment over behavior (Gilbert, 1996). This orientation was reflected in the question asked of respondents, "What do you want to do (with the system and within your work)?" Sensemaking helped guide the development of the tags further, using the questions, "What is your problem? Why have you come here? What are you missing?" In combination, information was gathered about people, not objects. The effort was to see what their needs and problems were, then to consider the actions they would take to make sense of situations, the type of searches they would like to undertake.

It is important to stay focused on end users—their needs, problems, and perceptions. Losing sight of the end user is too easy and too common. The end user must drive the design and development throughout the process of analy-

sis, design, development, implementation, and evolution. Keeping this in mind helped to guide me to and through the completely unexpected finding that fewer rather than more tags were needed for the unique schema.

Much remains to be done. This was a small study. Testing the model with a larger sample will be interesting, to see if the schema will still fall into a neat, simple set of tags. In addition, the model could be applied to different user groups. A unique schema is applicable to any group with homogeneous information needs. It would also be interesting to test the model and application with groups with very fast changing information needs, that are geographically diverse, such as international marketing teams.

The schema developed in this project must be evaluated. The test is not the speed of the search, or the quantity of objects returned, but how effective or useful the results are. The search method needs to be tested with users, to see if this new method makes sense, if they will use it and, most important, if it returns objects that meets their needs.

If others try to apply this model to the development of unique schema, a dialogue could begin about the findings of different development groups building systems for a variety of organizations. If others further explore the new assumptions, they, too, may develop new models based on them. As the field develops a richer understanding of the process of developing schemas, one hopes that it can also develop a rich and more explicit theoretical view of the process. □

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