Interactive Features of Web 2.0 Technologies and their Potential Impact in Teaching-Learning Mathematics

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Abstract: Computer-Based Instruction (CBI), stand-alone applications, and traditional web-based instruction are well known programs that have been popular in the mathematics classrooms for decades. Unfortunately, these factors limit the availability of many programs to developed countries, and are often not accessible to students and teachers in developing and underdeveloped countries. As a result, many students, teachers and classrooms across the world are unable to take advantage of this mathematical software and these web-based activities. Web 2.0 technologies have a great potential that can meet these demands. The basic rationale of this paper is to focus on the interactive features of Web 2.0 technologies and their potential impact in teaching-learning mathematics.

Introduction

Mathematics courses have a long tradition of using specialized notations and graphical representations to communicate technical information precisely and concisely. Recently, many mathematicians, mathematics educators, and researchers have developed and delivered web-based and web-assisted mathematics and mathematics education courses (Thomas & Li, 2008). Web-based Virtual Learning Environments (VLEs) such as WebCT, Blackboard, and eCollege are well-known programs that have been developed to provide online mathematics courses (Engelbrecht & Harding, 2004). These and many other web-based VLEs have gained popularity and are used worldwide.

Using full functionalities of Web 1.0 technology, WebCT allows instructors and designers to manage and control online courses easier than others. Although, the WebCT discussion forum provides the means to decrease many of the limitations of traditional online systems and increase students' critical thinking for such discourse, many students lack the intellectual maturity and experience necessary for true collaboration (Thomas & Li, 2008). For instance, in WebCT discussion, students often feel uneasy when asked to correspond and collaborate via threaded online discussion with other students taking the same class. Similarly, many of them struggle when asked to respond constructively but critically to other students' postings (Thomas & Li, 2008; Wuensch, Aziz, Ozan, Kishore, & Tabrizi, 2006).

Other limitations of WebCT classes are that these courses are provided only through the use of supporting tools and technologies that require additional cost, installation, and support in both school and home computers that may have different configurations, operating systems, and security setups (Thomas & Li, 2008). Moreover, students' and instructors' access to a WebCT class is limited to the semester or class offering time only. Once the class or semester is over students do not have access to the WebCT system. Thus, students cannot go back to the discussions, emails, or any course content unless they have previously saved them. Most importantly, WebCT programs need technology savvy instructors that are sometimes unavailable or unaffordable to schools in the rural districts or in many developing or underdeveloped countries.

Statement of the Problem

Technology has been a powerful engine in teaching-learning mathematics for the past several decades. Computer-Based Instruction (CBI), stand-alone applications, and traditional web-based instruction are well known programs that have been popular in mathematics classrooms. It is well known that by using these programs students can start a lesson through the use of tutorials, continue to learn through guided practice, add to their understanding by watching animated presentations, enjoy applying the learned material by playing games, and finally show that they have learned the material by taking simulated tests. Geometer's Sketchpad, Maple, Magma, Mathematica, Heymath, IXL, and MathScores are some of the popular mathematics programs among students and teachers.

Most mathematics teaching-learning software is very costly and requires purchasing updated licenses frequently. Some require a yearly license fee and a high-speed Internet and computer system to run. Mathematics teaching-learning software is only available for the most part in developed countries. Unfortunately, this software is often not accessible to and teachers in developing and underdeveloped countries. As a result, a large portion of students, teachers and classrooms in the world cannot use technology in the teaching and learning of mathematics. Therefore, it is important for the educators and technologists to develop a system that will be available and affordable to almost all students, teachers, and mathematics classrooms across the world. Thus, there is a great potential that the Web 2.0 technologies can provide new opportunities and challenges, especially for mathematics students, teachers, and educators seeking to develop new models of teaching-learning mathematics using technology.

Understanding Web 2.0 Technologies

"Web 2.0 is a set of social, economic, and technology trends that collectively form the basis for the next generation of Internet – a more mature, distinct medium characterized by user participation, openness, and network effect" (Musser, 2006). The current widespread popularity and use of Blogs is a good example of Web 2.0 (Maddux, Liu, & Johnson, 2008). Web 2.0 refers to the second generation of Web development and design that is more tailored to providing Web applications to next-generation Internet users. It transforms static Hypertext Markup Language (HTML) Web pages into more dynamic Web pages which can be used to develop a collaborative virtual society for sharing information interactively and interoperably based on next-generation Internet access through cellular and handheld devices (O'Reilly, 2005). Unlike traditional web technology which allows web users to accept information passively, Web 2.0 provides web users with an opportunity to actively accept and modify web information.

Web 2.0 includes additional Web-based features beyond traditional Web 1.0 tools that are available to users anytime from anywhere when they are connected to the Internet through personal computers or handheld mobile devices. It allows users to adapt and customize information. In order to do this, Web 2.0 technology uses open source coding. This means that the Web design codes are available for others to use and customize freely (Solomon & Schrum, 2007). Blogs, Flickr, Wikis, and similar social networking sites, including Facebook, Google+, Hi5, LinkedIn, MySpace, Nexopia, Twitter, YouTube, Wikipedia, and so forth, are examples of the successful implementation of new-generation Web 2.0 technology. Almost all of these emphasize no-cost online social collaboration and resource sharing among users (O'Reilly, 2009).

Numerous tools and applications are included under the label of Web 2.0 Technologies. These include Blogs, Wikis, Audio-Video and Photo Sharing Sites, Social Networking Sites, and online document management applications. These social broadcasting tools have been in use in their current form and at their current capacity for less than a decade, and, for some tools, less than half of a decade. Currently, numerous websites offer one or more of these tools and applications. Each of these websites has a unique purpose that may or may not benefit the user. Many Web 2.0 applications are created for educators to use in their classrooms, while others are used for easy access and communication between the user and the outside world.

Interactive Features of Web 2.0 Technologies

Compared with traditional Web 1.0 development tools, Web 2.0 includes additional features that are accessible to users through a browser located anywhere – connected to the Internet via personal computer or handheld mobile devices (O'Reilly, 2009). Web 2.0 applications provide web hosting, audio-video sharing, social

collaboration, and many more web-based applications and services. Web 2.0 not only has additional features not possessed by its predecessor Web 1.0, but it is qualitatively different from Web 1.0 in many ways. Web 2.0 enables users to interact with other users actively as well as to view information passively. The dynamic features of Web 2.0 allow users to interact with each other and to change website content jointly over time. On a Web 2.0 site, users can own and have control over data (O'Reilly, 2005). A Web 2.0 site allows its users to interact with other users or to simultaneously change website content from any location at any time. In order to do this, Web 2.0 technologies use open source coding, which means that the Web design codes are available for others to use and customize freely. This has caused the Web to shift from being a medium in which information is transmitted and consumed to a platform where content is created, shared, remixed, repurposed, and passed along (Downes, 2005).

The improved functionality of Web 2.0 includes open source applications, open share of information, open control, and open communication with an emphasis on Web-based communities of users free of charge (O'Reilly, 2005). Web 2.0 tools are referred to as open source applications because in the Web 2.0 world there is proprietary ownership (Downes, 2005; O'Reilly, 2006b). In the Web 2.0 platform everyone may be both a consumer and producer of information that appears on the Web. The interactive features of Web 2.0 technologies enable users to actively participate and contribute to developing and extending web page content. They permit free online collaboration, social connections, and resource sharing among users. On a Web 2.0 site users can own the data and exercise control over that data (O'Reilly, 2005). Web 2.0 users are also able to develop, share, and enhance their knowledge and thinking through interactions with other users. Most of the Web 2.0 sites hosted by individuals, non-profit, or even commercial organizations are dedicated for free use; and are customizable to the desire of the users (Solomon & Schrum, 2007).

Potential Impact of Using Web 2.0 Technologies in Teaching-Learning Mathematics

Over the years Web 2.0 participation, accessed via desktops, laptops, cell phones and handheld cellular devices, has been gaining popularity all over the world (Hodson, 2008). Text messaging, blogging, online discussion groups, social networking sites, and other interactive technologies are a part of the daily lives of many faculty and students (Baker, Wentz, & Woods, 2010). Everyday thousands of new users sign up for Web 2.0 based online participatory networks such as Blogs, Wikis, Social Networks, and audio or video hosting sites. The interactive features of Web 2.0 technologies have the potential to reach students at home, in their dorms, in between classes and work, and on the weekends. This may be an especially effective avenue for fostering mathematics learning in today's technologically advanced American youth, who tend to use the Internet extensively from desktops, laptops, netbooks, mobile phones, PDAs, and similar devices (Ramirez, 2008). The continuing spread of Web 2.0-based free applications might be an alternative to purchasing licensed mathematics software.

Collaboration is a fundamental feature of Web 2.0 technologies (Anderson, 2007; Boulos & Wheeler, 2007; Cash, 2010; O'Reilly, 2006a). It is an important component for success in Web-based environments (Boulos & Wheeler, 2007). McConnell (1999) defines collaborative learning as "an activity where learners who are brought together through the Internet focus on working together as a learning community in which they share knowledge, experience, resources, and responsibilities." Kear (2004) asserts that "students participate collaboratively mainly to obtain help and guidance from others." Studies have found that the implementation of specific Web 2.0 technologies enhance student learning and collaboration (Cormode & Krishnamurthy, 2008; McGee & Diaz, 2007; Purushotma, 2006; Thomas & Li, 2008; Ullrich et al., 2008). A Web 2.0-based learning environment fosters collaboration among students and faculty; and allows the student to create and share new knowledge among their peers (Ajjan & Hartshorne, 2008).

As Web 2.0 emphasizes a collaborative learning environment, it can generate and promote the development of new ways of thinking, learning, and sharing in online education where participants can play the central role in creating, using, and redesigning resources. In such an environment participants can share their resources and merit through self-publishing media such as Blogs, Facebook, Podcasts, Wikis, and similar social networking media. Such an online syndication of learning materials may become a repository of online resources in collaboration with millions of participants with anywhere and anytime accessibility. Using Web 2.0-based mathematics resources allow mathematics students and teachers the ability to show their true talents and interests in mathematics and prepare themselves for competitive tests and future careers.

Motivation is another notable feature of Web 2.0-based teaching-learning activities. Studies find that motivation is a key component that affects student performance and learning, particularly in online learning (Cole, Field, & Harris, 2004; Papastergiou, 2009; Ryan, 2001; Tüzün, Yilmaz-Soylu, Karakus, Inal, & Kizilkaya, 2009). According to Butler and Butler (2008), "one method of motivation is to use technology to engage students inside

and outside of the classroom." In the Web 2.0-based collaborative environments students and teachers become self-motivated to engage themselves inside and outside the classrooms (Malhiwsky, 2010). Interactive features of Web 2.0 tools motivate participants to spend more time online, and share their creativity with a broader audience that might not be possible in a regular classroom (Malhiwsky, 2010).

Thus, the integration of Web 2.0 tools with constructivist learning theories can motivate and facilitate young mathematics learners through knowledge creation, sharing, and dissemination in more dynamic ways than the transmission of static knowledge from teachers to passive learners does. Web 2.0 technologies are likely to motivate technologically advanced youth, who may be more interested in new technologies than other existing learning aids that have served mathematics instruction in the past. Thus, Web 2.0 activities could motivate young students and classroom teachers, whose voice and experience usually do not come to the print media, to share their perspectives in a public forum (Hossain & Wiest, 2011).

Most importantly, Web 2.0 technologies and tools can be used in the mathematics classrooms to make teaching-learning processes interesting, faster, and longer lasting. In the context of static to dynamic, in an interactive mathematics program, technology can increase students' ability of achieving a variety of higher-order learning outcomes, such as reasoning, reflection, problem posing, problem solving, and decision-making. These tools also enable students to practice and capture difficult mathematical problems in easier and faster ways that might otherwise be too difficult for them to understand in a paper-pencil format.

Conclusion

Most of the tools and applications of Web 2.0 technologies are relatively new and many of them are still being developed. This brief paper finds that a number of educators and researchers have already started to examine feasibilities, and found a potential impact of using Web 2.0 technologies for teaching and learning purposes. However, Web 2.0 usage in mathematics classrooms at the K-12, college and preservice teacher education program levels is still in its infancy; and sufficient studies have not been conducted in these critical areas. Further, no publications were identified that evaluated various Web 2.0 tools and their relationship with student achievement in mathematics at the high school or preservice teacher levels. Thus, starting with general discussion on the current trends and use of Web 2.0 technologies this paper focused on the interactive features of Web 2.0 technologies and their potential use and impact in teaching-learning mathematics.

References

Ajjan, H., & Hartshorne, R. (2008). Investigating faculty decisions to adopt Web 2.0 technologies: Theory and empirical tests. *Internet Higher Education, 11*(2), 71-80.

Anderson, P. (2007). *What is Web 2.0? Ideas, technologies and implications for education. JISC Technology and Standards Watch.* Retrieved July 15, 2010, from http://www.jisc.ac.uk/media/documents/techwatch/tsw0701b.pdf

Baker, S. C., Wentz, R. K., & Woods, M. M. (2010). Using virtual worlds in education: Second Life® as an educational tool. *Teaching of Psychology, 36*(1), 59-64.

Boulos, M. N. K., & Wheeler, 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*(1), 2-23.

Butler, F., & Butler, M. (2008). Using Technology to Enhance Liberal Arts Math. *Academic Exchange Quarterly, 12*(4), 227-231.

Cash, J. C. (2010). *Web 2.0 and self-reported student performance among high school students in rural schools.* (Doctoral Dissertation. UMI #3416273), The University of Southern Mississippi, Mississippi - United States. Retrieved from http://proquest.umi.com/pqdweb?did=2100301511&Fmt=7&clientId=1846&RQT=309&VName=PQD

Cole, M. S., Field, H. S., & Harris, S. G. (2004). Student learning motivation and psychological hardiness: Interactive effects on students' reactions to a management class. *Academy of Management Learning & Education, 3*(1), 64-85.

Cormode, G., & Krishnamurthy, B. (2008). Key differences between Web 1.0 and Web 2.0. *First Monday. 13(6), June 2, 2008.* Retrieved June 30, 2011, from http://firstmonday.org/htbin/cgiwrap/bin/ojs/index.php/fm/article/view/2125/1972

Downes, S. (2005). E-Learning 2.0. *National Research Council of Canada Elearn Magazine.* Retrieved November 10, 2009, from http://www.elearnmag.org/subpage.cfm?article=29-1&section=articles

Engelbrecht, J., & Harding, A. (2004). Technologies Involved in the Teaching of Undergraduate Mathematics on the Web. *Journal of Online Mathematics and its Applications.* Retrieved August 2, 2011, from http://science.up.ac.za/muti/technologies.pdf

Hodson, J. (2008). *A tangled web: Public reason, web 2.0 and a new definition of action for participatory technologies.* (M.A. MR45943), York University (Canada), Canada. Retrieved from http://proquest.umi.com/pqdweb?did=1672517351&Fmt=7&clientId=1846&RQT=309&VName=PQD

Hossain, M. M., & Wiest, L. R. (2011). Web 2.0 Technologies in Building Collaborative Teaching-Learning Environments for Middle School Geometry Instruction *Proceedings of Global TIME 2011* (pp. 73-76). Chesapeake, VA: AACE.

Kear, K. (2004). Peer learning using asynchronous discussion systems in distance education. *Open Learning, **19***, 151–164.

Maddux, C. D., Liu, L., & Johnson, L. (2008). Web 2.0: On the cusp of a revolution in information technology in education? *Computers in the Schools, 25*(3-4), 159-162.

Malhiwsky, D. R. (2010). *Student Achievement Using Web 2.0 Technologies: A Mixed Methods Study.* (Doctoral Dissertation), University of Nebraska, Lincoln, Nebraska. Retrieved from http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1057&context=cehsdiss

McConnell, D. (1999). Examining a collaborative assessment process in networked lifelong learning. *Journal of Computer Assisted Learning, 15*, 232-243.

McGee, P., & Diaz, V. (2007). Wikis and Podcasts and Blogs! Oh, My! What is a faculty member supposed to do? *EDUCAUSE Review, 42*(5), 28-41.

Musser, J. (2006). *Web 2.0 Principles and Best Practices*. Sebastopol, CA: O'Reilly Radar.

O'Reilly, T. (2005). *What is Web 2.0: Design patterns and business models for the next generation of software* Retrieved February 16, 2010, from http://www.oreillynet.com/pub/a/oreilly/tim/news/2005/09/30/what-is-web-20.html

O'Reilly, T. (2006a). Web 2.0: Compact definition: Trying again. Retrieved from http://radar.oreilly.com/2006/12/web-20-compact-definition-tryi.html

O'Reilly, T. (2006b, October 20). Web 2.0: Compact definition: Trying again. Retrieved from http://radar.oreilly.com/2006/12/web-20-compact-definition-tryi.html

O'Reilly, T. (2009). The war for the Web. *IT Conversations.* Retrieved October 30, 2010, from http://itc.conversationsnetwork.org/shows/detail4317.html

Papastergiou, M. (2009). Digital game-based learning in high school computer science education: Impact on educational effectiveness and student motivation. *Computers and Education, 52*(1), 1-12.

Purushotma, R. (2006). *Communicative 2.0: Video games and digital culture in the foreign language classroom.* (Master's Thesis), Massachusetts Institute of Technology, Massachusetts - United States. Retrieved from http://www.lingualgamers.com/thesis/

Ramirez, E. (2008). How to Solve Our Problem with Math.U.S. *News and World Report.* Retrieved December 4, 2009, from http://www.usnews.com/articles/education/high-schools/2008/12/04/how-to-solve-our-problem-with-math.html

Ryan, S. (2001). Is online learning right for you? *American Agent & Broker, 73*(6), 54-58.

Solomon, G., & Schrum, L. (2007). *Web 2.0 new tools, new schools.* Washington, DC: International Society for Technology in Education.

Thomas, D. A., & Li, Q. (2008). From Web 2.0 to Teacher 2.0. *Computers in the Schools, 25*(3-4), 199-210.

Tüzün, H., Yilmaz-Soylu, M., Karakus, T., Inal, Y., & Kizilkaya, G. (2009). The effects of computer games on primary school students' achievement and motivation in geography learning. *Computers and Education, 52*(1), 68-77.

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. *In Proceeding of the 17th International World Wide Web Conference* (pp. 705-714). Beijing, China: ACM.

Wuensch, K. L., Aziz, S., Ozan, E., Kishore, M., & Tabrizi, M. (2006). Pedagogical Characteristics of Online and Face-to-Face Classes. In T. Reeves & S. Yamashita (Eds.), *Proceedings of World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education 2006* (pp. 2422-2429). Chesapeake, VA: AACE.