

Teacher Educators and Elementary Math Instruction: Two Technology “Novices” Use *Free* Technology in A Teacher Preparation Program

Angela L. Snyder, PhD

Lisa H. Pallett, MS

Notre Dame of Maryland University
United States of America

Abstract

This article describes the use of wikis, blogs, Google docs and virtual manipulatives to teach differentiated mathematics in an Elementary Math Methods course, differentiation techniques in a Special Education Methods Course, and for group collaboration in a Research Methods course. Two technology novices used an action research model to investigate the use of free technology in a college classroom to engage teacher candidates and integrate readily available technologies that could help them reach all abilities of learners in an inclusive classroom.

Keywords: wiki, blog, Google doc, virtual manipulatives, technology integration, math instruction

Introduction

In today’s technology driven society, teacher preparation programs face the challenge of developing teacher candidates that can keep up with K-12 students that are tech savvy and very comfortable with technology at a young age. These teacher candidates, sometimes young and technology savvy themselves (and sometimes not), come to class to learn techniques that can help them motivate their students and manage the vast array of abilities in the classroom. A number of studies have demonstrated the beneficial impact of technology integration on student engagement (Chen, Lambert, and Guirdy, 2010; Laird and Kuh, 2005; Ringstaff and Kelly, 2002), motivation (Wang and Reeves, 2007; Gabrielle, 2003), differentiation of instruction (Colombo and Colombo, 2007; Herzog and Klein, 2005) and achievement (Judge, 2005; Middleton and Murray, 1999). These studies taught us “technology challenged” teacher educators that we needed to use readily available technology to prepare our teacher candidates to meet the challenge of teaching students who use technology on a regular basis. Even most “at risk” students have access to computers and the internet (Technology Counts, 2007); therefore, guided by principles of Universal Design for Learning, we developed teaching strategies using free and publically available technology to prepare teachers to reach all students.

Methods

This article describes the use of wikis, blogs, Google docs and virtual manipulatives that were used to teach mathematics in an Elementary Math Methods course and a Special Education Methods course. The use of Google docs in a Research Methods Course for group collaboration will also be discussed. This action research project was undertaken by two faculty members in a teacher preparation program at a small private university. Knowing we were novices in using instructional technology, we developed lesson plans incorporating wikis, blogs, Google docs, and virtual manipulatives for teaching elementary math and special education differentiation methods, as well as for collaboration among teacher candidates. Multiple reports of the positive impact on student outcomes of wikis (Parker and Chao, 2007; Schrand, 2008), blogs (Boling et.al., 2008; Hong, 2008; Pyon, 2008), and collaborative learning (Suh, Johnston, and Douds, 2008, Tuttle, 2007), including their use in higher education courses (Ebner, Kickmeier-Rust, Holzinger, 2008; Williams and Chinn, 2009) guided the development of our lesson plans. These strategies were employed in two course sections; pretest surveys were used in one section (n=10) to determine candidates knowledge and fluency in using these four techniques and then follow up surveys were completed to test their post class fluency. Additionally, three candidates participated in informal interviews regarding outcomes and potential for use in their own classrooms.

Through the use of these instructional technologies, we were able to differentiate instruction, engage teacher candidates in multiple ways, improve their overall understanding of the use of technological strategies and demonstrate implications for classroom instruction.

Technology Use in the Classroom

The National Council of Teachers of Mathematics (NCTM) identifies technology as an essential resource for teaching mathematics, and the use by teachers impacts not only the mode of instruction, but also the content (NCTM, 2000; NCTM 2014). Effective teaching can be supported by technology tools to meet goals of 1) equity for all students, 2) communication, and 3) multiple representations of mathematical thinking. Technology can help students learn and make sense of mathematical ideas, reason mathematically, and communicate their mathematical thinking (NCTM 2014). Additionally, It can provide teachers with the ability to differentiate according to individual needs using online tools to tier and scaffold assignments, and can assist teachers in providing students with appropriate feedback to further their mathematical understanding.

Further, the NCTM position statement on the role of technology states "It is essential that teachers and students have regular access to technologies that support and advance mathematical sense making, reasoning, problem solving, and communication" (October, 2011). Wikis, blogs, and Google Documents enable students the ability to collaborate and discuss mathematics concepts and problems requiring higher levels of thinking (Pyon, 2008). Technology such as Virtual Manipulatives (VM) can enhance learning by providing visual representations of abstract mathematical concepts. These virtual manipulatives are not intended to replace physical models but are powerful representations that often have capabilities beyond the scope of the physical models in the mathematics classroom (NCTM, 2000). VM can assist in transitioning students that require additional prompts to less concrete representations, and technology can transform reluctant students into eager learners (NCTM, 2008).

Wikis, blogs, and Google Documents (now through Google Drive) enable students to collaborate and discuss mathematics concepts and problems requiring higher levels of thinking (Pyon, 2008). Technology such as Virtual Manipulatives (VM) can enhance learning by providing visual representations of abstract mathematical concepts. These virtual manipulatives are not intended to replace physical models but are powerful representations that often have capabilities beyond the scope of the physical models in the mathematics classroom (NCTM, 2000). VM can assist in transitioning students that require additional prompts to less concrete representations, and technology can transform reluctant students into eager learners (NCTM, 2008).

What is a Wiki?

A wiki is an internet based space that allows users to collaborate and build a "website" that can be edited and used synchronously or asynchronously by many users. Wiki's can be used in a variety of ways instructionally, and there are many sites that will host your wiki for free. A sampling of these sites include wikispaces.com, pbwiki.org, wiki.com, and wikidot.com, among others.

Once you've learned what a wiki can do, it is best to visit one of these user friendly sites and play around. Wikis can be available to the public or only available to those people invited. The professors in this study created wikis for their methods classes, so they sent invitations with the link to the students in the classes. Once the students received the e-mail invitation, they were able to view and edit the wiki. Wikis proved to be an excellent way to create an online collaborative community.

Using Wikis in a Special Education Methods Course

In the Special Education methods course, a wiki was used for several reasons: 1) to communicate with candidates, 2) provide resources for use in the college classroom, 3) elicit candidate input on tools and materials already in use in their own classrooms, and 4) provide a repository of resources for use in the elementary classroom. The university professor created a wiki using www.wikispaces.com, and invited the teacher candidates to join. Throughout the course, the professor posted resources for their use, and encouraged them to do the same. Additionally, the professor taught them how to create their own wikis and discussed various ways they could be used. Candidates were encouraged to use a wiki, and several used them for assignments in the class. For example, one assignment instructed teacher candidates to create a parent teacher communication tool that could be used with individual parents in their own classrooms as well as the class parents as a whole. Several teacher candidates developed class wikis to communicate with parents, using individualized communication within the wiki as well as an overall wiki page for the class communication.

A second classroom assignment instructed teacher candidates to create a document/brochure/etc. to share information about Special Education law and parental rights during the IEP process. Several teacher candidates created a wiki for this purpose, including information that was made appropriate for parents as well as resources they could use to find out more information about their rights, advocacy, and other issues relevant for parents of students with disabilities. Teacher candidates reported to the university professor that this was a great use of a wiki; one teacher candidate even reported that her principal asked if her class project could be shared with other parents in the elementary school in which she was employed.

What is a blog?

A blog is a web based forum that can be used to share writing and other media content in the form of a post. Readers can not only view posts, but they can interact with the author by commenting on the posts. Blogs allow for expression of personal opinions and can be used in a variety of ways, including: reflections, sharing of ideas, and discussions. Blogs are commonly used for social media forums and have revolutionized the way people communicate. Due to the interactivity of the author of the blog (blogger) and the reader, bloggers are able to build social relationships with readers.

Using Blogs in a Mathematics Methods Class

A blog can be a powerful tool in developing a mutually beneficial relationship between pre-service teacher candidates and elementary students. Unfortunately, pre-service teachers do not always much contact with and experience working with elementary-aged students while taking their early coursework. Since many pre-service teachers work full time during the day and take evening classes, it is necessary to be creative with how to give teacher candidates experience working with students in the classroom. Blogs are a useful tool to make this “virtual” connection to the classroom possible.

The university mathematics methods professor collaborated with a local private school teacher, Patty, who taught both 4th and 5th grade mathematics. The university professor was interested in having her pre-service teachers communicate with elementary mathematics students to gain experience working with elementary students in mathematics. The elementary classroom teacher’s goal was to encourage her students to clearly communicate their mathematical understanding through writing. The professor and classroom teacher determined that a blog would be a good way to encourage the elementary students to clearly communicate their mathematical understanding while giving the pre-service teachers experience working elementary mathematics students. On the blog, problems could be posed and others would be able to comment on the post with a solution.

The classroom teacher and university professor set up a blog and posed a mathematical problem for the elementary students. It was planned that the pre-service teachers would review the student responses and give appropriate feedback; giving the pre-service teachers the opportunity to analyze the mathematical thinking of the students. Responses from the students and the significant role of feedback would ideally lead to interesting discussions in the university classroom. Then, the pre-service teachers would assume the role of the teacher and pose questions to the elementary students. The University students would have the opportunity to evaluate not only the responses, but the quality of the questions based on the responses.

The first problem posed to the elementary students was:

A pair of prime numbers in which the digits are reversed such as 17 and 71 are called mirror primes. Can you find the mirror prime pair that is less than 50? Please post your answers and let us know how you got there.

Unfortunately, all did not go as planned. The elementary students did not communicate their understanding clearly; the students jumped to answering the problem and did not explain the process they used to solve the problem. During the next mathematics methods class, the university teacher candidates had a brainstorming session to consider how they could help the elementary students elaborate on their thinking and clearly communicate the process they used to solve the problems.

The pre-service teachers decided that they should answer a question posed by the teacher to model exemplary responses. The university professor and elementary teacher collaboratively decided to focus on fractions since it was the current unit of study for the elementary students. The university professor posted the following on the blog:

Okay, so here is a problem for my university students. 4th and 5th graders- leave them comments and let them know what you think of their mathematical thinking. Then, they will post some problems for you to solve. Is the fraction 10/16 closer to zero, one half, or one whole? Explain your thinking.

This was a good experience for the pre-service teachers since they had to consider the elements of a model response as they crafted the solution to the problem. Then, the pre-service teachers crafted and posted original problems to the elementary students in the hope that now that they had been exposed to model answers, the students would share their thinking clearly. The pre-service teachers enjoyed creating high quality tasks that were actually posed to students and enjoyed integrating students' names from the class as well as upcoming holidays in the task. It was near St. Patrick's Day, so many problems revolved around leprechauns and pots of gold.

Unfortunately, the initial responses from the elementary students were not what was expected. Responses such as "I like fractions, fractions are fun!" and "Happy St. Patrick's Day!" were common posts from the elementary students. It was apparent that they were familiar with using blogs for social purposes, rather than for academic purposes. To ensure the students were staying on task and putting forth their best effort, the classroom teacher put in place a process that required students to share their responses with her prior to posting them online. This way, the teacher was able to encourage and monitor the level of detail necessary. Once students understood the expectation, since they saw the responses that were approved for posting on the blog, they were able to communicate their mathematical thinking clearly. The pre-service teachers practiced crafting quality questions, analyzing the thinking of the elementary grade students, and providing feedback. These abilities and skills will be valuable to the pre-service teachers as they develop into teachers.

Using blogs in the math methods class was a good experience for the professor, the pre-service students, the elementary students, and their classroom teacher. It was a learning experience; everyone learned that you don't always get the responses you are hoping for. But, with modeling appropriate responses and appropriate feedback, blogs were an effective vehicle for teaching students to communicate their mathematical thinking clearly.

What is a Google Document?

A Google document is simply a document that has been created or moved to an online space and can be accessed and edited by multiple users synchronously or asynchronously. The current vehicle for this process is Google Drive, a free service of Google, which simply requires one of the users to possess a google email address/account. This online collaborative space can house a variety of types of documents, including text documents, presentations, spreadsheets, drawings, and forms.

Using Google Docs/Google Drive in University Courses

Having the ability to collaborate outside of class time is a necessity in the author's university, where the majority of students work full time and attend courses at night, often driving a significant distance to come to class. Many of the courses taught by the authors of this paper use collaborative learning as well as group projects. These strategies reinforce techniques that teacher candidates can then employ in their own classrooms, and enhance their own learning. Both authors of this paper have used Google Drive in their university courses in a variety of ways, including 1) collaboration on group projects between teacher candidates, 2) eliciting survey responses from teacher candidates, and 3) as a peer feedback tool (spreadsheet) for group projects between peers and the professor.

For collaboration on group projects, both text documents and presentations were used, allowing teacher candidates to work together to create and edit their projects, both synchronously and asynchronously. This allowed all users, often groups of four candidates, to work on the documents collaboratively, outside of class time, without the need to meet in person. There is even a chat feature within Google Drive that allows users to chat while editing their work.

What is a virtual manipulative?

Virtual manipulatives are computer based manipulatives that can be used in addition to or as alternative "hands-on" instruction tools. Most physical manipulatives, such as base-ten blocks, pattern blocks, and geo-boards can be found online. Teachers and students are able to interact with the manipulatives online by moving them around on the computer using the mouse on a computer or using their fingers on a touch screen. While this technology should not replace all hands-on instruction with concrete models, teachers will find it a useful tool to use in conjunction with concrete models. Additionally, it can be used as a resource when classroom sets of physical manipulatives are not available.

How virtual manipulatives can be used in the classroom

Virtual manipulatives can be used in the classroom as a teacher demonstration or with small groups or individual students at the computers. Using manipulatives for a teacher demonstration does not allow each student to manipulate the material, but can be beneficial. Teachers can display manipulatives on a screen using technology as students use the concrete manipulative. This will build the connection between the three-dimensional concrete manipulative and the two-dimensional graphic representation. This is an important connection that must be made so students ultimately have success when they work with virtual manipulatives and/ or graphic representations on paper. Displaying the manipulatives will also encourage classroom discourse as manipulatives can be used to share examples and clarify explanations. However, teacher demonstration should not be the only way virtual manipulatives should be used in the classroom. Students need to experience using virtual manipulatives on their own as well.

There are many ways virtual manipulatives can be used by students. For example, a child could be posed with a subtraction problem with base ten blocks virtually on a base ten chart. He or she could drag the base ten blocks to another column to regroup them. When a ten is moved to the ones place it immediately separates into ten ones. He or she can then drag the blocks to another portion of the screen to subtract them. Meanwhile the computer records the work using the standard algorithm. Not only are students able to complete the problem using concrete models, but they are able to connect the algorithm to the manipulation of the materials. This connection will enable them to develop a conceptual understanding of the standard subtraction algorithm. Ultimately, once students understand conceptually, they will transition away from using the manipulatives and use only the algorithm.

Teacher candidates must be equipped for using technology with students to prepare them for 21st century learning. In this new era of testing, computer interactive tests are going to become a reality. Both assessment consortiums Smarter Balance and PARCC are implementing computer based assessments. Students are going to be required to work online with virtual manipulatives to arrive at a solution and show their thinking. Teacher educators must encourage teacher candidates to use virtual manipulatives with their teacher candidates to prepare them for learning and assessment today. Virtual manipulative resources, such as the National Library of Virtual Manipulatives must be shared with teacher candidates. Teacher candidates must be involved in meaningful activities that incorporate virtual manipulatives and be encouraged to use them in their lesson planning. This will equip future teachers for the current teaching and assessment practices that will prepare students to learn with conceptual understanding of mathematical concepts and the ability to use a computer to solve problems and display their thinking.

What Our Students Told Us

Using action research methodology, the authors collected pre and post lecture surveys from one section of students (n=10), and conducted informal follow up interviews with students from a second course (n=3). While the students prior to the lecture were “somewhat familiar” with GoogleDocs, wikis and blogs, none of the students had been exposed to virtual manipulatives. Additionally, only one student had ever created a wiki or blog, and no one had used them in a classroom setting. After the lecture and hands on demonstrations of all the tools, every student reported feeling comfortable enough with the technology to try these tools out in their own classrooms. Informal interviews with students demonstrated that they greatly “appreciated an opportunity to learn how to use some free technology” and “specifically, how to apply that use of technology to [their] own instruction”. Additionally, one student indicated that the ability to have students collaborative work outside of class using Google Drive and GoogleDocs “will transform the way I teach”.

Implications for Teaching and Learning

As demonstrated through this collaborative teaching and learning opportunity, the use of free technology can be used extensively in courses within the university setting and within the k-12 classroom, using school provided technology or student's’ “bring your own technology”. Using collaborative technology such as wikis, blogs, and Google docs allowed for a much richer integration of inclusion methods and created a virtual space for students to work together. Additionally, using virtual manipulatives when traditional hand held manipulates are not available, or when a different method is desired, allowed teacher candidates to develop lessons to teach their students in new way. Free instructional technology tools that can be integrated into the classroom in easy and small ways can make a huge difference in student engagement and understanding, allow for differentiation of instruction to meet the needs of all learners, and create a truly collaborative space where teachers and students can communicate and grow.

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