Tag Clouds as a Pathway to Improved Pedagogical Efficacy in Information Systems Courses: A Baseline Study Involving Web 2.0 Technologies

Samuel S. Conn
samuel.conn@kysu.edu

John English
john.english@kysu.edu

Fred Scheffler
fred.scheffler@kysu.edu

Kentucky State University
Frankfort, KY 40601 USA

Simin Hall
simin.hall@vt.edu
Virginia Polytechnic Institute and State University
Blacksburg, VA 24061 USA

Abstract

Various Web 2.0 technologies can be used to support pedagogy. Examples include wikis, blogs, and social media including forum discussions. Online class forum discussions involving electronic text can result in robust strings of data containing meta-knowledge, inherent meaning, themes and patterns. Based on instructional design, learning outcomes guide and reflect class generated work product such as assignments, activities, and discussions. As such, class discussions should evolve with alignment to learning outcomes. One measurement of instructional efficacy involves the closeness with which this alignment occurs. In this experimental research the authors report on the design and prototyping of a deterministic model utilizing a tag cloud engine to determine dominant and emerging themes from a text string, namely word data collected from a threaded discussion. Textual data used in this investigation involved two Information Systems online classes where threaded discussions during one week were captured as a text string. Text from a learning management system threaded discussion was fed into a tag cloud engine where emerging and dominant asynchronous conversation themes were determined. Calculating a correlation coefficient as an indicator of pedagogical efficacy, the application evaluated the pedagogical efficacy evidenced in the discussion forum through comparison of themes with instructional objectives. In this experimental research, a real-time online analytical processing (OLAP) tool prototype to support pedagogical intelligence via systemic formative evaluation was designed and developed. Findings from the investigation were used to reach conclusions regarding the use of Web 2.0 technologies in guiding instruction.

Keywords: Web 2.0, eLearning, tag cloud, word cloud, correlation, coefficient

1. INTRODUCTION

This study represents a continuation of an existing line of inquiry (Conn, Hu, Boyer, and Wilkinson, 2009) involving the use of Web 2.0 technologies in curriculum and instruction. Motivation for this study also is supported by consistent advances in eLearning tools, technologies, and applications. Higher education institutions continue to engage in eLearning initiatives at an accelerating rate. According to Sloan Consortium [Sloan-C] (2009), by the end of the decade the number of students taking courses online is expected to grow to over 2.6 million. Moreover, 40.7% of institutions offering eLearning courses found that students have an equivalent level of satisfaction with online instruction, 56.2% had no opinion, and a minor population (3.1%) was not satisfied with online instruction.

eLearning courses, as a percent of the overall market for education and training, now exceed 10% of the total. The trend toward fully online programs continues to increase; two-thirds of the largest United States (U.S.) higher education institutions now have fully online programs (Sloan-C, 2009). Moreover, a traditional learning management system (LMS) is no longer able to keep pace with advanced Internet technologies and increasing e-Learner requirements (Dagger, O'Connor, Lawless, Walsh, & Wade, 2007). Of concern is seamless information interoperability in the eLearning platform; thus, the monolithic architecture of the LMS is not an accommodating solution (Dagger et al.). Although this research was conducted primarily with an Information Systems online eLearning student environment in mind, the research also is applicable to ground-based classroom environments and other disciplines where technology is available to facilitate and mediate instruction.

The term tag cloud refers to a visualization of word data based on a scheme of relevance, importance, or popularity represented by manipulated visual properties such as font size, color, intensity, width, position, or weight (Bateman, Gutwin, & Nacenta, 2008). According to Xexéo, Morgado, and Fiuza (2009), many new approaches to the use of tag clouds exist. In this experimental research specific Web 2.0 technology, namely a tag cloud engine, was used to generate outputs that were evaluated using Spearman's rho (**ρ**), a rank correlation coefficient. The researchers sought to construct a deterministic model using prototyping. Initially, conceptually applying various methods to examine relationships, the researchers considered use of:

(i) functions to determine if a causal relationship exists,
(ii) regression analysis,
(iii) pattern assessment using scatterplots,
(iv) reasoning under uncertainty using probability, and
(v) correlation coefficient.

After consideration of the phenomena between bivariates, the researchers selected a coefficient of correlation as the estimating equation. This selection provided confirmatory data to determine if an empirical relationship exists between the data or if discipline specific or contextual narrative (data) generally yields physical constants.

For the purpose of this study the terms tag cloud, word cloud, and data cloud are used interchangeably. As noted, the theory of performance in the prototype design utilizes a correlation coefficient as an indicator of how closely student discussions are following stated learning objectives. A rising correlation coefficient would indicate a class discussion in close alignment with stated learning objectives; whereas, a sinking correlation coefficient would indicate a class discussion is off-track with stated learning objectives. In the latter case, instructor intervention would be required to alter the discussion in response to the stated learning objectives.

Instructor interventions could take the form of restating goals and learning objectives for the class, guiding the discussion through leading questions, highlighting threads in the discussion that are in alignment with learning objectives, or radically altering the discussion via corrective narrative. The correlation coefficient serves as a dynamic indicator of instructional efficacy and can be visualized in a digital dashboard embedded in the LMS or as a stand-alone application.

The experimental prototype developed for this study extracts a text string from any mediated discussion (e.g., wiki, blog, or discussion thread) as the input to a tag cloud engine. The output of the tag cloud is analyzed and sorted based on the level at which the word appears in the cloud. Higher level words are considered emerging themes, dominant arguments, or narrative basis for the discussion. The standard or goal for the discussion is seen in the tag cloud output from the learning objectives. Code base evaluates the correlation coefficient of the student discussion to the learning objectives to determine how closely the discussion correlates to the goal.

The outcomes of this study provide a basis for follow-on investigation into the use of Web 2.0 technologies in guiding instruction and improving pedagogical efficacy. The act of relating relevant keywords to a site is known as tagging. Tagged data exists that could supplement the accuracy of diagnosing online discussion efficacy using tag cloud engines. The authors present case findings from two populations of online Information System students where discussion threads from one week on instruction addressing learning objectives related to the study of database technology were generated. The prototype model was applied to the week-long discussions from each population to determine which population most closely tracked with stated learning objectives.

2. LITERATURE REVIEW

The term Web 2.0 refers to services and user processes created with emerging Internet and Web open standards and technologies. Concatenation of maturing Web applications and technologies to create innovative, facilitative design for collaboration, knowledge creation, and information mediation (infomediation) represents a central Web 2.0 concept. Aggregation and brokering of user data, construction of social networks, creation of Web services, and exploration and discovery are driving goals in Web 2.0 initiatives. In effect, the old model of the Web as an information repository passively accessed by users changes to a platform for social constructs and collaboration, interaction and exchange, and personalized content ontologies (Torniai, Jovanović, Gašević, Bateman, & Hatala, 2008).

According to Anderson (2007), the term Web 2.0 is not best described by a set of technologies but as an idea encompassing individual contributions to content, knowledge construction using a "power of the crowd" methodology, large volumes of data and information, user participation, open architecture, and network attributions. In 2004 Dale Dougherty, a vice-president at O'Reilly Media Inc., introduced the term Web 2.0 and defined it as using the Web as a platform to construct collaborative, user-centric content and interactive applications. Safran, Helic, and Gütl (2007) posit that Web 2.0 has coalesced with the eLearning domain. Following O'Reilly's introduction of the Web 2.0 term, Stephen Downes introduced the term eLearning 2.0 (Wever, Mechant, Veevarte, & Hauttekeete, 2007).

The primary attribute associated with Web 2.0 technologies, and associated eLearning 2.0 concept, involves a focus on making connections between learners and learning resources (*connectivism*) and the inclusion of social networking and Web 2.0 technologies as new elements of eLearning instructional design (Wever et al., 2007). As a result of implementing Web 2.0 technologies, learning spaces and communities of learners are created and social data can be utilized to best meet the instructional needs of a given learner population.

Nascent Web technologies, now associated with Web 2.0, offer an opportunity to change development and delivery of instruction. Web 2.0 is less a category of technologies and more an idea or design concept that supports constructivist approaches to eLearning. For example, the Community of Inquiry (CoI) model (Garrison, Anderson, & Archer, 2000) optimizes synchronous and asynchronous computer mediated communication in a design focused on three core elements: social presence, cognitive presence, and teaching presence. eLearning environments utilizing Web 2.0 can play a key role in supporting discourse, based on the CoI model. Parturient eLearning is accommodated not by a Web used only for component connectivity, but a Web used as a platform for development.

Conceived by Jorn Barger in 1997, Weblogs (Blogs) refers to Web-based scrolls, presented in reverse chronological order, utilized as a mechanism for communication between interested user groups (Boulos & Wheller, 2007). Blogs are ideal for controlling a 1:M relationship between an instructor and a class of students (Ullrich, Borau, Luo, Tan, Shen, & Shen, 2008). Blogs contain posts and each post is generally tagged with one or more keywords. Associated tags allow the post to be cataloged based on a theme in a standard menu system. Meta-data

tags appear in close proximity to the posts and allow the user to navigate to other related posts (Alexander, 2006). Generally, blogging facilitates syndication, or the generation of feeds using RSS or, increasingly, Atom. Blog aggregators and special blog reading tools accept these feeds. The term blogosphere refers to the universe of bloggers who contribute to blogs in real time.
Wikis were introduced by Bo Leuf and Ward Cunningham in 1995 as an online system to permit users to create, edit, revise, or link hypermedia. Ideal for collaborative work, the term wiki can be described as a knowledge management system used as collaborative media groupware. According to Ebner (2007), wikis have alternative functionalities to blogs. Wikis contain a history function, storing previous versions, and a rollback function, to restore previous versions. As a group work tool, wikis feature a simple, hypertext-style linking of pages to create navigation pathways.

The term social bookmarking refers to a method for Web users to organize, store, manage, and search for bookmarks of resources online and has evolved into folksonomies which social bookmarking tools use as meta-data tags for search purposes. Essentially, folksonomies represent an ontology that has evolved from a community of practice where folksonomic meta-data is created by users who generate and attach related words to content. As a result, folksonomies interrelate learning content information. According to Boulos, Maramba, and Wheeler (2006), tools based on folksonomies are available to locate information related to specific research and capitalize on the observations and comments of other similar researchers. Folksonomies can identify a collection of resources that is evolving in concert with a specific research initiative. Folksonomical tagging illustrates a best-practice with respect to meta-data. Szomszor, Cantador, and Alani (2008) studied the correlation of user profiles using folksonomies and presented a framework to demonstrate cross-linking distributed user tag clouds to identify users separately on the Web.

According to (Ullrich et al., 2008), social bookmarking services allow for the collection and annotation (i.e., tagging) of online content. This action enables a simple distribution and sharing of resources among a user community. Examples of social bookmarking sites include del.icio.us (http://del.icio.us), Furl (http://www.furl.net), Connotea (http://www.connotea.org), and CiteULike (http:www.citeulike.org). Social bookmarking sites can be used as an online community tool to classify resources based on informally assigned, user-defined keywords or tags. Tags, when made public, can serve as a methodology for locating sites and other Web-based resources based on common or related keywords. Tags, in effect, serve as meta-data definitions for digital content and/or digital content objects.

Moreover, sets or groups of tags (i.e., tagsets), can be visually displayed in a form of concept map known as a tag cloud. Tag clouds are useful in determining common or dominant themes from tagsets, Websites, documents, or other text-based content, such as the discussion in an online forum (e.g., blog, wiki, chat, or threaded discussion). According to Schrammel, Leitner, and Tscheligi (2009), tag clouds are used frequently to interact on the Web. As an adjunct outgrowth of tags, the concept and use of *folksonomies* (folk taxonomies) has increased. Based on the use of taxonomies to define and provide structural organization, folksonomies are developed by users as a collection of tags, created for personal use. Folksonomies involve the grouping of common user-created tags as a structured means of organizing and accessing digital content. Research tools using folksonomies as a methodology for locating related information are available.

Moreover, tag clouds provide a helpful visual summary of content (Schrammel, Leitner, & Tscheligi, 2009). Szomszor, Cantador, and Alani (2008) studied the correlation of user profiles using folksonomies and presented architecture to demonstrate cross-linking distributed user tag clouds to identify users separately on the Web. Xexéo, Morgado, and Fiuza (2009) describe the output of a tag cloud with the term *semantic field*. The semantics illustrate and define the contextual meaning of the input text string. According to Hearst and Rosner (2008), tag cloud input primarily involves unstructured social data or annotations of information by authors where clouds are generated using query terms, word frequencies, category labels, or other heuristically determined algorithm. They also note that the primary value of the cloud is as a signal or marker of individual or social interaction with the contents of an information collection and functions as a suggestive device for some underlying phenomena.

Kuo, Hentrich, Good, and Wilkinson (2007) used tag clouds to summarize Web search results and found that tag clouds provide an overview of knowledge represented by an entire response and an interface to discover potentially relevant information hidden deep within the text string. In a study by Koutrika, Zadeh, and Garcia-Molina (2009), the researchers found that tag clouds can dynamically highlight the most significant concepts and hidden relationships within unstructured data. According to Bateman, Gutwin, and Nacenta (2008), clouds have been shown to assist in understanding data and semantic exploration.

3. EXPERIMENTAL RESEARCH PROTOTYPE CASE

Theory of Prototype Construction
The prototype application was fashioned as a digital dashboard and consists of three primary modules:

(i) data extraction and staging,
(ii) a tag cloud engine, and
(iii) correlation coefficient calculation and output rendering.

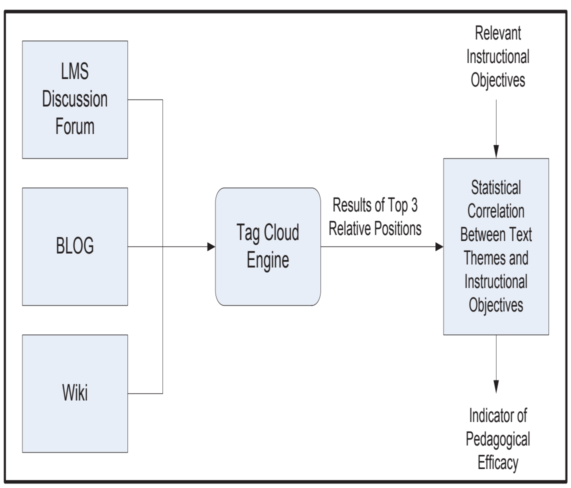

Figure 1: High-level architecture for prototype design and construction

As illustrated in Figure 1, a text string can be extracted from any social media communication forum, in this case the discussion threads from a LMS. The text string serves as the input to a tag cloud engine where the tag cloud output is organized by (minimally) the top three relative positions. Level one indicates the top level output, level two indicates the secondary level output, level three indicates the tertiary level output, and so forth.

Visually, the tag cloud output matches the organization of words into levels. In this research, the prototype evaluated words to 15 levels. With more levels evaluated and scored, more data is available for calculation of the correlation coefficient, the final module of the prototype application.

Use Case Applied to Prototype
The student populations involved in this study included two sections of a graduate level Information Systems course on database system development. Both sections of the course were sampled in the fifth week of the term. During the fifth week of the term the control group (population 1) received no pedagogical facilitation or intervention, whereas the variable group (population 2) received daily pedagogical facilitation and intervention. The control group (N=15) and variable group (N=17) were composed of the following homogenous demographics:

(i) 28-40 years of age,
(ii) professional, adult students,
(iii) technical undergraduate degrees, and
(iv) at least four previous online courses completed.

In this experimental research, three text strings acted as input to a tag cloud engine:

(i) the learning objectives specified for the fifth week of instruction,
(ii) the week five discussion forum for student population 1 taken from a LMS, and
(iii) the week five discussion forum for student population 2 extracted from the same LMS.

Text string output from a tag cloud engine for populations 1 and 2 were individually compared to the text string output from a tag cloud engine for the learning objectives. Populations 1 and 2 were provided instruction online based on intended learning objectives.

Two behavioral learning objectives were specified for the week of instruction utilized in this study and were stated as:

After successful completion of this course, students will be able to:

1) Compare structured and agile development methodologies and, after comparing, evaluate for the most appropriate life-cycle methodology for a given database or information system project; and
2) Utilizing a structured approach, apply a system development life-cycle methodology in construction of a database system.

Figure 2 features the tag cloud generated from the learning objectives captured as a text string. Based on tag cloud visual properties, dominant themes are defined by the terms *system*, *development*, and *methodology* at the top (most important) level, followed by the terms *database*, *life*, and *cycle* at a secondary level of emphasis. This output is noted in Table 1.

Figure 2: Tag cloud engine results (learning objectives)

Figure 3: Tag cloud engine results (Student population 1: control group)

The tag cloud output from student population 1, the control group where no instructor facilitation or intervention occurred during the week, is featured in Figure 3. Based on tag cloud properties, dominant themes are noted by the term *development* at the top level, the term *agile* at the secondary level, and the terms *database*, *methodology*, and *project* at a tertiary level. Additional levels of word data for this population are shown in Table 1.

The tag cloud output from student population 2, the variable group where instructor facilitation and intervention occurred during the week, is featured in Figure 4. Based on tag cloud properties, dominant themes are noted by the term *data* at the top level, the terms *development*, *database*, and *system* at the secondary level, and the terms *requirements* and *process* at a tertiary level. Additional levels of word data for this population are shown in Table 1.

Figure 4: Tag cloud engine results (Student population 2: variable group)

5. RESULTS AND CONCLUSIONS

Based on output from the tag cloud engine, Table 1 illustrates the word groupings by dominant theme for three text strings:
(i) the stated learning objectives for the week,
(ii) the week-long discussion forum for the control group, and
(iii) the week-long discussion forum for the variable group.

Table 1: Word groupings by dominant theme

	Learning Objectives	Student Population 1: Control Group	Student Population 2: Variable Group
Level 1	System, Development, Methodology	Development	Data
Level 2	Database, Life, Cycle	Agile	Development, Database, System
Level 3		Database, Methodology, Project	Requirements, Process
Level 4		Process, Software, Design, System, Approach	Agile, Design, Work
Level 5			Methodology, Warehouse, Manage

To achieve results and subsequent conclusions, the authors utilized a ranking scoring system based on the level at which each word data occurred where 100 represented the primary level, 90 represented the secondary level, etc. The integer 1 represents the lowest level where no occurrence exists.

Table 2 illustrates the level and associated score for occurrence. The ranking scoring method appropriately awards higher level word positioning and assigns linearity to best accommodate use of **ρ** rank correlation coefficient to calculate the strength of linear relationships between the data.

Table 2: Scores assigned by level of occurrence

Level	Score for occurrence
1	100
2	90
3	80
4	70
5	60

Fifteen distinct terms, taken from the top five levels of word data in the three tag clouds were assigned scores based on the linear scoring method (Table 3). Two correlation coefficients were calculated: tag cloud output from the stated learning objectives and student population 1, and tag cloud output from the stated learning objectives and student population 2.

The authors found that student population 1, the control group with no instructor facilitation or intervention, calculated significantly lower than student population 2, the variable group with instructor facilitation and intervention. Using r coefficient inclusive values of +1 (positive correlation) to -1 (negative correlation) as an indicator of pedagogical efficacy as measured through class topical discussions, lack of instructor facilitation and intervention is shown in the control group by a **ρ** score of .481. Evidence of instructor facilitation and intervention in the variable group is shown by a **ρ** score of .715. In practice, online class facilitators using a digital dashboard dynamic indicator of a weekly discussion's correlation to intended learning objectives could intervene appropriately to alter course discussions toward higher positive correlation. In large online classes, facilitators could save time reading long discussion threads by utilizing correlation coefficients as indicators to intervene and meet a pre-determined threshold of acceptable achievement in discussions.

Table 3: Correlation coefficients

	Word	Learning Objectives	Student Population 1: Control Group	Student Population 2: Variable Group
1	System	100	70	90
2	Development	100	100	90
3	Methodology	100	80	60
4	Cycle	90	1	1
5	Life	90	1	1
6	Database	90	80	90
7	Project	80	80	1
8	Structured	80	1	1
9	Agile	80	90	70
10	Information	80	1	1
11	Apply	80	1	1
12	Approach	80	70	1
13	Appropriate	80	1	1
14	Comparing	80	1	1
15	Construction	80	1	1
Correlation Coefficient to intended learning objectives			**0.48168**	**0.71584**

Qualitative evaluation of the forum discussion in both populations revealed that students in population 2, the variable group, engaged in discussion more directly related to achievement of the intended learning objectives. Moreover, their discussion was more detailed, cited more examples in support of arguments, and resulted in end-of-week summarizations reinforcing what had been learned. The qualitative evaluation served to reinforce the outcomes of this study.

6. CONTRIBUTIONS AND FUTURE RESEARCH

This experimental research contributes to the existing body of knowledge on application of Web 2.0 technologies in eLearning environments. Construction of a prototype based on the architecture represented in Figure 1 demonstrates that social data, as collected in wikis, blogs, and LMS discussion forums, can be used to increase the efficacy of online and ground-based classroom instruction. Moreover, this research serves to inform educators of innovative uses and applications for Web 2.0 technologies, specifically tag clouds. As a baseline study, this research serves as a foundation for additional exploration using an Information Systems approach to construction of mediated learning applications.

Future research opportunities include collection of data in disciplines other than Information Systems to better understand the generalization of the application. Additionally, additional technology research into integration of the code and tag cloud engine with a LMS to create a digital dashboard as a component of the LMS. Currently constructed as a software development kit (SDK), the application programming interface (API) would benefit from further development. Other tools and utilities could be developed to provide analysis and reporting of the data in support of indicators such as the correlation coefficient.
Finally, future research opportunities include prototype use in real-time. Students using laptops to blog during class on lecture related material could be sampled in short (60 second) intervals to determine at a group level the threshold of understanding based on learning outcomes. Online sample frequency also should be investigated further to determine the impact on pedagogical strategies and interventions.

7. REFERENCES

Alexander, B. (2006). Web 2.0: A new wave of innovation for teaching and learning? *EDUCAUSE Review*, 41(2), March-April, 2006, pp. 32-44.

Anderson, T. (2007). Distance learning – social software's killer app? *Proceedings of the 17th Biennial Conference of the Open and Distance Learning Association of Australia*, November 9-11, 2005.

Bateman, S., Gutwin, C., & Nacenta, M. (2008). Seeing things in the clouds: The effect of visual features on tag cloud selections. *Proceedings of HT '08*, June 19-21, 2008. Pittsburgh, PA.

Boulos, M., & Wheller, S. (2007). The emerging web 2.0 social software: An enabling suite of sociable technologies in health and health care education. *Health Information and Libraries Journal*, 24, pp.2-23.

Boulos, M., Maramba, I., & Wheeler, S. (2006). Wikis, blogs and podcasts: A new generation of web-based tools for virtual collaborative clinical practice and education. *BMC Medical Education 2006*, 6(41).

Conn, S., Hu, D., Boyer, J. & Wilkinson, T. (2009). Scaling large-size undergraduate classes at a top research university via eLearning strategies: A facilitated model of instruction using Web 2.0 paradigm. *Proceedings of the Information Systems Educators Conference 2009*, Washington, D.C.

Dagger, D., O-Connor, A., Lawless, S., Walsh, E., & Wade, V. (2007). Service-oriented e-learning platforms: From monolithic systems to flexible services. *IEEE Internet Computing*, May-June 2007, pp. 28-35.

Ebner, M. (2007). E-learning 2.0 = e-learning 1.0 + web 2.0? *Proceedings of 2nd International Conference on Availability, Reliability and Security (ARES'07)*, April 10-13, 2007. Vienna, Austria.

Garrison, D., Anderson, T., & Archer, W. (2000). Critical thinking, cognitive presence, and computer conferencing in distance education. *The American Journal of Distance Education*, 15(1), pp. 7-23.

Hearst, M. & Rosner, D. (2008). Tag clouds:Data analysis tool or social signaller? *Proceedings of the 41st Hawaii International Conference on System Sciences-2008*. Kauai, Hawaii.

Koutrika, G., Zadeh, Z., & Garcia-Molina, H. (2009). Data clouds: Summarizing keyword search results over structured data. *Proceedings of EDBT 2009*, March 24-26, 2009. Saint Petersburg, Russia.

Kuo, B., Hentrich, T., Good, B., & Wilkinson, M. (2007). Tag clouds for summarizing web search results. *Poster paper presented at WWW 2007*, May 8-12, 2007. Banff, Alberta, Canada.

Safran, C., Helic, D., & Gütl, C. (2007). E-learning practices and web 2.0. *Proceedings of the Conference ICL 2007*, September 26-28, 2007. Villach, Austria.

Schrammel, J., Leitner, M., & Tscheligi, M. (2009). Semantically structured tag clouds: An empirical evaluation of clustered presentation approaches. *Proceedings of CHI 2009*, April 4-9, 2009. Boston, MA.

Sloan Consortium [Sloan-C] (2009). Learning on Demand: Online Education in the United States, 2009.

Szomszor, M., Cantador, I., & Alani, H. (2008). Correlating user profiles from multiple folksonomies. *Proceedings of HT '08*, June 19-21, 2008. Pittsburgh, PA.

Torniai, C., Jovanović, J., Gašević, D., Bateman, S., & Hatala, M. (2008). E-learning meets the semantic web. *Proceedings of the 8th IEEE International Conference on Advanced Learning Technologies*. July 1-5, 2008. Cantabria, Spain.

Torniai, C., Jovanović, J., Gašević, D., Bateman, S., & Hatala, M. (2008). Leveraging folksonomies for ontology evolution in e-learning environments. *Proceedings of the 2nd IEEE International Conference on Semantic Computing*, August 4-7, 2008. Santa Clara, CA.

Ullrich, C., Borau, K., Luo, H., Tan, X., Shen, L., & Shen, R. (2008). Why web 2.0 is good for learning and for research: Principles and prototypes. *Proceedings of the WWW Conference 2008*, April 21-25, 2008. Bejing, China.

Wever, B., Mechant, P., Veevarte, P., & Hauttekeete, L. (2007). E-learning 2.0: Social software for educational use. *Proceedings of the 9th IEEE International Symposium on Multimedia 2007*, December 10-12, 2007. Taichung, Taiwan.

Xexéo, G., Morgado, F., & Fiuza, P. (2009). Differential tag clouds: Highlighting particular features in documents. *Proceedings of 2009 IEEE/WIC/ACM International Conference on Web Intelligence and Intelligent Agent Technology*. Milano, Italy.