Applying Collaborative Tagging to E-Learning

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ABSTRACT
This paper outlines our experiences with applying collaborative tagging in e-learning systems to supplement more traditional metadata gathering approaches. Over the last 10 years, the learning object paradigm has emerged in e-learning and has caused standards bodies to focus on creating metadata repositories based upon strict domain-free taxonomies. We argue that the social collection phenomena and flexible metadata standards are key in collecting the kinds of metadata required for adaptable online learning. This paper takes a broad look at tagging within e-learning. It first looks at the implications for tagging within the domain through an analysis of tags students provided when classifying learning objects. Next, it looks at two case studies based on novel interfaces for applying tagging. These two systems emphasize tags being applied within learning content through the use of a highlighting metaphor.

Categories and Subject Descriptors
H.1.2 [**User/Machine Systems**]: Human factors

K.3.1 [**Computer Uses in Education**]: Collaborative learning, Computer-assisted instruction (CAI)

General Terms
Human Factors, Collaborative learning

Keywords
Collaborative tagging, folksonomies, ontologies, video, annotation, e-learning

1. INTRODUCTION
The learning object paradigm suggests that online educational content can be collected, aggregated, and packaged for delivery to learners. Key goals of this paradigm are to enable the discoverability, modularity, and interoperability of learning resources [8]. This has led to an increase of activity around specifications and standards for metadata for describing the form and functions of learning objects. A key standard is the IEEE Learning Object Metadata specification [12], which primarily outlines categorizational and technical aspects of learning objects. Recent work had criticized this standard as being overly broad and ineffective due to the time and skill that it takes to fill in the metadata fields [8,13], and that metadata authors need support during the metadata authoring process [9]. While there has been some investigation towards the automatic mining of metadata from textual content [4,11], these solutions often end up with incomplete or incorrect data (see [3] for more discussion on this).

We subscribe to the notion that metadata is best created if it focuses on a particular goal, is contextualized to a particular user, and is created in an ambient manner by observing the actions and interactions of students in learning environments. We believe collaborative tagging has a strong possibility of being a leading method by which we collect this learner-centric metadata.

Tagging represents an action of reflection, where the tagger sums up a series of words into one or more summary tags, each of which stands on its own to describe some aspect of the resource based on the tagger's experiences and beliefs [14]. Intuitively, when analyzed in terms of the classical Bloom's Taxonomy of Learning [2], learners who use tags show evidence of moving up the hierarchy from the lower "consumption"-based levels of learning (knowledge and comprehension) to higher levels of applied and metacognitive knowledge (application and analysis). Further, reviewing of tags (i.e. comparing tags used by a community of taggers) would potentially facilitate the move to the highest levels of Bloom's Taxonomy of Learning (synthesis and evaluation).

Traditional tagging systems tend to focus on a coarse grained view of digital artifacts, and taggers typically annotate individual web sites or pages in web sites. While this has been shown to be a worthy endeavor (given by the popularity of such sites), we believe that there is room in educational tagging systems for more fine grained annotation of content. Intuitively, we liken this to the highlighting or margin note-taking that can be observed in student textbooks and other traditional educational materials.

This paper is broken into two major sections; section 2 outlines the results of an experiment we completed in the spring of 2006 where we asked students to provide tags for educational content, and then compared them to automatic tagging systems and expert taggers. In this section we focus on coarse grained pieces of learning content – whole webpages. The next section, section 3, describes two e-learning systems that we are in the process of deploying that contain collaborative tagging features. Both of these applications focus on contextualizing tagging through fine grained annotation of learning content; the first in typical web pages, and the second in multimedia displays. The work concludes in section 4 with a discussion of our current directions for future research.

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2. AN ANALYSIS OF TAGGING

In this section we compare the results of a small-scale tagging experiment done on delivered educational content. We asked two senior graduate students with teaching backgrounds to create short pieces of content relating to topics on artificial intelligence to be delivered to first year non-majors. These graduate students could write in any style they deemed suitable, but were given rough guidelines as to the form content should take (e.g. page length, reading level of students, and specific subtopics that should be taught). We then collected tag and tag phrase sets using three different approaches. The first approach was by having the graduate students create (independently) a set of tags for each page of content (five pages in total). The second approach was to use the Automatic Metadata Extractor application [10] that has been designed specifically for creating learning object metadata in the form of Dublin Core or IEEE LOM. In our analysis, we have focused on the keywords being extracted, as sentences pulled out of the documents by the tool seemed relevant but not precise enough for use in tag clouds or keyword-based searching. Finally, we asked students (over 200 unique participants, though not all students completed tags for each page) who viewed the content to "...write several keywords to describe this page (e.g. keywords you would use in a Google search to find this page)", and collected their input tags as well.

2.1 Qualitative Differences

A reading through the different tags sets created provides some interesting insights. The tags created by the Automatic Metadata Extractor are simple and include no tag phrases. These tags leaned towards very broad concepts. For instance, the tags created for the content around "Case Based Reasoning" included "case", "reasoning", "cbr", and "problem"; all very high level. The instructor tags tended to provide very specific sub-topics that the page discussed. In addition, there was mixed use of both single tags and tag phrases, the latter of which provided more contextualized tags (e.g. "computational intelligence", "human intelligence", or "artificial intelligence"). Student created tag sets had a less than perfect signal to noise ratio, and some students wrote seemingly useless tags (less than 5% of all student tags were in this category). We believe this is due to low motivation – students were being extrinsically rewarded by participating in this study, however most tagging systems are collaborative in nature, and thus intrinsic motivation can play a strong part (e.g. the learners didn't necessarily view themselves a benefiting from the tags that were created).

2.2 Quantitative Differences

After normalizing the tags[1], we plotted the number of occurrences of tags against the set of all tags collected (using only the data we collected from the students).

The students produced a total of 211 tags, of which 122 were unique. The experts produced 60 of which 38 were unique. While the automatic metadata generator produced 25 tags of which 24 were unique.

The students' results produced a power law curve, and is similar in nature to those described by Shirky in [18]. We then integrated across these values to separate the head from the tail (shown in Figure 1, the assumption was made that the tail would contain 50% of the total tags provided). When overlaying the tags produced by the automatic metadata generator and the instructors we notice several interesting points:

-39% of the tags provided by the metadata extractor were within the head, while only 28% of the tags provided were in the tail (the remaining 32% were tags that students had not suggested).

-Hits within both the head and the tail were less for the experts, coming in at 25% for each. Half of the tags provided by the instructors were new tags. In addition, out of the tags that instructors agreed on, 66% of these (four of six tags) were not in the set of tags the students provided.

We will provide further discussions and analysis on the results in section 4**.**

3. TAGGING AND ANNOTATING

In this section we discuss how we are applying tagging within the domain of e-learning. First, we make clear the differences between web annotation systems and tagging systems, both of which provide opportunity for learning object metadata creation. We believe that combined, these two approaches can improve some typical activities in learning (e.g. revisiting learning material, personal note taking, and connecting with peers). This will be shown in two separate applications, the Open Annotation and Tagging System (OATS) which applies the idea of applying tagging from within text-based learning content, and the iHelp Presentation application, which extends these ideas to multimedia.

3.1 Web Annotation Systems

Web annotation systems fall into two main categories; those that are meant for single users to organize and share information, and those that are meant for collaborative exchange and creation of information between users. The first of these tends to focus on developing simple-to-use interfaces to support content-aware annotation on any arbitrary web page. Gibeo[2] is an example of one of these annotation systems. Upon registration with the Gibeo website, in order to annotate any webpage the user simply adds ".gibeo.net" to the domain part of a URL. When any part of the text on the page is selected, a set of options is displayed to allow the user to specify the quality of the highlighted text, with labels such as "important", "wrong", or "cool". Users can also add comments, corrections, links, or shared discussion to any part of the text. Every annotation is shared with all users of the system and clicking on the annotation provides detailed information, such as the annotation author. Marginalia [19] is a similar JavaScript web annotation system that focuses on providing intuitive functionality for any arbitrary web page. Marginalia allows users to highlight any part of the text and write associated comments in

[1] To normalize the tags sets we did the following: we removed all extraneous punctuation, and converted all words to lower case. If the set included commas or semicolons, we created tag phrases out of each delimited item that was more than one word long, and individual tags out of those items that were only one word long. For each set that included no commas or semicolons we considered each word to be a tag and did not create any tag phrases. Finally, all words were stemmed using the Porter Stemmer provided by Natural Language Toolkit [http://nltk.sourceforge.net/].

[2] htttp://gibeo.net

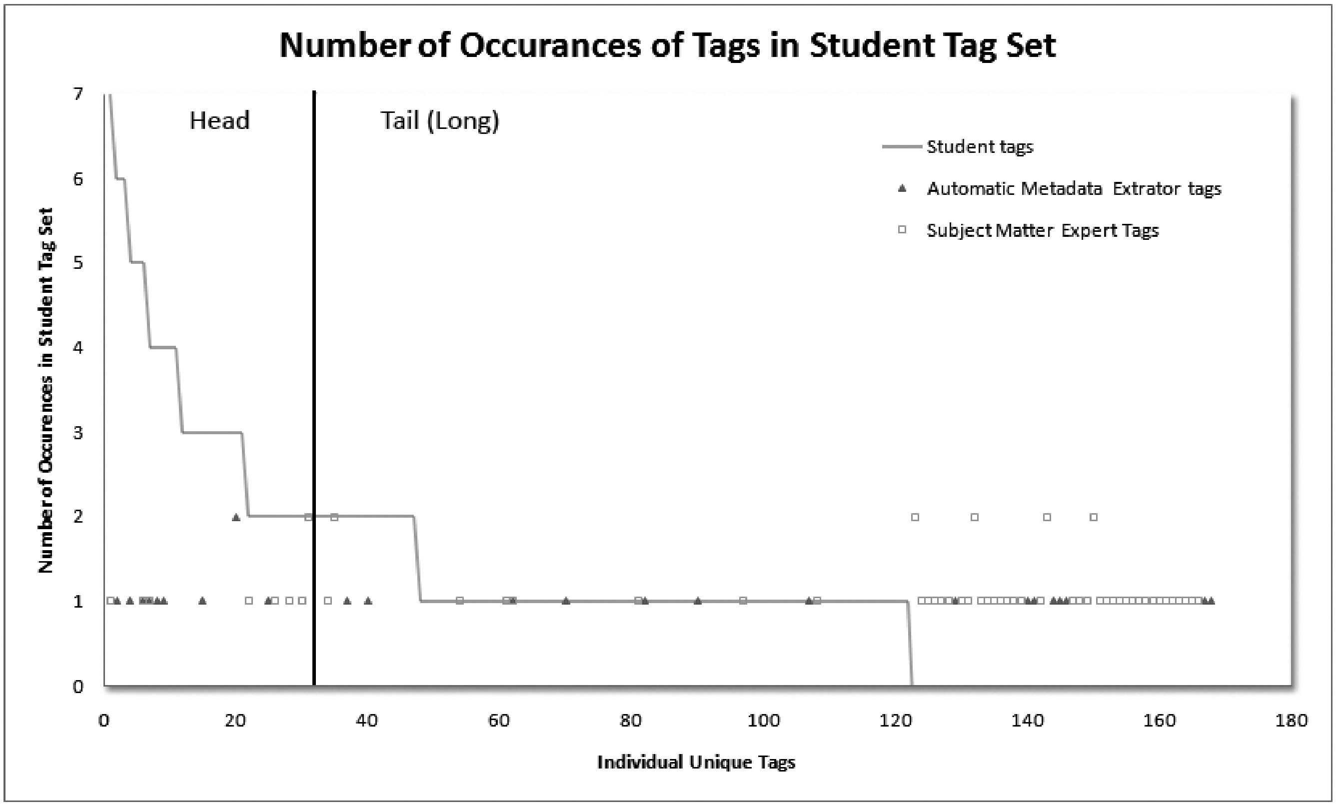

Figure 1. Shows the unique student tags ordered by occurrence on the X-axis and the number of occurrences for each tag on the Y-axis. Placed over the graph are triangles which denote the occurrences of automatically generated tags, and squares which mark the occurrences of expert tags. The graph is further divided by the line into equal number of tags (the area under the curve), giving a power law-like distribution, containing a head and a long tail. Note, the placement of the divider line is somewhat arbitrary, as the tags with an occurrence of 2 could have been ordered differently, and thus fall on either side of the line.

the margin of the pages. Annotations notes may be marked as public or private.

In contrast to the first group which focuses on the best way of collecting user-information for sharing, the second group instead aims to improve the process of collaborating to create collective information. The most famous tool in this group is Annotea [15], which enhances the collaborative development of the Semantic Web via shared web annotations. Annotations are in the form of comments, notes, explanations, or any other type of external remarks attached to any web document or portion of the document. The users are able to access all attached annotations when they open the original document [5]. Another popular tool is a "web discussion" feature in Microsoft Office 2000 that allows collaborative annotation of any web page.

Within the domain of e-learning, AnnotatEd, is an excellent example of a web annotation system [7]. Besides annotations, it also incorporates the notion of "social navigation support", which leverages the activities and annotations of individual learners to provide visual cues to the entire group of learners. This is not dissimilar to suggesting tags which are available in collaborative tagging systems. These visual cues are used to help guide students to the most widely used and/or heavily annotated documents.

3.2 Tagging in E-Learning

Online learning material in typically hypertext-based, and includes mostly text, images, and links. For learners to create notes on the information usually means relying on an external tool or creating a bookmark to a given page of interest. Tools such as del.icio.us[3], furl[4], and spurl[5], are particularly well suited for this task. These systems apply tags at the document level and work well which can be shown by their large userbases and tagsets. However, these tools don't facilitate the quick recall and discovery of more finely grained content, from within the web pages itself.

Using tags enables useful resource organization and browsing techniques, such as "pivot browsing" (clickable usernames and tags) [16], which provides a simple and effective method of for discovering new and relevant resources. While the viewing of tags used on a webpage can give a learner some idea of its importance and its content, it falls short of supporting a learner in finding the exact point of interest within the page.

We believe that collaborative tagging systems have potential to be a good fit with e-learning systems, because of the following:

[3] http://del.icio.us

[4] http://furl.net

[5] http://spurl.net

1. Learning managements systems currently lack sufficient support for self organization of learning content.

2. Collaborative tagging has potential to further enrich peer interactions and peer awareness centered around learning content.

3. Tagging, by its very nature is a reflective practice, which can give students an opportunity to summarize new ideas, while receiving peer support (through viewing other learners' tags; tag suggestions).

4. The information provided by tags provides insight on learner's comprehension and activity, which is useful for both educators and administrators.

While these ideas are quite straightforward, tagging is largely unemployed in e-learning. Indeed, popular web-based Learning Management Systems such as WebCT, Blackboard, Moodle, and Sakai, lack any native use of tagging.

3.3 Case Study: OATS

The Open Annotation and Tagging System (OATS) [1], is an open source tool[6] which was created to further enrich the functionalities provided in Learning Management Systems. The aim is to motivate learners to tag learning content by providing self-organizational tools. Further, OATS provides a method for note-taking which is integrated directly into learning content. While it uses a traditional approach for tagging, it incorporates several other approaches based on combining web annotation systems with collaborative tagging systems that are targeted for e-learning. OATS' architecture has been designed so that it may easily be incorporated into any Learning Management System or webpage. So, while it has been targeted for e-learning may also be used as a general web annotation and tagging tool.

Among the approaches used in the system is an extension of the tagging metaphor to a highlighting tool. To create a highlight annotation using OATS the user simply selects a piece of text in a webpage, by clicking-and-dragging. The selected text becomes highlighted (the background color is changed to yellow). From the users point of view this flags the piece of text as being important. Highlighting enables the user to apply to a specific piece of content: tags, private notes and public/discussion notes. When the user returns to that particular page, the highlights previously made by that user will reappear, as shown by the lightly colored highlights in Figure 2.

Users are also able to turn on "community highlights" to see what other learners have written using a highlight concentration visualization. The visualization works by calculating the overlap of highlights in the text made by learners other than the current learner. In the case of no support, the text remains unchanged. As the concentration increases (e.g. when more people have highlighted the same area), the colors change in hue from pink through to red and maroon. These levels are predefined based on a static scale of annotation frequency, and we have not yet focused on determining what algorithm would best work to convey information on "importance" or "relevance" accurately to a learner. We call this type of information visualization *social annotation support*, and this system has been inspired by similar techniques used in social navigation support systems [7]. The community highlights allow a user to quickly survey a page, and see the most frequently highlighted parts of the text. This can give an indication of the most important parts of the content, and thus which points should be focused on. A very similar technique has been employed in CoRead [6], and study into this system shows that this technique may also lead users to create consensus on which parts of a page are important.

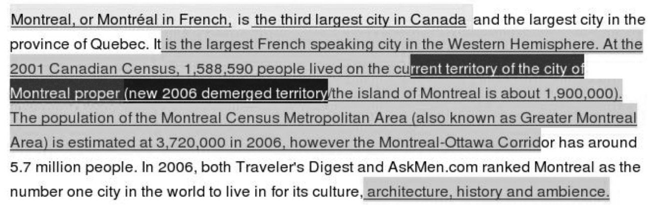

Figure 2. Shows OATS displaying highlights within a webpage. Yellow highlights (the lightest highlight) are content highlighted by the current learner. While pink, red and maroon (the progressively darker highlights), shows the progressively higher concentration of highlights by other learners in the community.

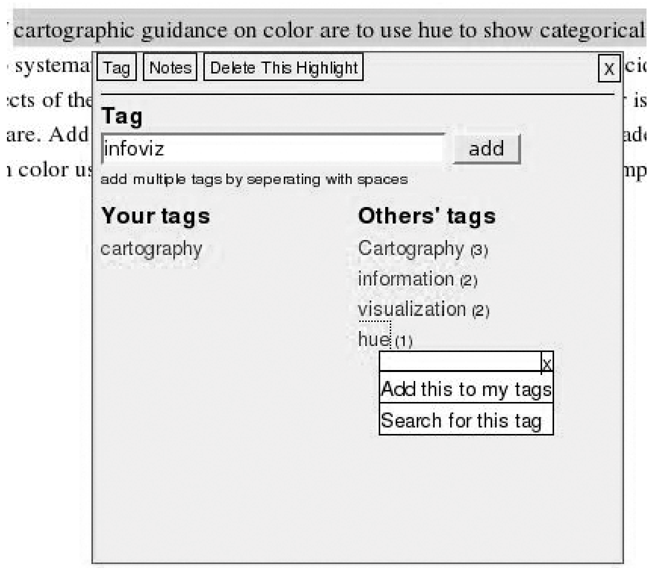

Figure 3. The OATS popup from clicking a highlighted piece of content with interfaces for tagging.

By clicking on an existing piece of highlighted text (community or personal) in a document, a new dialog appears providing an interface for adding notes and tags. Figure 3 shows the interface for a learner who has highlighted a piece of text. This user has already added a tag, "cartography", and a list of suggested tags are available based on tags received from other learners (under "Others' tags" label on the right). This list contains the ten most frequently used tags along with how many times they have been used for the particular text. The learner can also bring up a note taking interface by clicking on the "Notes" button at the top of the dialog. This allows them to enter longer free-text messages that can serve as self reminders (stored privately or publicly), and can be doubled as a simple discussion forum for learners, allowing contextualized discussion to take place. If learners change their minds about a highlight it can be removed, along with all of their notes and tags about the highlight, by clicking on "Delete This Highlight" button.

Both highlighted text and notes are organized automatically into different categories (Figure 4), based on the tags used. In the

[6] Available for download at http://www.cs.usask.ca/~ssb609/oats

community sense, these categories help one to gain a "global view" of the tagging of the entire community – a form of collective intelligence which facilitates concept discovery and exploration. From the point of view of the individual, the tag category provides a quick method of reviewing material on a conceptual basis, where a tag represents a concept of interest annotated by a learner. Figure 4, shows two tags "color" and "colorblind", with the latter tag expanded. Learners can view pages, highlighted text content, or notes that have been tagged with "colorblind". Here the learner has chosen to view the highlighted text. Below the text, is a link to the page on which it occurred, so the learner can return the page directly so it may be reviewed in context.

In addition to the automatic categorization, a search interface is provided to perform more detailed discovery of pages, notes, and tags.

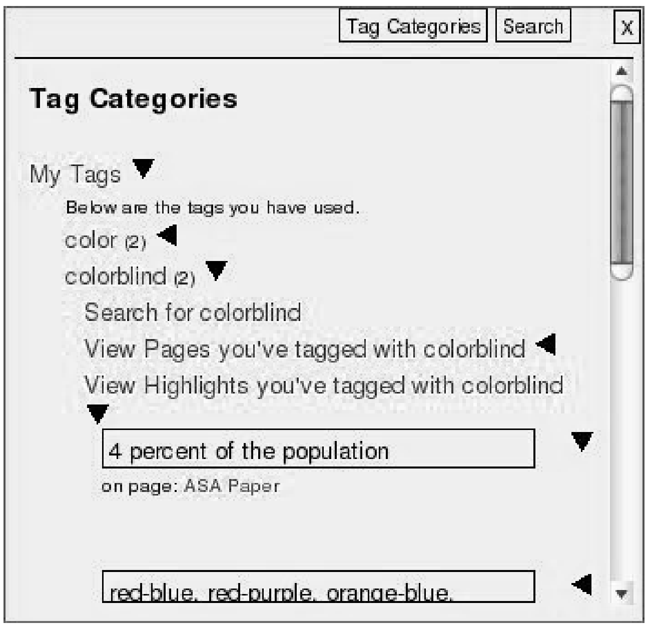

Figure 4. Tag categories within the OATS system provides a quick interface to browsing concepts (tags), as well as the content, notes, and pages associated with the concepts. The current learner is viewing all content that has been highlighted and tagged with "colorblind".

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3.4 Tagging in Multimedia

There are many commercial projects available for capturing video on live lectures. These systems offer a cradle-to-grave solutions for capturing, editing and delivering videos, and often offer discussion forums to help raise questions to take care of the lack of temporal and physical locality to the lectures. This type of content development is attractive to universities and colleges for creating e-learning content quickly and cheaply from traditional face-to-face lectures. With the number of video lectures available growing at an ever increasing rate, the need to organize, sort, and search through this content is needed. The temporal nature of video offers some greater challenges than those of text-based content. Video doesn't lend itself to be searched at all using keywords, unless sufficient metadata or transcripts of dialog are made available. Instead, to get an indication of video content it must be viewed sequentially.

Youtube[7], has shown that tagging of video content can work to effectively annotate videos to facilitate their sharing and discovery. These clips are generally quite short, generally in the 5-10 minute range. The tags therefore help discover whole videos, and not subclips within a video (say, a 30 second segment). Youtube also offers no functions for annotating or note taking around the videos themselves, and only offers a simple public forum for the discussion of videos.

We have begun an annotation and content project called iHelp Presentation, which has the aim is to make classroom lectures available online and support student tagging, annotation, and collaboration features around the resulting videos. Figure 5, shows a prototype of the interface that only includes video playback and annotation (no collaboration or video control features are shown).

The learner's view of the presentation is separated into 3 main parts. Figure 5a, is a video of the educator presenting the lecture. Figure 5b, presents the desktop of the educator, which generally includes lecture slides, but presents anything that occurs on the educator's desktop (i.e. the slides from Figure 5b, match the slides shown on the screen in Figure 5a). Figure 5c, shows the popup annotation controls which occur from drawing highlights, through a click-and-drag, on any part of the video in Figure 5a or Figure 5b.

In this example the user has created two annotations on the slide. In the first annotation the user has highlighted XHTML, on the slide and is uses the notes field to raise a question, "What does XHTML stand for?", shown in the lower annotation popup. The learner also tagged this portion of the video with "XHTML".

The annotations use a recording methaphor to accommodate for the temporal based nature for which they occurred. Thus an annotation is visible from the point in which it was created until the user stops the recording. Annotations and annotation popups will reappear for their defined lifetime when the user watches the appropriate part of the video. A user may also optionally view the annotations of other users while they watch the video

There are two options available for creating the end point of an annotation. The first is the user may simply specify the end-point of an annotation by manually ending the recording. The second option is enabled by default, which is to automatically stop an annotation when a slide has been changed. Slide change events are currently created manually through the educators presentation machine (through a powerpoint macro), though future versions of this system are likely to use frame differencing to automatically detect these changes in context.

A potential issue is the understanding required of the annotation stop point. We hope to provide sufficient introductory instruction and online help to address this forseen problem. While this system is still a work in a progress, we are encouraged by the ease of use of the prototype thus far.

4. CONCLUSIONS AND FUTURE DIRECTIONS

Our initial tagging study (section 2) has given us several new questions with regards to the implications of tagging in e-learning. Given that 50% of the expert tags were tags not within the body of tags used by students (head or tail), we question the benefits of

[7] http://youtube.com

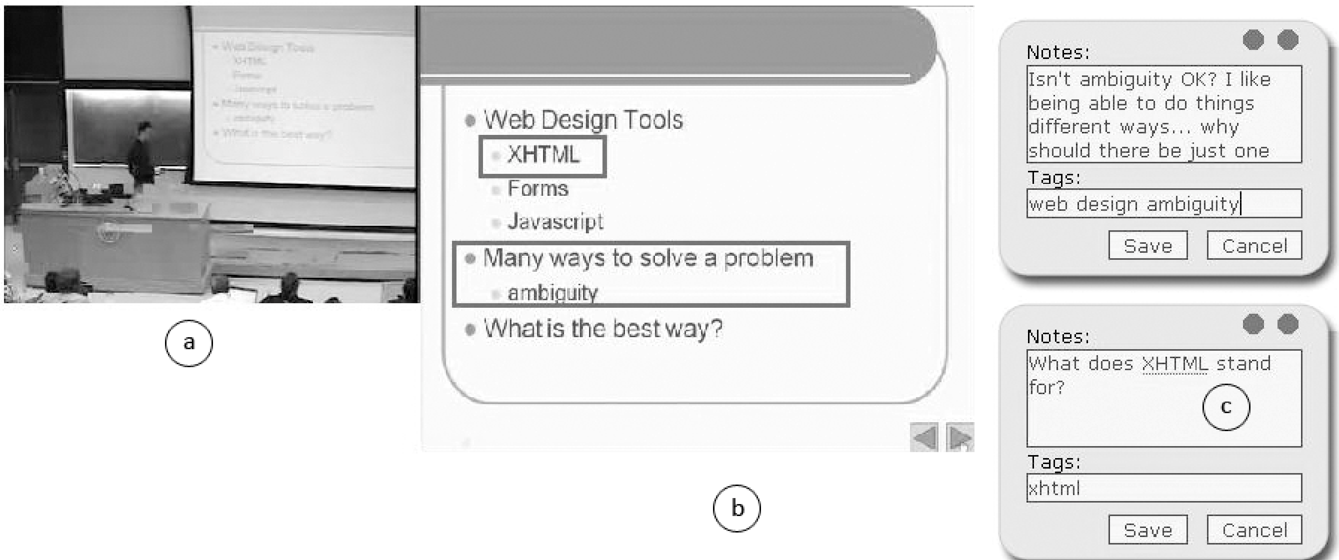

Figure 5. The prototype interface for the iHelp Presentation multimedia video presenter. It allows learners to collaboratively annotate video and slides, with highlights, notes and tags. a) Shows a video of the lecture. b) Shows a screen capture of the educators computer, with new highlights made by learners watching the video (boxes). c) Shows the annotation controls, which allow tags and notes to be made and which correspond to the highlights made in either the educator screen or lecture video.

providing these tags to students at all. The lack of expert time and willingness to fill in metadata has been cited [8,13] as a significant hurdle to deploying learning objects. If expert tags provide limited value to students, it may be more appropriate to bootstrap data sets with automatic tagging features and reduce the load on those who are creating content. We note the potential pedagogically benefits of collaborative tagging as suggested by [14]; that the tags themselves represent the expertise of the users. This suggests that at a collaborative level, a tag set can be inspected as the course is being given by the experts to gain an insight into the topics and concepts that learners are distilling from the online material.

Beyond the issue of expert time is the issue of control in the classroom. Unlike the open web, where individual success is evaluated by the individual, success in e-learning systems is typically dictated through a series of educator prepared exams. We have observed that educators are hesitant to change their teaching to adopt new methods in the classroom (virtual or otherwise), because of a loss of control. By engaging educators actively in the process of creating tags, it may reduce their fears of these new technologies. However, our results showed only 50% of the expert tags were represented in the tags of the students and of these, only half were in the head (perhaps perceived as the most important tags by educators). Thus educators would need to be convinced that the long tail of tagging is also important. We also would like to suggest that unlike open web system, the educator in the classroom is not merely a peer, and their tags may be more relevant to the examinations (not necessarily the content), which may be useful to learners. The end-use of tags in an educational context is of significant interest to us.

We have observed that there is a good level of agreement between text-mining methods and students (a 68% occurrence of the former in the latter). This was surprising to us: we assumed that the learners would have a broader range of context (e.g. activities in the course, previously learnt materials, etc.) and would use this to alter their tag sets. We are interested in applying the method we described here, along with several other cluster-based groups (e.g. [4][11]) to see if this occurrence can be strengthened If so, text mining may be an appropriate seed for educational communities (though we note that there are benefits of the long tail [18] as well, and the effects of such seeding would have to be studied to ensure a healthy tagbase remains).

Tagging systems, like most forms of social networking software, require a critical mass before they become useful to a community. In this paper, we have taken the first steps in identifying how we can create seed tags from different sources (e.g. experts, text mining, etc.). We are interested in pursuing this further, and quantifying the effects of applying various seeding algorithms against the growth, sustainability, and satisfaction of a learner community. Do learners prefer expert-created tags, or do these tags limit the vision of the students? Can we leverage data mining to overcome the cold-start issue with collaborative tagging in e-learning? Does the kind of student (e.g. learning style, time spent reading a learning object, or other attribute such as level of achievement) affect the quality or fitness of purpose of a given set of tags?

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