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Emerging Web Technologies in Higher Education: A Case of Incorporating Blogs, Podcasts and Social Bookmarks in a Web Programming Course based on Students' Learning Styles and Technology Preferences

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ABSTRACT

The adoption level of emerging web technologies is on the rise in academic settings. However, a major obstacle in the practice of web-based instruction is the limited understanding of learners' characteristics and perceptions about technology use. Thus there is a need to understand the relationship between students' learning styles and their preferences for instructional strategies, including the use of emerging web technologies. Since learning styles provide information about individual differences in learning preferences they can suggest how instruction can be best designed to support the learning preferences. In this paper, a research framework has been proposed to incorporate emerging web technologies into higher education based on students' learning styles and technology preferences and a case study has been carried out to validate the proposed framework. An action research methodology has been adopted to carry out the study, which comprises of conducting a survey about students' learning styles and technology preferences; incorporating a combination of emerging web technologies based on the survey findings; and analyzing key achievements and shortcomings of the study to redefine research objectives. The study provides support for the proposed framework by highlighting the significant relationships among students' learning styles and technology preferences and their impact on academic performance.

Keywords

Emerging web technologies, Learning styles, Technology preferences, Higher education

Introduction

The growth of web-based applications has made the web an important educational medium (Siau, Nah, & Teng, 2002). Notably, with the creation of emerging web technologies such as blogs, wikis, instant messengers (IM), social bookmarks, podcasts and vodcasts, the web is transforming into a fully interactive space and the control of content has been decentralized to allow every one to collaborate, create, publish, subscribe, and share information (Asmus, Bonner, Esterhay, Lechner, & Rentfrow, 2005). However, a major obstacle for the practice of web-based instruction is the limited understanding of learners' characteristics (Yang & Tsai, 2008). In addition, the success of educational programs involving web-based technologies depends to a considerable extent on students' acceptance and use of these technologies (Raaij & Schepers, 2008). Therefore students' learning styles and technology preferences should be taken into account in order to effectively incorporate emerging web technologies into our courses. Due to the recent developments in e-learning applications the education system is in the midst of a fundamental change. This transformation from traditional classrooms to web-based learning environments has changed the learning styles and interactions between instructors and students (Agres, Edberg, & Igbaria, 1998). Therefore it is important to investigate the learning styles and preferences of the current generation in order to effectively incorporate emerging web technologies into their courses.

Since learning styles provide information about individual differences in learning preferences they can suggest how instruction can be best designed to support learning preferences (Akdemir & Koszalka, 2008). A review of learning theory literature suggests that learning styles and preferences influence the effectiveness with which individuals learn. Therefore, a first hand knowledge of students' learning styles and preferences can help lecturers choosing the right methods of instruction for the right audience (Smith & Dalton, 2005). In this paper, we present a research framework and hypothesize that students' learning styles influence their preferences for using technology and that the use of appropriate technology positively influence their academic performance. An action research methodology is adopted by conducting a survey to collect students' learning styles and their preferences for emerging web technologies; incorporating a combination of web technologies in a *web programming* course based on survey outcomes; and analyzing the effect of above experiments on students' academic performance. The study outcomes

provide support to our proposed framework which can serve as a guideline for educators who wish to incorporate emerging web technologies into their courses.

Literature Review

Educational uses of emerging web technologies

The adoption level of emerging web technologies is on the rise in academic settings (Long, 2006; Pulichino, 2006). These technologies include blogs, wikis, instant messaging (IM), social bookmarks, podcasts, vodcasts, etc. A blog (or weblog) is a type of website, usually maintained by an individual with regular entries of commentary, description of events, or other material such as graphics or video (http://en.wikipedia.org/wiki/Blog). A wiki is a collection of web pages that are linked to each other, and reflect the collaborative works of many authors (Beldarrain, 2006). Instant messaging is a form of real-time communication between two or more people based on typed text via Internet (http://en.wikipedia.org/wiki/Instant_messaging). Social bookmarking is a method for Internet users to store, organize, search, and manage bookmarks of web pages on the Internet, typically in the form of tags (http://en.wikipedia.org/wiki/Social_ bookmarks). Podcasting is a method of distributing audio recordings via the Internet, allowing users to subscribe to a feed of new files (Walton, Childs, & Blenkinsopp, 2005) while vodcasting refers to the distribution of video files. Several examples of incorporating these technologies into courses can be found (Augar, Raitman, & Zhou, 2004; Belanger, 2005; Farmer & Bartlett-Bragg, 2005; Lu, Chiou, Day, Ong, & Hsu, 2006).

Emerging Web technologies mentioned above have the potential to create engaging learning environments. In academic settings, students and lecturers alike are achieving many of the benefits of these interactions (Baird & Fisher, 2005). For example, blogs facilitate the publication of knowledge, opportunities for subsequent reflection and analysis, and help learners understand the relational and contextual basis of knowledge, knowledge construction and meaning making (Ferdig & Trammell, 2004). Students enjoy blogging and use it for community building, resource-consolidation, sharing ideas or as a personal journal (Kerawalla, Minocha, Kirkup, & Conole, 2008). Wikis facilitate the creation of shared knowledge, dissemination of information, and group interaction (Augar, et al., 2004). Instant messaging promotes collaborative learning and team work, encourages collaborative learning, and promotes interaction and communication skills (Lu, et al., 2006). Social bookmarks allow quick and easy access to online resources and provide an 'insiders' guide to information and references (Asmus, et al., 2005). Podcasts and vodcasts provide an innovative and exciting way for people to improve communication, collaboration and social networking (Ractham & Zhang, 2006). They can also be used for dissemination of knowledge, broadcasting news to staff and students, supplementing class materials, guest lecture presentations and as a marketing tool for attracting prospective students (Harris & Park, 2008). The above mentioned features are key learning elements and make emerging web technologies appropriate for educational use. However, to help students achieve full cognitive development, lecturers need to integrate these technologies with the end-user experience and learning styles (Baird & Fisher, 2005). This paper aims at addressing these issues by exploring relationships between students' learning styles and their preferences of using emerging web technologies in higher education.

Learning styles and learning preferences

The cognitive learning theory emphasizes on the importance of individual differences in learning and considers learning style as a criterion for individual differences (Kia, Aliapour, & Ghaderi, 2009). Learning style is defined as signed indicator that how students perceive, interact and response to learning environments (Keefe, 1979). (Kemp, Morrison, & Ross, 1998) found that learning styles form a student's unique learning preference and help instructors in the planning of teaching / learning environment. (Sadler-Smith, 1996) states that learning style is a distinctive and habitual manner of acquiring knowledge, skills or attitudes through study or experience while learning preference is favoring of one particular mode of teaching over another. Several classifications of learning styles can be found in the learning theory literature including: Hill's Cognitive Style Mapping, Kolb's Learning Styles, Dunn and Dunn Learning Styles, Grasha-Reichman Learning Styles, and Gregorc Learning Styles (Ayersman & Minden, 1995). More recently, the Felder learning model focuses on the aspects of learning styles that are particularly significant in engineering and IT education (Zywno & Waalen, 2002). The index of learning styles (ILS) questionnaire developed by Felder and Soloman measures four learning style dimensions: active–reflective, sensing–intuitive, visual–verbal, and sequential–global (Felder & Soloman, 1993). Felder suggests that students learn in a variety of ways. Some tend

to focus on facts, data and algorithms; others feel more comfortable with theories and mathematical models. Some conceive more from visual information like pictures, diagrams and simulations; others get more from spoken and written information. Some prefer interactive learning; others learn well individually (Felder, 1996).

Understanding the relationship among learning styles and instructional strategies holds great promise for enhancing learner perceptions of their own learning (Claxton & Murrell, 1987). (Akkoyunlu & Soylu, 2008) emphasized on the importance of knowing students' learning styles to design and manage different web-based environments or other learning materials in various subject areas. Several existing studies showed that matching learning styles with teaching methods is advantageous to academic achievements (Huey Wen Chou & Wang, 1999; Lipsky, 1989; Smith & Dalton, 2005). For example, (H. W. Chou, 2001) found clear differences in the performance and learning preferences of field dependent and field independent students in their study of comparing learning styles with training methods. (Sun, Lin, & Yu, 2008), using Kolb's learning style inventory, also reported that 'accommodators' made the most significant 'achievements' in the study. (Becker, Kehoe, & Tennent, 2007) reported that students preferred traditional methods of delivery as compared to flexible web-based delivery methods. Similarly, (Butler & Pinto-Zipp, 2006) compared the learning styles with online teaching preferences (using Gregorc Learning Styles Delineator) and reported 'dual' learning style (Concrete-Random / Abstract-Sequential) as dominant with strong preferences for asynchronous interactions. However, their study did not report any relationships between learning styles and the technologies used. We would like to explore such relationships in our study using Felder's dimensions of learning styles. Some previous studies also attempted to highlight the impact of learning styles on academic performance and reported that learners with particular learning styles performed better than others. We would also like to explore these trends in our study.

Research Hypotheses

As mentioned earlier that matching learning styles with instructional methods is advantageous to academic achievements. Our research framework is based on the fact that learners' individual characteristics influence their preferences for using technology and that the use of appropriate technology positively influences the academic performance. We present our research framework in *Figure 1* and hypothesize as follows:

H1: Preference/use of instructional technology is influenced by student's learning style.
H2: Academic performance is positively influenced by the use of appropriate instructional technology.

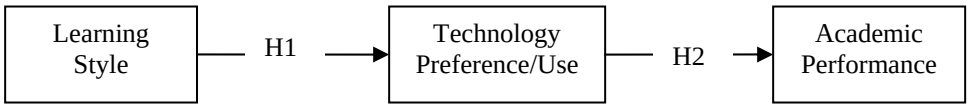

Figure 1. Research framework

We would attempt to validate our first hypothesis by examining the impact of students' learning styles on their preferences for using various technologies. Based on this, we would incorporate a combination of emerging web technologies in course delivery. Such a technology use would address the needs of a wide spectrum of learning styles and help achieving well-balanced performances across all learner types, thus validating our second hypothesis.

Research Methodology

Experimental design

An action research approach was adopted to carry out the study. Action research is considered as a collaborative activity for finding ways to improve teaching and increase student achievement. It is characterized by spiraling cycles of problem identification, systematic data collection, reflection, analysis, data-driven action taken, and finally, problem redefinition (Kemmis & McTaggart, 1988). We followed this approach and identified the following phases in our study:

- To collect students' learning styles and technology preferences for emerging web technologies.

- To experiment a combination of emerging web technologies based on students' learning styles and technology preferences.
- To analyze the impact of above experiments on students' academic performances.
- To identify key achievements and shortcomings of the study and redefine our research objectives.

Participants

The study was conducted during 2007 with a total of 204 students in a *web programming* course. The participants were studying toward the completion of Bachelors or Masters of IT degrees.

Measurement

The data for this study were gathered by means of online surveys. Learning styles data was gathered using Felder-Soloman's learning style inventory (LSI) (Felder & Soloman, 1993). As stated earlier that Felder learning model focuses on the aspects of learning styles that are particularly significant in engineering and IT education (Zywno & Waalen, 2002) and is considered as one of the mostly used models to capture individual differences during the last decade (Dag & Gecer, 2009), therefore deemed suitable for our study. Felder's model classifies students as: active–reflective; sensing–intuitive; visual–verbal; and sequential–global learners (Felder, 1996). The Felder's LSI consists of 44 questions each carrying two responses (a or b). It provides the scores (as 11A, 9A, 7A, 5A, 3A, 1A, 1B, 3B, 5B, 7B, 9B, 11B) for each of the four scales. Scores 1-3 on either side of the scales represent well-balanced or 'mild' preference, scores 5-7 represent 'moderate' and scores 9-11 represent 'strong' preference - a total of 12 possible outcomes on each scale.

To collect technologies preference data, the authors designed a questionnaire presented in Appendix A. The participants were asked to rate their technology preferences against various academic activities on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

Results of learning style and technology preference surveys

Demographics

With a total number of 204 enrolled students, 119 responded to learning styles survey, including 101 (84.9%) males and 18 (15.1%) females, with a response rate of 58.3%. The majority (85.7%) was aged between 21 and 29. For technology preference survey, we received 105 responses including 90 (85.7%) males and 15 (14.3%) females, with a response rate of 51.4%. Nearly 70% reported their Internet usage as more than 15 hours per week, and 82.2% described 'Study' as the major reason for using Internet, which suggests that the majority was well aware of the web usage in academia and was familiar to some extent with the web-based e-learning technologies.

Learning styles frequency distribution

Table 1 presents the mean and standard deviation values for each of the learning style scales. These figures show that the majority of students exhibited well-balanced learning style except those on the visual-verbal scale where verbal dimension was dominant.

Table 1. Mean and standard deviation (SD) of four learning style scales

LS scales	Mean	Standard Deviation
Active – Reflective	.73	4.288
Sensing – Intuitive	2.45	4.459
Visual – Verbal	5.8	4.063
Sequential – Global	2.16	3.959

Relationships within learning styles

The Pearson correlation coefficient revealed two significant relationships within the four learning style scales. A small positive relationship between active-reflective and visual-verbal scales (r=.191, N=119; p<0.5); and another small positive relationship between sensing-intuitive and sequential-global scales (r=.216, N=119; p<0.5) (In large samples (N>100), very small correlations may be statistically significant (Pallant, 2005)). These results suggest that reflective learners were correlated with verbal learners while intuitive with global learners. The strength of above relationships was measured as follows: r = .10 to .29 → small; r = .30 to .49 → moderate; r = .50 to 1.0 → strong (Pallant, 2005).

Relationships within technology preferences

In the technology preference survey, participants were asked to rate their technology preferences against various academic activities. Besides collecting the preferences for emerging web technologies we also asked our participants to rate their preferences for some conventional technologies like email and *Blackboard* as these were used as an integral part of course delivery in our University. Pearson correlation coefficient revealed several significant relationships as shown in *Table 2*: three strong (figures in bold), three moderate (figures in italic) and two small relationships, all significant at p<.05. All relationships appeared positive, i.e., the higher preference for one technology lead to the higher preference for the other. These results suggest that the learning preferences of various technologies were closely related, i.e., our students preferred to try various technologies in their study routines instead of relying on one particular tool. These results were also encouraging for us to experiment a variety of technologies in our study. However, it was interesting to see that none of the emerging web technologies (blog, wiki, IM, podcast, vodcast) correlated with the conventional technologies (email and *Blackboard*). It should be noted that "*Social bookmark*s" is not included in Table 2 as it does not correspond to any academic activity mentioned in the technology preference questionnaire (Appendix A).

Table 2. Correlation between technology preferences

	Blackboard	Blog	Email	IM	Podcast	Vodcast	Wiki
Blackboard			**.51**				
Blog				*.38*	.29		
Email	**.51**						
IM		*.38*			**.56**	*.39*	*.38*
Podcast		.29		**.56**		**.57**	.29
Vodcast				*.39*	**.57**		
Wiki				*.38*	.29		

Relationships between learning styles and technology preferences

To see the impact of students' learning styles on their preferences of using emerging web technologies, we combined the data from learning styles questionnaire and technology preference questionnaire. The corresponding results suggest that active-reflective scale did not yield any significant relationship when correlated with various technologies. However, sensing-intuitive scale was negatively correlated with the preference of using email (r=-.12; N=89; p<0.5) while positively correlated with that of blog (r=.12; N=89; p<0.5). This implies that sensors preferred to use email while intuitive learners preferred to use blog. The visual-verbal and sequential-global scales found to be negatively correlated with the preference of using vodcast (r=-.16; N=89; p<0.5) and podcast (r=-.14; N=89; p<0.5) respectively. These results suggest that visuals preferred vodcast while sequentials preferred podcast. We will discuss more on these results later in the *Discussion* section.

Matching learning styles with technology preferences

Based on the above statistical analyses, we incorporated a combination of web technologies in the *web programming* course based on the following rationale: As mentioned in the previous section that podcast, vodcast, email, and blog were the preferred technologies for sequential, visual, sensing and intuitive learners respectively. Therefore, to facilitate these four learner types, we decided to incorporate a course blog, audio (podcast) / video (vodcast) recordings of lectures and email communication in the above course. To match the appropriate technologies for the

remaining four learner types we made some assumptions based on the statistical results presented in the previous sections.

Table 3. Technology preferences for various learner types

Learning style	Technology preference	Learning style	Technology Preference
Active	Social Bookmarks	Reflective	Podcast
Sensing	Email	Intuitive	Blog
Visual	Vodcast	Verbal	Podcast
Sequential	Podcast	Global	Blog

The first assumption was based on the fact that like intuitive learners, global learners would also prefer to use blogs because these two learner types were significantly correlated. Second, we assumed that audio recordings (podcast) of lectures would suit verbal learners since they are characterized as those who learn best by using words, written or oral (Felder, 1996)**.** Following this argument we assumed that like verbals, reflective learners would also prefer podcast because these two learner types were significantly correlated. Finally, to facilitate active learners, who usually prefer new and innovative ways of learning, we assumed that social bookmarks would be a good match for them as social bookmarking is relatively a new trend in academia. *Table 3* presents a summary of matching various technologies with each of the learner types.

Experiments with incorporated technologies

Based on the criteria discussed above, we incorporated a course blog, a social bookmarks page and audio / video (podcast / vodcast) recordings of lectures in the *web programming* course. In order to avoid the hassle of setting up extra blogging and bookmarking software on the University servers, we relied on free hosting services. For the course blog we chose *Blogger* from *Google* (*http://www.blogger. com*), as *Blogger* is considered fast, reliable and well-known blogging service (Bryant, 2006). To set up the course bookmarks page, we chose *Delicious* (*http://del.icio.us*), a well known social bookmarking service. For the recording and delivery of lecture podcasts / vodcasts, we used the local recording services available at our University. The experiments were carried out for the whole semester from February to May 2007.

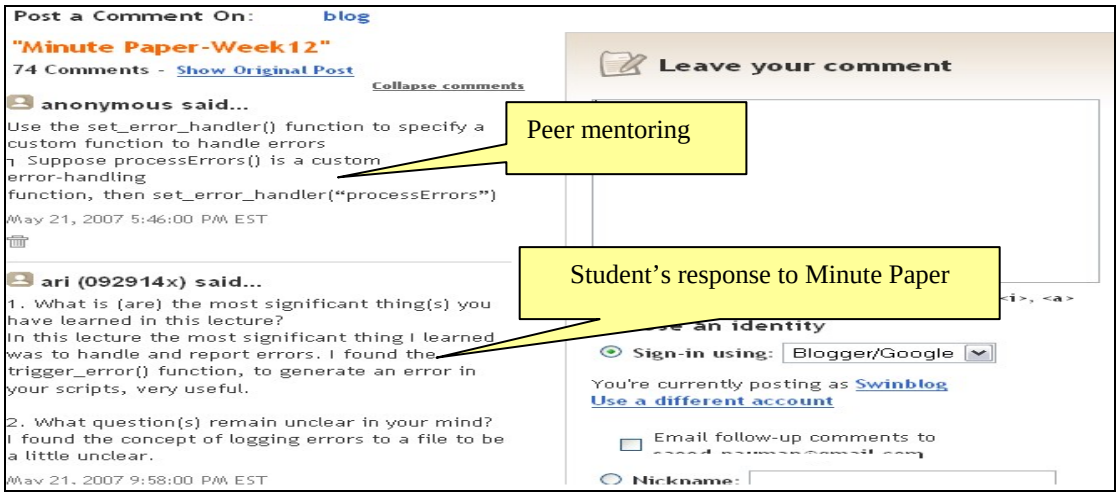

Figure 2. Students' response to weekly 'minute paper' and peer mentoring on the course blog

Course blog

The course blog was set up on *Blogger* with the following aims: (1) to get quick feedback on teaching and learning issues from students; and (2) to enhance student collaboration. To achieve the first objective, we used a weekly "*minute paper*" on the course blog. Minute papers are considered a way to promote meta-cognition thinking amongst students and to provide academics with un-graded and immediate feedback in order to assess how well and how

much students have learned (Murphy & Wolff, 2005). A minute paper is comprised of two simple questions: 'what is (are) the most significant thing(s) you have learned in this lecture', and 'what question(s) remain unclear in your mind?' (*Figure 2*). Students were encouraged to submit their course related problems and queries using weekly minute papers. To achieve the second objective, we encouraged students to post solutions to the queries raised by fellow students. This was intended to help students publish their thoughts, become critical thinkers, help others understand course contents, enhance online communication and collaboration, and create a virtual community, thus improving understanding level of the whole course.

Course bookmarks page

The course bookmarks page was set up on *Delicious* with the following aims: (1) to build a repository of online (*web programming)* resources with easy access to every class members; and (2) to engage students in the knowledge building and sharing process.

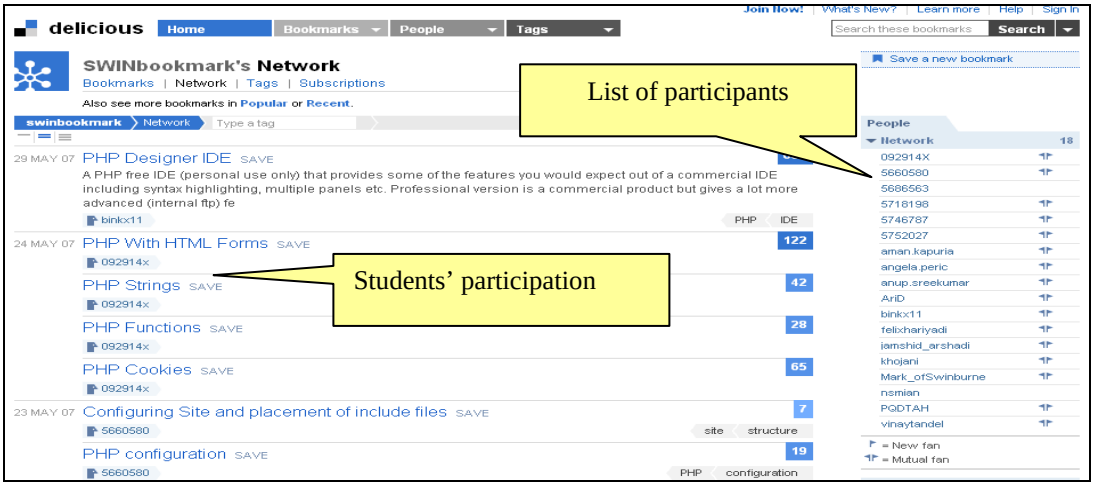

Figure 3. Students' contribution of *web programming* resources on the course bookmarks page

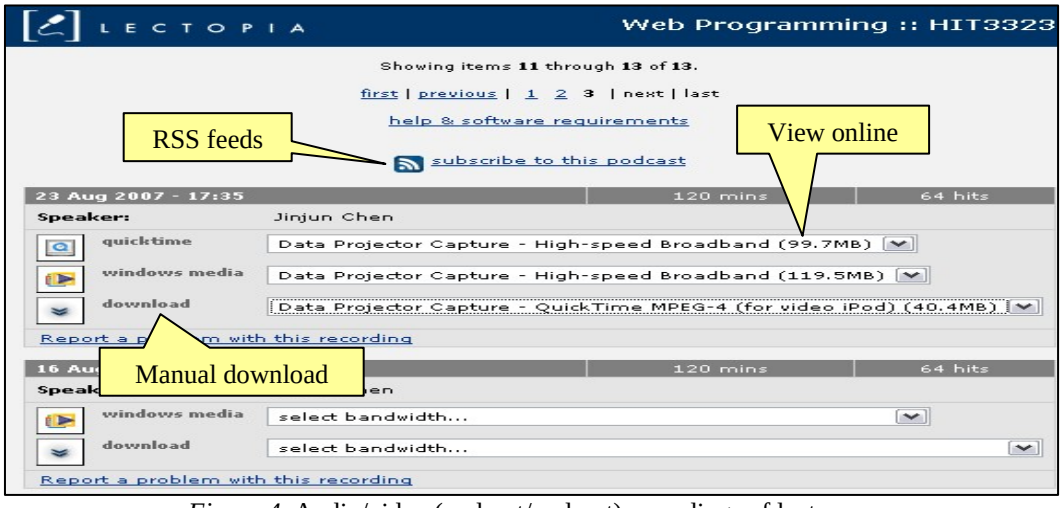

Figure 4. Audio/video (podcast/vodcast) recordings of lectures

To achieve the first objective, lecturers posted their online resources (bookmarks) on a weekly basis, covering main topics of the week. For easy access to relevant course topics, the bookmarks were also bundled (grouped) into individual text book chapters. To achieve the second objective, students were strongly encouraged to maintain their own Delicious accounts and post their favorite bookmarks on weekly course topics (Figure 3). Students' accounts

were then added to the network list, which allowed lecturers to monitor students' participation. It also allowed students to see what fellow students were contributing.

Lecture podcasts

As mentioned earlier, we used local recording services at our University to record and publish the audio and video recordings of all lectures. Students could access the recordings in three different formats: live streaming, manual download, and automatic subscription (*Figure 4*). They were also able to access those recordings through *Blackboard* (http://www.blackboard. com), which is used as an integral course management system in our University. All lectures were recorded and published with the aim of complementing teaching and learning through podcasting.

Analyses on academic performance

At the end of the semester after all assessments were completed for the *web programming* course, we conducted some further analyses in order to see the impact of gender, age and learning styles on students' academic performance. The Chi square analysis of academic performance and gender variables revealed no significant differences in the overall performance of males and females. This means that we found no evidence in our study that males performed better than females or vice versa. Similarly, no differences were found in the overall performance of young and mature-age students in the class.

The Chi square analysis of four learning style scales and high achievers (who scored 85% or more) across various assessment components (programming assignments, multiple choice questionnaire, and final examination) also revealed no significant differences. For example, the proportion of active learners who scored 85% or more in the overall assessment was not significantly different to that of reflective learners. Similar results were obtained for the low or average performers in the class. These results suggest that our teaching approach, including the use of emerging web technologies, was not biased toward any particular learning style(s). In other words, it accommodated all learner types to achieve well-balanced academic performance. This is consistent with the findings of (Akkoyunlu & Soylu, 2008) and (Sun, et al., 2008) but in contrast with several previous studies such as: (Chamillard & Karolick, 1999), (Thomas, Ratcliffe, Woodbury, & Jarman, 2002) and (Allert, 2004), which were highly biased toward particular learning styles.

Discussion

The learning style survey helped in analyzing the dominant learning style, frequency distribution, and correlations within various learning styles. Although the verbal style emerged as the most frequent single learning style, the majority appeared to be 'well-balanced', which is consistent with the findings of (Alfonseca, Carro, Martin, Ortigosa, & Paredes, 2006) and (Zywno & Waalen, 2002). (Butler & Pinto-Zipp, 2006) also reported "*verbal*" as the most frequent single learning style and "*dual*" (combination of two) learning style as the dominant, in their study of comparing learning styles with the preference of online teaching methods. Our findings also support Butler's idea that today's learners are more flexible in stretching their learning styles to accommodate a variety of teaching methods. The correlations within four learning style scales revealed significant relationships between *reflective* and *verbal* as well as *intuitive* and *global* learners, which are consistent with the findings of Alfonseca et al. This is a significant outcome of our study and has implications for forming appropriate groupings in programming assignments or projects.

The relationships within various technology preferences revealed that our students preferred to use both synchronous and asynchronous communication tools in their academic communication. This is in contrast with Butler's findings which reported the preference of asynchronous tools only (Butler & Pinto-Zipp, 2006). These results also suggest that today's students are ready to experience new technologies in their study routines and are willing to collaborate using multiple communication channels.

The correlations between learning styles and technology preferences also revealed some interesting outcomes. Sensing learners preferred email more than intuitive learners. Felder defines sensors as those who feel more comfortable with details and happen to be more careful (Felder & Soloman, 1993). Our finding also highlights this characteristic of sensors as they preferred to rely on a traditional communication tool like email as compared to IM, blog, or wiki. Intuitive learners, on the other hand, are defined as those who prefer discovering possibilities and relationships and are always ready to try out new things. This characteristic of 'intuitors' is highlighted by their preference for blogs over other traditional technologies like email or *Blackboard*. The relationship between visual learners and vodcast was a natural phenomenon as 'visuals' learn best from pictures, diagrams, flow charts, and demonstrations (Felder & Soloman, 1993). These results also highlight the acquaintance of intuitive and visual learners with the new technology. Similar trends were reported by (Zywno & Waalen, 2002) where active, intuitive and visual learners were the most frequent users of hypermedia-based instructions. Finally, sequential learners tend to gain understanding in linear steps and follow logical stepwise paths, hence podcast was a good choice for them to run sequence of lectures at their own pace over and over again to get a better understanding of the course contents. Above results support our hypothesis *H1*, which states that instructional technology is influenced by learners' learning style. The above outcomes can serve as a guideline for lecturers for choosing the right technology for the right audience in their courses.

Another significant finding of our study is the achievement of well-balanced academic performances across all learner types. No significant differences were found on the proportion of high, average or low achievers across various learner types, age-groups, or genders. This is consistent with the findings of (Akkoyunlu & Soylu, 2008) where no significant differences were found between students' achievement level according to their learning styles. (Sun, et al., 2008) also reported that the web-based virtual learning environment was suitable for various learner types as no significant differences were found in their grade achievements. These results fully support our hypothesis *H2*, which states that academic performance is positively influenced by the use of appropriate instructional technology. However, this is in contrast with some previous studies, where academic performance was heavily biased toward particular learning styles. For example: (Chamillard & Karolick, 1999) reported that reflective and verbal learners performed better than others in their study. Similar findings were reported by (Thomas, et al., 2002) and (Allert, 2004). At this stage, we can not rule out other contributing factors behind these well-balanced performances such as students' background of web programming, motivation for the course, assessments, sample size, etc. Also, involving students from a *web programming* course could have introduced a bias toward a certain type of learning style as most of the students involved would have some kind of scientific background.

Conclusion and future work

The research framework presented in this paper is supported by the data collected through user surveys, experiments performed with incorporated technologies and student performances in a *web programming* course. We have been successful in highlighting the technology preference of various learner types as well as incorporating a novel combination of emerging web technologies in the course delivery. Our findings suggest that today's learners are flexible in stretching their learning styles and are able to accommodate varying instructional strategies including the use of emerging web technologies. They further suggest that learning styles of today's learners are flexible enough to experience varying technologies and their technology preferences are not limited to a particular tool. Our experiments with incorporated technologies and achievement of well-balanced academic performances across all learner types motivate us to extend the study to other courses combined with varied technologies. The inclusion of students from non-scientific backgrounds in our future studies would further help understand the relationships among various learner types and their technology preferences.

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Appendix A

Learning styles questionnaire (Index of Learning Styles)*

The complete questionnaire is available at: < http://www.engr.ncsu.edu/learningstyles/ilsweb.html >.
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Technology preference questionnaire

SECTION I: Demographics

1. What is your age _____ (in years)?
2. What is your gender?
   a) male
   b) female
3. How many hours do you use the Internet per week?
   a) 5-10 hours
   b) 10-15
   c) 15-20
   d) more than 20 hours
4. For what purpose do you use Internet mostly?
   a) study
   b) work
   c) personal
   d) entertainment
   e) others

SECTION II: Technology preferences

Please read through the following statements and decide how much you prefer to use each of these technologies to perform the following academic activities. Using the scale provided write the number that best indicates how you feel on the space provided before each statement (please enter only digits from 1 to 5).
Least preferred 1 2 3 4 5 Most preferred

1. I would prefer to revise lecture online by:
a) _____listening to *podcast* (audio) of the lecture
b) _____watching *vodcast* (video) of the lecture
c) _____ discussing it on the course *blog*
d) _____ discussing it on the course *wiki*
e) _____discussing it with my peers on *IM*
f) _____discussing it with my peers through *email*
g) _____discussing it with my peers through *Blackboard*

2. I would prefer to submit online a group project to lecturer:
a) _____as a *podcast* presentation
b) _____as a *vodcast* presentation
c) _____through course blog
d) _____through course *wiki*
e) _____through *IM*
e) _____through *email*
f) _____through *Blackboard*

3. I would prefer to have online class discussion with lecturer through:
a) _____*podcast*
b) _____*vodcast*
c) _____course *blog*
d) _____ course *wiki*
e) _____*IM*
f) _____*email*
g) _____*Blackboard*

4. I would prefer to have online group discussion through:
a) _____*podcast*
b) _____*vodcast*
c) _____course *blog*
d) _____ course *wiki*
e) _____*IM*
f) _____*email*
g) _____*Blackboard*

5. I would prefer to have online study discussion with a friend through:
a) _____*podcast*
b) _____*vodcast*
c) _____course *blog*
d) _____ course *wiki*
e) _____*IM*
f) _____*email*
g) _____*Blackboard*

6. I would prefer my lecturer to conduct virtual office hours through:
a) _____*podcast*
b) _____*vodcast*
c) _____course *blog*
d) _____ course *wiki*
e) _____*IM*
f) _____*email*
g) _____*Blackboard*

7. I would prefer to receive assignments online from lecturer through:
a) _____*podcast*
b) _____*vodcast*
c) _____course *blog*
d) _____ course *wiki*
e) _____*IM*
f) _____*email*
g) ____*Blackboard*