Building Web 2.0-Based Collaborative Environments for Teaching-Learning High School Geometry

Md. Mokter Hossain
University of Nevada, Reno
E-mail: mokter@unr.edu

Dr. Lynda R. Wiest
University of Nevada, Reno
E-mail: wiest@unr.edu

Abstract: The NCTM encourages teachers and students to use advanced features of technology to broaden and deepen their mathematics understanding. Web 2.0 is a newly developing technology that offers rich possibilities for building collaborative environments in mathematics instruction. Participating students, teachers, and experts all over the world can use this emerging technology to build a collaborative mathematics learning website. Most high school geometry teachers and students likely have sufficient computing knowledge to build such collaborative environments using the interactive features of Web 2.0 technologies. This paper addresses the interactive features of Web 2.0 technologies, the feasibility of using Web 2.0 technologies in teaching-learning high school geometry, and a Web 2.0-based collaborative model for a high school geometry class.

Introduction

Technology is included as an important principle in the National Council of Teachers of Mathematics' (NCTM; 2000) *Principles and Standards for School Mathematics.* Highlighting the importance of technology in teaching-learning mathematics, *Principles and Standards* encourages teachers and students to use technology to broaden and deepen their mathematics understanding. The NCTM notes, "When technological tools are available, students can focus on decision making, reflection, reasoning, and problem solving" (p. 24). It recommends, "In mathematics-instruction programs, technology should be used widely and responsibly, with the goal of enriching students' learning of mathematics" (p.25). According to *Principles and Standards*, with appropriate use of technology students can better understand the underlying meaning of mathematics and learn mathematics more easily. Technology can enrich students' range and quality of mathematical investigations by providing a means for viewing mathematical ideas from multiple perspectives (NCTM, 2000).

Two- and three-dimensional shapes, mechanical compasses, protractors, geoboards, graphing calculators, and dynamic geometry software are popular tools for geometry instruction. These tools allow students to engage in hands-on and investigative learning. For instance, students might manipulate various rectangles to identify their common and unique properties. Moreover, using dynamic geometry software, such as Geometer's Sketchpad, Cinderella Geometry, or Cabri Geometry, and other stand-alone or web-based mathematics applications, students may explore and thus become familiar with families of geometric objects. These technologies allow students to investigate more varied and sophisticated models. The NCTM (2000) notes, "Using technology, students can generate many examples as a way of forming and exploring conjectures" (p. 41).

This paper discusses the use of Web 2.0 in high school geometry instruction. Specifically, it addresses the interactive features of blogging technology, the feasibility of using blogs in teaching and learning geometry, and a proposed model for creating a collaborative environment for using blogs in a high school geometry class.

What is Web 2.0?

"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" (O'Reilly Radar Team, 2007, p. 12). 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 transitions users from static HTML Web pages to more dynamic Web pages 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).

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, and it allows users to use 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, Hi5, LinkedIn, MySpace, Nexopia, Twitter, YouTube, Wikipedia, and so forth, are the successful implementation of new-generation Web 2.0 technology. Almost all of these emphasize no-cost online collaboration, social collaboration, and resource sharing among users.

Interactive Features of Web 2.0 Technologies

Web 2.0 is a collaborative Web development platform (O'Reilly & Battelle, 2004) that allows users to develop user-centered, participatory Web applications to add, control, and share information interactively, simultaneously, and interoperably, accessible entirely through a browser from anywhere with an Internet connection. Web 2.0 enables users to create, share, consume, revise, and extend data from multiple sources and exercise control over that data (O'Reilly, 2006). Accordingly, Web 2.0 includes additional Web-based features beyond traditional Web 1.0 tools, allowing users to use and customize information to suit their needs. Web 2.0 applications are those that make the most of the intrinsic advantages of the Web 2.0 platform. Building Web 2.0 applications improves as more people work together to use them (O'Reilly, 2006).

Other improved functionality of Web 2.0 involves openness and harnessing, remising, and freely controlling data, offering vastly new possibilities. Users can own the data on a Web 2.0 site and exercise control over that data (O'Reilly, 2005). Web 2.0 tools allow users to add their own content with few or no rules or restriction. Users can not only retrieve information but also enhance applications as they use them. A Web 2.0 site allows users to interact with each other or to change website content simultaneously from any location. It enables the Web to shift from being a medium in which information is transmitted and consumed into being a platform in which content is created, shared, remixed, repurposed, and distributed (Downes, 2005).

Blogging is an easy but powerful Web 2.0 tool. Blogs allow users to create and publish web pages that share personal and anecdotal information with others (Richardson, 2006). A typical blog contains text, images, and links to other web pages, blogs, and content related to the topic. Creating and editing most blogs is free and relatively easy and fast, requiring only basic computing knowledge rather than programming knowledge. High school teachers and students typically have enough computing knowledge to build and maintain blogs for their academic and personal purposes. Thus, blogging could be an appropriate tool for creating collaborative high school geometry teaching-learning environments.

Feasibility of Using Web 2.0 Technologies in Teaching-Learning High School Geometry

Distance education has been one of the fastest growing trends in educational technology in the past several decades (Gu, 2006; U.S. Department of Education, 2009). Distance education has improved in recent years by enabling distant learners to participate in collaborative, Web-based discussions (Jones, Golann, & Vollmers, 2006; Zhang & Kenny, 2010). Flexible schedules, electronic classrooms, and abundant study materials available online have made Web-based learning popular among students and teachers (James, 2002; Su, Bonk, Liu, & Lee, 2005). Consequently, online learning has diminished face-to-face learning as the main medium for gaining knowledge and information (Nikolov, 2007). A meta-analysis of evidence-based practices in online learning showed that, on average, students of online learning performed better than those with face-to-face instruction (U.S. Department of Education, 2009).

Web-based classes are offered mainly at the higher education level. In 2004-05, 5% of middle schools and 39% of high schools had students enrolled in technology-based distance education programs (Institute of Education Sciences, 2009). More than one million K-12 students were projected to take online courses in the 2007–08

academic year (Picciano & Seaman, 2007). By fall 2007, 28 states had online virtual high school programs (Tucker, 2007). K-12 schools have lagged behind higher education and corporate training in the movement toward online learning because policy makers lack scientific evidence on the effectiveness of emerging alternatives to face-to-face instruction (U.S. Department of Education, 2009). Further, the lack of natural interaction between online instructors and class members poses challenges and shortcomings for students and instructors (Belanich, Wisher, & Orvis, 2004; Dong, Xu, & Lu, 2009). However, the interactive learning tools that can engage and stimulate students more than in a face-to-face classroom can compensate for the absence of direct interaction between teachers and students and is thus gaining support from students and educators (Dong, Xu, & Lu, 2009).

Web 2.0 could provide effective ways to help students discuss and explore geometry topics. Most high school teachers likely have sufficient computing knowledge to learn how to develop and maintain blogs in their school or on a free server. If not, computer teachers or other school district professionals can arrange short training sessions to teach high school teachers the necessary skills for this rather simple application. School district or state education agencies could also supply demonstrative CDs or DVDs to schools to show teachers how to develop and maintain blogs. Many videos on the Internet also serve this purpose. Thus, it is relatively easy for high school teachers to learn how to develop and maintain blogs.

A Web 2.0-based Collaborative Model for High School Geometry

Blogging can be an appropriate tool for building a collaborative teaching-learning environment for a high school geometry class. A high school geometry teacher can develop a blog to upload carefully selected problems for students to discuss in and out of class. Before starting the activity, the teacher needs to divide the class into several groups based on the number of students in the class and the number of problems, topics, or chapters to be included in the activity. The teacher can then develop a blog free on a server such as Google or WordPress and post group members' names and instructions for the blogging activity. Student groups might be named and assigned specific tasks according to the topic or chapter to be discussed. For example, a high school geometry teacher who wants to give more focus to geometric shapes and their measurement could divide the class into six groups as follows:

- Polygons Group
- Circles Group
- Polyhedrons Group
- Non-polyhedral Solids Group
- Perimeter and Area Group
- Surface Area and Volume Group

In addition to teaching the above topics in class, the teacher posts a set of relevant problems in the blog. Every group member for a designated topic is asked to post two or three complete solutions to each problem. Students from other groups are asked to read, verify, and comment briefly on two solutions. Based on the nature and depth of the topic, the teacher can allocate two or three weeks to complete a phase. For instance, the teacher might post a problem set on the blog. Students of the relevant group might be given ten days to post complete solutions to two problems each. Then the entire class might have five days to verify and comment on the solutions. Now the assigned group has the chance to revise, correct, or update their previous responses. By this time, every student in the class will have had the opportunity to read and comment on their own and other classmates' responses. The teacher might further discuss particularly efficient or creative solutions in class. Thus, in a two- to three-week period the teacher can orchestrate discussion of a topic with active participation of the entire class.

Similarly, at some point during another topic or chapter, the teacher can start another phase of the blogging activity for another group by posting a set of problems in the same fashion discussed above. During this blogging activity, students are expected to verify their conjectures about various geometric shapes and to share, justify, and critique problem solutions. They might develop broader, class-inclusive thinking, as well as enhanced collaboration skills. For example, upon reading and comparing the findings, students might notice that rectangles have congruent diagonals that bisect each other and rhombuses have diagonals that bisect each other perpendicularly. Once a student learns something new or important and uploads that information on the blog, others can investigate the idea further in order to justify it. Students are likely to learn new ways of looking at concepts and solving problems. Thus, once group members explore an idea or strategy and publish it on the blog, it is anticipated that all or most participants will personally acquire and retain the concepts discussed.

Nature, Benefits, and Limitations of the Proposed Model

This model uses several phases of technology integration. In the first or *planning phase*, the teacher plans the basic structure of the model, including evaluation methods, and divides the class into working groups. In the second or *initiating phase*, the teacher develops a blog with any related technical components and usage guidelines. In the third or *designing phase*, the teacher chooses problems that are appropriate for uploading to and solving and discussing on the blog. With many blogging sites, it might not be possible for students to post solutions of problems that require graphs, images, or construction tools. Thus, the teacher needs to select problems carefully. In the fourth or *implementing phase*, participants complete the tasks described earlier in this paper. Finally, in the *evaluation phase*, the teacher applies evaluation criteria established at the beginning of the project to assign student grades.

This model has several potential benefits. Working in groups may motivate students to explore, discuss, and share research knowledge and findings with classmates. These kinds of collaborative activities are useful for high school geometry teachers to help students analyze properties and attributes of two- and three-dimensional objects, explore relationships among shapes, discuss geometric transformations, and solve geometry problems related to real-life situations. Teachers and students can locate additional resources for the topic, such as other blogs and websites, and place the links to these resources on the blog. Geometry teachers can start multiple blogs to continue ongoing discussions to prepare students for mathematics assessments and competitions that are local to international in scope. They can record and publish full or partial class activities and podcasts on the school's or a free server so students can access this information repeatedly at their own pace until they understand a concept clearly.

Online publishing could be a good opportunity for students and teachers to publicly share their knowledge and perspectives. Participation in collaborative learning activities might enable students to disseminate their ideas among each other more readily than in traditional classroom discussions. Once participants see that their texts and opinions are available online, they might be more enthusiastic to post solutions or comments more often or more thoughtfully. Once group members finalize key ideas about their specific task component, they may gain the confidence to continue further discussion or participate more in other groups or blogs within and outside of the class. As the teachers and students participate in such activities in more classes they will be more familiar in it.

At first, this activity may seem complicated to some students. However, it becomes easy to understand and use rather quickly. Some students may have limited access to the Internet, but teachers can help students know where and when to have computer access at school, local libraries, and elsewhere. In sum, blogging could be a crucial tool for high school teachers and students to create and participate in virtual collaborative groups to discuss school geometry topics. Ultimately, blogging activities could motivate young students toward higher study in geometry, the arts, engineering, and architecture. Participation in these activities may also encourage students to continue to take advantage of educational opportunities via the Web and thus engage in lifelong learning.

Conclusions

Geometry is an important area of mathematics study from the early grades on, especially for the high school grades, and it is used widely in real-life situations. However, the topic can be challenging for many students. In the past, a variety of static technology tools have been popular and widely used in geometry classrooms. In recent decades, more sophisticated technologies, such as dynamic geometry software, have been a powerful engine in mathematics instruction. Computer-Based Instruction (CBI), stand-alone applications, and traditional Web-based instruction have been popular in the mathematics classroom. However, these can be costly and may require high-speed Internet or computer systems, thus making these options affordable only in developed countries. As a result, many students, teachers, and classrooms in the world cannot readily incorporate technology into mathematics education.

In this era of WiFi and handheld mobile devices with Internet connections, Web 2.0 technologies could offer valuable and practical possibilities for building collaborative teaching-learning environments for high school geometry. The openness, interactivity, and interoperability features of Web 2.0 technologies could enable high school geometry teachers to engage students collaboratively in sophisticated areas of the subject matter. They might, for example, develop blogs for uploading homework problems for the class to solve.

Due to the inclination of the young generation, both students and teachers, to use Web 2.0 technologies in their personal lives, it is assumed that traditional geometry instruction in the static mode is not sufficient to meet the needs of today's students. Web 2.0 technologies have already started to be adopted in the fields of computer science, engineering, business, language, journalism, and the medical sciences. It is time to use the interactive and impressive features of emerging Web 2.0 technologies for learning high school geometry, which is the gateway to higher studies in art, architecture, engineering, and many other important fields. This may engage today's youth to a greater degree in school learning and capitalize on their existing knowledge and skills outside of school by applying it to the mathematics classroom.

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