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Collaborative Middle School Geometry Through Blogs and Other Web 2.0 Technologies

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This paper explores the use of blogs, a simple application of Web 2.0 technologies, in middle school geometry instruction. Specifically, it provides an overview of the interactive features of Web 2.0 technologies and the feasibility of using Web 2.0 technologies in geometry teaching and learning, as well as a proposed model for creating a collaborative environment using a blog, a free and simple Web 2.0 application in geometry instruction. Incorporation of Web 2.0 technologies into today's classrooms builds on student interests and knowledge. Further, the interactive nature of these technologies lends itself well to collaborative learning, which motivates students, creates a "safer" learning environment, and enhances knowledge and skills.

Technology has been a powerful engine in mathematics teaching and learning over the past few decades throughout the world. In the United States it is included as one of six principles in the National Council of Teachers of Mathematics' (NCTM; 2000) *Principles and Standards for School Mathematics*. The NCTM encourages teachers and students to use technology to broaden and deepen their mathematics understanding. It states, "In mathematics-instruction programs, technology should be used widely and responsibly, with the goal of enriching students' learning of

mathematics" (p. 25). The NCTM maintains that appropriate technology use helps students learn mathematics by affording an opportunity, for example, to examine a broad range of visual models and dynamic transformations.

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).

The NCTM (2000) envisions that all students should have access to technology-enhanced mathematics learning facilitated by a skilled teacher. Web 2.0 is a new development of the Internet services available on the World Wide Web that allows Internet users to collaborate and share Web information actively (O'Reilly, 2005). The interactive and emerging features of Web 2.0 technologies could enable geometry teachers and students to build collaborative learning environments inside and outside of the classroom. 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 desktop computers, laptops, netbooks, mobile phones, PDAs, and similar devices (Ramirez, 2008).

This paper explores the potential use of Web 2.0 in secondary geometry instruction. Specifically, it provides an overview of the interactive features of Web 2.0 technologies and the feasibility of using Web 2.0 technologies in teaching and learning geometry before proposing a model for creating a collaborative environment using a blog, a simple application of Web 2.0 technologies, in geometry instruction.

WHAT IS A WEB 2.0 TECHNOLOGY?

"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, p. 4). 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 that 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 that allows Web users to accept information passively, Web 2.0 allows Web users to accept and modify Web information actively.

INTERACTIVE FEATURES OF WEB 2.0 TECHNOLOGIES

Web 2.0 is a collaborative Web development platform that involves cumulative information production and development of applications, which has changed the types of benefits users gain from the Web (O'Reilly, 2005). It allows users to develop user-centered, participatory Web applications to add, control, and share information interactively. Compared with traditional Web 1.0 development tools, Web 2.0 includes some additional features that are accessible to users entirely through a browser located anywhere, connected to the Internet via personal computer or handheld mobile devices (O'Reilly, 2009). Social-networking tools such as blogs, wikis, and podcasts are popular Web 2.0 applications that provide Web hosting, audio-video sharing, social collaboration, and many more Web-based applications and services. They permit free online collaboration, social connections, and resource sharing among users.

Blogs allow users to create and publish Web pages that share personal or 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. Wikis allow users to create and easily edit material with any number of interlinked Web pages using a traditional Web browser (Alexander, 2006). Podcasts allow users to publish audio and video recordings on the Web and to download them through such devices as mobile phones, iPods, netbooks, laptops, and desktops (Richardson, 2006). Social-networking sites are Web 2.0-based applications that allow users to share personal information with each other conveniently. Social-networking sites build and maintain social relations and interaction among people with similar interests. They enable users to share ideas, opinions, activities and events, and interests within their individual networks over the Internet. Facebook, Hi5, LinkedIn, MySpace, Nexopia, Twitter, and YouTube are some successful applications of social-networking 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 (for example, in chat rooms) as well as view provided information passively. The dynamic features of Web 2.0 allow users to interact with each other and to change Web site content jointly over time. 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 contents. Web 2.0 users also become able to develop, share, and enhance their knowledge and thinking through interactions with other users.

Web 2.0's improved functionality in features such as openness, customization, and freedom of control over data has led to significant advances compared with the traditional Web development approach. Web 2.0 tools allow users to add their own content with few or no restrictions, encouraging them to contribute material in addition to retrieving it. 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 Web site 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 being a platform where content is created, shared, remixed, repurposed, and passed along (Downes, 2005). Creating and editing most Web 2.0 applications is free and relatively easy and fast, requiring only basic computing knowledge rather than programming knowledge (Solomon & Schrum, 2007).

FEASIBILITY OF USING WEB 2.0 FOR GEOMETRY TEACHING AND LEARNING

Development of 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 was improved in recent years by enabling distance learners to participate in collaborative discussion through Web-based activities (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 et al., 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 (U.S. Department of Education, 2009) showed that, on average, students of online learning performed better than those with face-to-face instruction.

Web-based classes are offered mainly at the college and university levels. 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 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 instructors and class members online poses challenges and shortcomings for students and instructors (Belanich, Wisher, & Orvis, 2004; Dong, Xu, & Lu, 2009). Thus, interactive learning tools that may engage and stimulate students more than in a face-to-face classroom, which can compensate for the absence of direct interaction between teachers and students, are gaining support from students and educators (Dong, Xu, & Lu, 2009).

The emergence of Web 2.0 technologies and increased Internet access through desktop, laptop, and netbook computers, as well as cellular and handheld devices, has led to enhanced interest in exploring their potential use in K-12 teaching and learning. Increased access to and use of electronic classrooms, Web 2.0-based interactive applications, and contemporary Web-based conferencing tools are changing the ways students learn and teachers teach (Greenhow, Robelia, & Hughes, 2009; Lee, 2007; Tammets, Tammets, & Laanpere, 2009). Educators and students now seek to have "any time, any place, any path, any pace" learning opportunities (NASBE Study Group on e_Learning, 2001, p. 4).

Research shows that young students spend more time with computer, Internet, and mobile phone use than any other age group. A 2008 British study found that 94% of British teenagers had Internet access at home and school; 92% owned or had access to a mobile phone, 88% a computer with 29% an additional laptop, 69% an iPod/mp3 player, 73% a game console device, 40% a standalone digital camera, and 10% a video camera (Clark, Logan, Luckin, Mee, & Oliver, 2009). Another research report commissioned by the British Educational Communications and Technology Agency (BECTA) found that teens had high levels of access to the Internet and many technologies that support Web 2.0: 98.4% had access to a computer;

96.6% had access to the Internet; 74% had at least one social network site account; and over 50% had shared pictures, video, or music in the last week of the survey (Luckin et al., 2008). By that time more than 71% of American teens had mobile phones with an Internet connection (Lenhart, 2009).

Teens spend more time on the Internet for gaming, instant-messaging, file and photo sharing, and social communicating than on studying or information searching (Clark et al., 2009; Selouani & Hamam, 2007). They participate in Web 2.0-based activities as authors and consumers of content from file sharing to online gaming and writing on blogs (Boyd, 2007; Lenhart & Madden, 2007; Richardson, 2006). One survey showed that "35% of all teens do blogging, 54% post photos online, 19% post videos, 39% share their own artistic creations online, 26% remix content, 27% maintain personal Web pages, 28% have their own blogs" (Ivanova, Ivanova, & Smrikarov, 2009, p. 4). Clark et al. (2009) found that young students surf about 30 social-networking sites. Most use these sites in and out of school for social communication; only a few, however, use them for academic purposes. This might be because schools or students are unaware of the educational advantages of using social-networking sites and social-networking tools. Young students enjoy the benefits of getting multiple resources from the Web (Douma, Ligierko, & Romano, 2009).

Collaboration is a fundamental feature of Web 2.0 technologies (Anderson, 2007; Boulos & Wheeler, 2007; Cash, 2010; O'Reilly, 2006). It is an important component for success in Web-based environments (Boulos & Wheeler, 2007). Kear (2004) asserts that students "can ask others for help in understanding a concept which they find difficult, or tackling a particular problem" (p. 152) and that peers tend to be quite willing to respond. Studies also find that the implementation of specific Web 2.0 technologies enhance student learning and collaboration (Cormode & Krishnamurthy, 2008; McGee & Diaz, 2007; Purushotma, 2006; Safran, Helic, & Gütl, 2007; Thomas & Li, 2008; Ullrich et al., 2008). Web 2.0 technologies improve students' learning, writing abilities, and satisfaction with the course, as well as their interaction with faculty and with other peers (Ajjan & Hartshorne, 2008). Active participation and collaborative learning continually emerge as major pedagogical attributes of Web 2.0 technologies. The Web 2.0-based learning environment fosters collaboration among students and faculty, and it allows students to create and share new knowledge among their peers (Ajjan & Hartshorne, 2008).

Researchers have shown that use of collaborative activities leads to improved knowledge acquisition compared to instruction delivered through non-collaborative activities (Bonk & Wisher, 2000; Soller & Lesgold, 2000). Collaborative learning can help young learners advance their ZPD

(Zone of Proximal Development), the area between a learner's independent problem-solving ability and his or her potential for solving problems under the guidance of an expert or in collaboration with more capable peers (Vygotsky, 1978). Vygotsky (1978) holds that knowledge does not preexist in the world but is constructed first socially and then absorbed by young learners individually. Accordingly, collaborative work with Web 2.0 technologies can help young learners advance their knowledge and skills. Thus, it has become a recent quest to understand what young learners do with the emerging features of Web 2.0 technologies, and how technology use and Web 2.0 activities could be incorporated into classroom instruction.

A COLLABORATIVE MODEL USING A WEB 2.0 TECHNOLOGY FOR MIDDLE SCHOOL GEOMETRY

A blog is a standard example of a Web 2.0 application (Maddux et al., 2008). Blog use is free and relatively easy and fast, and it requires only basic computing knowledge (Solomon & Schrum, 2007). Due to the rapid growth of the Internet and mobile Web usage, it is expected that blogs will be one of the fastest growing Web 2.0 applications for mobile Internet users over the next few years (Kairer, 2009). Blogs offer unlimited possibilities for building collaborative teaching-learning environments for middle school geometry. The openness and collaborative and interoperability features of blogging technology enables teachers to engage students in working together in sophisticated areas of school geometry. Many middle school students and teachers typically have enough computing knowledge to build Web 2.0 applications to foster their mathematical knowledge (Solomon & Schrum, 2007). However, if needed, they can be trained to learn the process in a few hours or days. A blog can provide excellent ways to help students discuss and explore geometry topics. Thus, a blog can be an appropriate tool to evaluate the possible usage of other Web 2.0 technologies.

WordPress is an open source blog-publishing service that has been in use almost a decade. It allows anyone to create a blog without paying a registration or annual license fee. It has a Web template system that allows considerable customization (Mullenweg, 2003). WordPress is widely used for developing personal and commercial blogs; however, it has started to get the attention of students, teachers, educators, and researchers to be used for teaching and learning purposes (WordPress.org, 2011). Edmodo is another free and secure social learning network that is compatible with teaching-learning purposes. Edmodo's user interface is similar to Facebook. It has built-in security features that give teachers privacy controls over their

virtual classrooms (Carta, 2011). Using Edmodo, teachers can post messages, discuss classroom topics, and assign and grade homework. Students can then submit the homework and view their grade (Waters, 2011). A number of U.S. school districts are now promoting Edmodo for classroom use (Edmodo.com, 2011).

A sample Web 2.0-based activity for a middle school geometry class might involve in-depth discussion of the topic *Quadrilaterals*. This activity describes potential use of a blog, a simple Web 2.0 application. In this activity, the teacher prepares the class for exploring common and unique characteristics of different types of quadrilaterals: *parallelograms*, *rectangles*, *squares*, *rhombuses,* and *kites*. The project is initiated locally in a single class with approximately 20 students under the supervision of the class teacher. The teacher divides the class into five groups of four students each. She or he then creates a free blog on a free server such as Google or WordPress and adds students' email addresses or invites students to the blog address. Each group has a leader responsible for initiating the process and maintaining communication with the teacher and other group members. Group leaders also maintain good interpersonal relations within their group. Groups might be named and assigned specific tasks. For example, each of the following groups might be asked to research and explore the common and unique characteristics of their assigned two-dimensional shape as a type of quadrilateral:

- Parallelograms Group
- Squares Group
- Rectangles Group
- Rhombuses Group
- Kites Group
  (Trapezoids might also be added.)

To initiate this activity on a free blog such as WordPress.com, teachers first need to form small groups of students to work together on specific topics. For instance, a middle school geometry teacher might form several study groups for discussing important or sophisticated topics that he or she wants to explore more extensively so that students can clarify and deepen their understanding. Hossain and Aydin (2010) called these groups *iGroups* to reflect the interactive and dynamic nature of working together using Web 2.0 technologies such as blogs, wikis, and podcasts. An iGroup may pursue a topic for a long time even after the teacher covers a chapter or topic. Students may be more motivated to join and study in such a group if they are using a blog or other new technology instead of simply writing on paper (Solomon & Schrum, 2007). If someone outside the class requests to be a

member of a group, teachers can add or reject the request based on the nature of the activity.

A well-planned project requires several phases. Each phase might take several days to weeks, based on the intention of the class teacher. In the first phase the groups individually research and collect information about their task. In the second, they publish their findings on the blog. In the next phases they read and share all other groups' findings on the blog, and they offer comments and explanation about others' or their own findings. This time they have the chance to correct, modify, or change their own group's findings based on the discussion of their work. In the last phase the groups publish their summarized outcomes on the blog. Thus, by the end of the project, participants should learn the common and unique characteristics of the five types of quadrilaterals noted.

Participants are expected to verify their conjectures about various geometric shapes and their properties. They might develop broader, class-inclusive thinking. For example, the Squares Group might notice that squares are a subset of both rectangles and rhombuses but with perpendicular, congruent diagonals. Upon reading and comparing the findings of the Rectangles Group and Rhombuses Group, 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. 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 MODEL

This model requires five phases of technology integration. In the first or *planning phase*, the teacher plans the basic structure of the model and chooses a content area. In the second or *assessing phase*, the teacher administers an assessment survey to determine student needs related to the project. In the third or *designing phase*, the teacher structures a project-based assignment that includes tasks, appropriate online tools, and student groups that will address designated aspects of the topic. In the fourth or *implementing phase*, participants complete their first task effort collaboratively. In the fifth and final phase, the *integrating phase*, students update, correct, replan/recollect, and upload final findings on the blog or other shared-information tool.

This model represents an online version of project-based cooperative learning. It is a conceptual approach to curriculum. At first, it may seem to be complicated. However, it becomes easy to understand and use rather quickly. Communication among participants takes place most readily through use of computers with Internet connections. However, mobile phones and other portable devices with Internet connections may also be used.

This model has many benefits. Working in groups may motivate students to explore, discuss, and share research knowledge and findings with classmates. Blog-based collaborative learning enables students to disseminate ideas among each other more readily than in traditional classroom settings. Once group members determine key ideas about their specific task component, they may ultimately gain the confidence to continue further discussion or participate in other groups or blogs. This could be a great opportunity for first-time participants as well as classroom teachers to share their voices and perspectives in a "print" public forum. As more students participate in online discussion on important geometry topics and take the opportunity to publish their voice using Internet media, the depth and breadth of their mathematics study may increase.

These kinds of collaborative activities are useful for secondary geometry teachers to help students analyze properties and attributes of two-and three-dimensional objects, explore relationships among shapes, discuss geometric transformations, and solve real-world geometry problems. Teachers and students can locate additional resources for the topic, such as other blogs and Web sites, and place the links to these resources on the blog. Most importantly, geometry teachers can start multiple blogs to continue ongoing discussion to prepare students for mathematics assessments and competitions from local to international in scope. Geometry teachers can record and publish full or partial class activities and podcast that on a free server so that students can access this information again and again until they understand a concept clearly at their own pace.

Perhaps the most important advantage of this activity is that geometry teachers can motivate students to use time outside of class or school to participate in discussions. Students who have Internet access through their own or their parents' mobile phones and other handheld devices can take part in blog discussions while they are on the school bus, in the family car, or at a shopping mall. When a student needs more information or clarification about a topic, he or she can send a message to the teacher's cellular device. The teacher can respond to the student's inquiry privately or in the appropriate group discussion. Of course, the teacher should monitor group discus-

sions and occasionally pose thought-provoking questions and provide clarifications on his or her own but without being too leading.

It should be noted that the proposed model has some limitations. One major potential issue is that schools and school systems, especially in rural areas, may not provide students with access to computers that have an Internet connection. Even if they do, students may not have Internet access at home. Further, some parents might be reluctant to allow their children to use the Internet at home or in school. If the issue is at the school level, teachers who seek to use Web 2.0 applications for educational purposes will have to seek ways to bring appropriate technologies to their school. Besides seeking needed financial resources to do so, teachers may have to educate school staff and families on the substantial teaching and learning benefits that these technologies afford. At the individual level, teachers may have to help individuals who do not have Internet access to secure such access through means such as school use outside of class hours or use of free public computers with Internet access provided at local libraries, community centers, youth organizations, or the homes of community volunteers. Teachers may also have to educate parents on the educational benefits of this instructional medium and provide suggestions for safeguarding their child when using the Internet. Another potential problem is that unlike WebCT and selected other technology applications, the traditional blog does not allow end users to use construction tools or upload images and graphs. To avoid this problem, geometry problems requiring construction should be avoided in blogging activities. Finally, in the free blogs students may encounter problems with using mathematics symbols. MathJax and other Java applets might be recommended to convert plain text into display mathematics. However, this might create difficulty for some novice users. Thus, students must be taught to use these applets, or to avoid this problem, end users can be asked to type in mathematics formulas in plain text format, such as: (a + b)^2 = a^2 + 2ab + b^2; Area of a circle is: A = PIxr^2.

Teachers might review and compare the features of other Web 2.0 applications, such as Facebook, Google Docs, and Zoho, for geometry instruction. Although the Facebook interface is more suitable for social interaction, a group account in Facebook allows users to upload images, diagrams, and pictures required for geometry study. Google Docs allow students and teachers to create documents online and include mathematical symbols, diagrams, and pictures using Web or local programs. Google Docs can provide an alternative tool for geometry and other mathematics subjects that allows students to create reports and portfolios online, submit assignments to their teacher, and share work among group members. This can help with teacher

record-keeping. Zoho, a Web-based online office suite that contains almost all of the applications and features of the Microsoft Office program, can be used for similar purposes. Once a number of teachers and students start using Web 2.0 applications and draw attention to potential limitations, Web 2.0 developers will likely respond by developing solutions in the near future.

CLOSING COMMENTS

Geometry is an important area of mathematics study from the early grades on, and it is used widely in real-life situations. However, the topic can be challenging for some students. Dynamic geometry software and various static technology tools have been popular and widely used in geometry classrooms for decades. However, due to students' and younger teachers' current trend toward use of Web 2.0 technologies via computers and handheld devices, traditional geometry instruction is likely insufficient to satisfy student needs. Thus, our technological world demands that technology be used in dynamic, flexible, and interactive ways to build collaborative environments inside and outside the classroom in order to strengthen geometry learning.

Web 2.0 technologies have already started to be adopted in the fields of technology, engineering, business, language, journalism, and the medical sciences (Lemley & Burnham, 2009). Thus, it is time to utilize the interactive and impressive features of emerging Web 2.0 technologies for learning middle school geometry, which is the gateway to high school and higher studies in art, architecture, engineering, and many other fields. Web 2.0 technologies are likely to motivate today's youth, who are more interested in new technologies than existing learning aids that have served geometry instruction in the past. 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.

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