Providing Authentic Technology Experiences for K-8 Preservice Teachers in Elementary Mathematics Classrooms

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K-8 preservice teachers partnered with inservice teachers and participated in a yearlong collaborative effort to provide the teachers with authentic technology experiences in teaching mathematics in elementary classrooms. Implications of establishing collaborative working pairs of inservice and preservice teachers are highlighted.

Introduction

> **Using the math software you showed us, the learning experience was concrete and exciting for me *and* for the third and fourth graders I worked with.**
>
> **The demonstration of the math software by both you and my mentor teacher strengthened my desire to use technology in the mathematics classroom.**

These previous statements were spoken by two K-8 preservice teachers who participated in a one-year collaborative project, funded by a *Preparing Tomorrow's Teachers to Use Technology* (PT3) grant, designed to provide them with authentic, technology-based experiences in elementary mathematics classrooms. A total of fifty preservice teachers worked collaboratively with elementary inservice teachers to co-plan and team-teach software-based mathematics lessons to students in grades K-5. Serving as the rationale for this project, as well as for this article, is the importance of (1) K-8 preservice teachers learning how to effectively integrate technology into the teaching of mathematics in authentic classroom settings, (2) engaging K-5 students in rich mathematical investigations using technology, and (3) experiencing the potential of creating partnerships between preservice teachers and inservice teachers. The results, impact, and implications of this innovative initiative project between university level teacher education faculty and teachers at a local school are presented and serve as a model of best practices for faculty, administrators, and school leaders to consider.

Technology Preparation of Preservice Teachers

According to the National Center for Education Statistics (2000), teacher preparation in the area of technology is minimal. Further, the National Council for Accreditation of Teacher Education (NCATE, 2001), reported that preservice teachers are given instruction on computer literacy and shown software, but "rarely are required to apply technology in their courses and are denied role models of faculty using technology in their own work" (p.7). The American Association of Colleges echoed this sentiment years later for Teacher Education in a technology brief stating, "It is not enough for professors to use technology in their offices, or even to use presentation software in their classrooms. We must design courses that require our students to use technology themselves--only then will they be prepared to incorporate technology into the lessons they will teach their own students" (Wetzel, 2001, p. 5).

In an attempt to develop national standards for educational uses of technology that facilitate school improvement in the United States, the National Educational Technology Standards (NETS) Project, an ongoing initiative of the International Society for Technology in Education (ISTE), has defined standards for students, teachers, and administrators. As of May 2004, 49 states have "adopted, adapted, aligned with, or otherwise referenced at least one set of standards in their state technology plans, certification, licensure, curriculum plans, assessment plans, or other official state documents" (NETS, 2004, p. 1). The ISTE NETS for teachers focuses on preservice teacher education and provides models defining essential conditions for teacher preparation programs and school learning environments necessary for effective use of technology to support teaching, learning, and instructional management.

Citing technology as one of the governing principles in its *Principles and Standards for School Mathematics* (NCTM, 2000), the National Council of Teachers of Mathematics advocate that preservice teacher preparation programs, as well as professional development opportunities designed for inservice teachers, reflect changing technology developments. Further, because many university faculty "have considerable influence on whether teacher candidates enter the profession with the strong knowledge of mathematics needed to teach preK-12 mathematics" (p. 377), NCTM advocates that university faculty partner in the development of school-based mathematics communities where preservice and inservice teachers as well mathematicians work collaboratively to promote both teachers' growth and demonstrate the

value of learning communities. NCTM (2000) also asserts that refection and analysis can be enhanced by "teaming with an experienced colleague, a new teacher, or a community of teachers" (p. 19), especially in the area of technology.

The clear and distinct message resounding in these aforementioned standards as well as the research documenting preservice teacher preparation in the area of technology is the need to provide teacher candidates with meaningful, that is, authentic, experiences with technology. Completing in-house technology courses as part of their certification program is not enough. Teacher candidates must engage in or, at the minimal, observe technology being used by elementary students in actual classroom settings, as well as partner with inservice teachers, to truly experience technology and its impact on pedagogy and learning. Thus, this project was designed to provide K-8 teacher candidates with authentic technology experiences during their field-based methods semester where they not only broadened their own professional knowledge of using software in K-5 mathematics classrooms but, more importantly, they gained firsthand pedagogical experience with implementing it into the teaching of mathematics to elementary students while collaboratively working with inservice teachers.

Participants in the Mathematics Software Exploration Project

The project involved two cohorts of fifty elementary education majors enrolled in a field-based mathematics methods course at a large southwestern university during the fall 2003 and spring of 2004 semester. The methods courses in which these preservice teachers were enrolled comprise a semester-long, field-based program. Thus, the teacher candidates attended their methods courses part of the day, held in a classroom at a predetermined elementary school site, and spent the other portion of the day working and observing in K-5 classrooms under the mentorship of an elementary teacher. During their mathematics methods courses, the teacher candidates were taught in a manner consistent with reform standards (NCTM, 1991, 2000); that is, they engaged in the learning of mathematics by using manipulatives and technology and participated in activities focusing on problem solving, writing, discourse and making real-world connections. Following the successful completion of their methods courses, the preservice teachers continued on into their semester-long student teaching experience.

Additionally, in the fall 2003, nine K-5 teachers working at the same methods school site, along with the school's co-principal, reading specialist, and the computer lab technician, participated in this yearlong project. More specifically, a kindergarten teacher, two first grade teachers, and a second, third,

fourth, and fifth grade teacher comprised the population of nine teachers, along with a K-2 combined-age special education teacher and a teacher of a multi-age grades 1 and 2.

Description of the Software Trainings

At the very start of the fall 2003 and spring 2004 semesters, during their regularly scheduled elementary mathematics method course, the two cohorts of teacher candidates participated in three, one-hour long technology training sessions during which three mathematics software programs were explored namely, *The Graph Club* (Tom Snyder, 2003), *TableTop, Jr.* (TERC, 1994), and *TesselMania! Deluxe* (The Learning Company, 1997). These programs were selected because all three programs were appropriate for use across the K-5 continuum, were both teacher-friendly and student-friendly, and the software programs' content reflected the school's state standards for K-5 mathematics. Additionally, at the start of the fall 2003 semester, the nine elementary inservice teachers participated in a half-day training session in which the same three software programs were explored.

The Graph Club (Tom Snyder Productions, 2003) is an innovative, easy-to-use spreadsheet tool for creating, interpreting, and printing graphs designed for students in grades K-4. *TableTop, Jr.* (TERC, 1994), designed for students in grades K-5, encourages students to collect, organize, and interpret data by arranging and rearranging data into groups, cross tabulations, and Venn diagrams. Te*sselMania! Deluxe* (The Learning Company, 1997) is an interdisciplinary program inspired by the artwork of M.C. Escher that lets children in grades 3-12 explore transformational geometry and tessellations.

During the trainings, both the preservice and inservice teachers were informed that the purpose of the trainings was to serve as a catalyst for providing authentic opportunities for preservice teachers to experience technology implemented into the teaching of elementary mathematics. Thus, the inservice teachers were strongly encouraged to partner with their assigned preservice teacher for that semester and to co-plan and team-teach software-based mathematics lessons. Also, the teacher candidates were informed that, in order to become more proficient and knowledgeable of the programs' features, they would complete assignments throughout the semester, required for their elementary mathematics methods course, which would provide them with additional opportunities to independently and collaboratively explore the software and produce artifacts.

Data Collection and Analysis

Prior to each software exploration by students in the elementary classrooms, each of the inservice teachers electronically submitted a copy of their lesson plan to the researcher detailing the computer-based activity jointly planned by themselves and their assigned preservice teacher. On the scheduled day of implementation of the software-based activity, the researcher collected field notes recording the interactions between and among the inservice teacher, the preservice teacher, and the students. At the completion of the activity, both the inservice and preservice teacher submitted a reflection statement commenting on the successes, obstacles, outcomes, and implications of the software-based activity. Further, at the end of the fall and spring semesters, exit interviews were conducted with the inservice and preservice teachers in which they reflected upon their semester-long experience in a team-teaching technology setting.

The field notes as well as the inservice and preservice teachers' reflection statements and exit interviews were categorized by emergent themes (Lincoln & Guba, 1985). Prior to executing the exit interviews, the researcher chunked key data elements (Lincoln & Guba, 1985) from the field notes and reflection statements seeking the smallest parcels (i.e., phrases, sentences, paragraphs, etc.) that revealed meaningful information. To insure the trustworthiness and credibility of the data analysis process, a graduate student served as a peer debriefer (Lincoln & Guba, 1985) and examined the data and the researcher's coding scheme, verifying the categorization and analysis of the data. Additionally, member checking (Lincoln & Guba, 1985) was carried out during the exit interviews whereby the researcher shared the analytic categories and interpretations of the data with the inservice and preservice teachers, seeking their affirmation of adequate representation and interpretation and providing opportunity for clarification and further explanations.

Results

Over the course of the year, twenty software-based mathematics lessons were co-planned and team-taught. Additionally, seven lessons were implemented, but not observed, due to scheduling conflicts; however, reflection statements from the inservice and preservice teachers were collected and then analyzed. Analysis of the field notes as well as the preservice teachers' reflection statements and exit interviews revealed the following four major themes.

Impact of Technology on Student Learning

All of the preservice teachers commented in their exit interviews that the dynamic nature of technology enhanced student learning of the mathematics concepts at hand. For example, several preservice teachers stated that the software "offered a different mode of learning" and provided opportunities to "develop a deeper understanding of content." Additional comments included:

> **Some of the students discovered that they could not enter a numeric value of 13 into the data table since the max value was set to 10…The students had to learn that one symbol equaled two and how to interpret half an icon. (Preservice teacher paired with a second grade teacher using *The Graph Club*)**

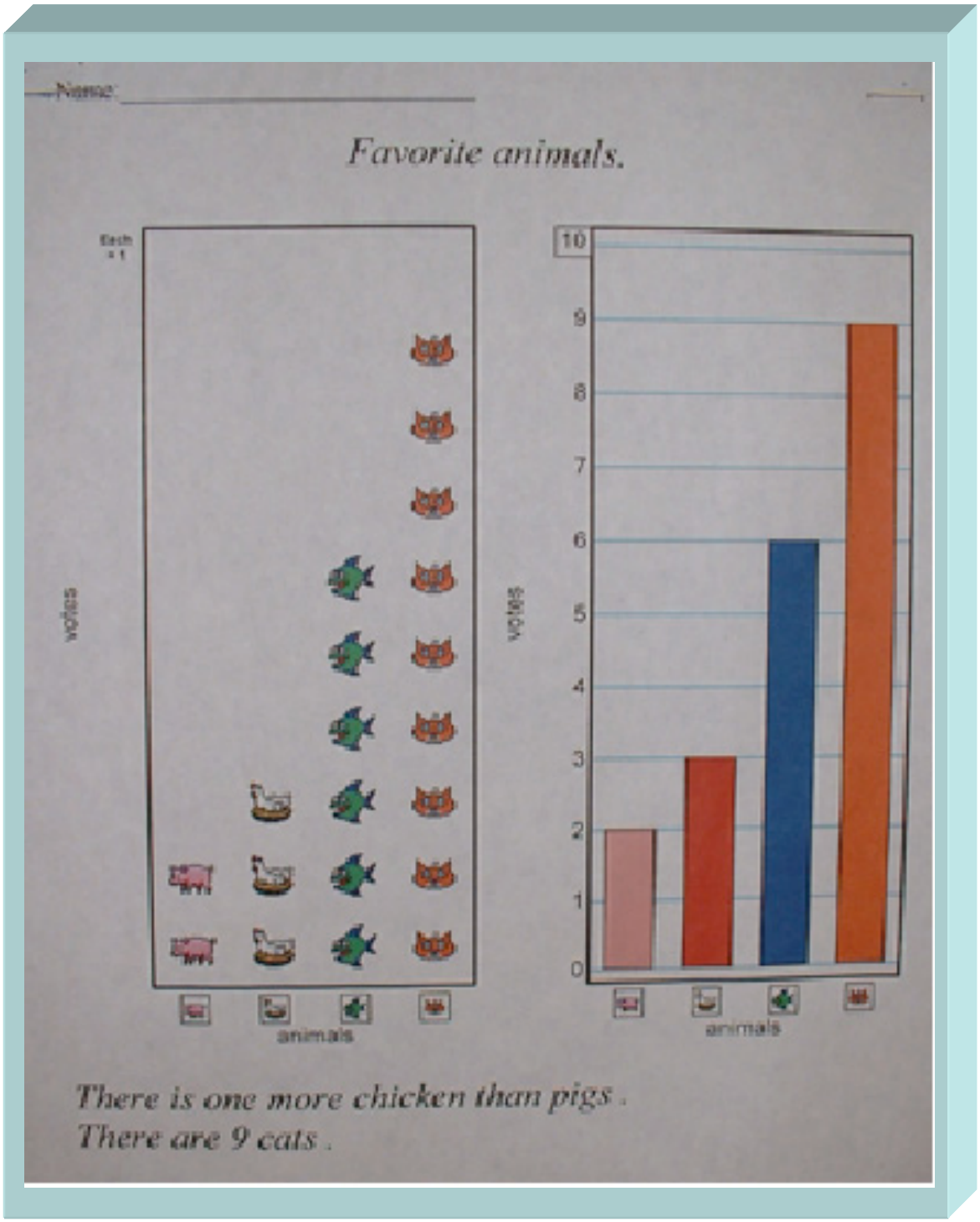
> **The software nurtured hands-on, visual learners…and challenged them academically while opening them up to the world of technology…The software's ability to sort, re-sort, and quickly re-sort again added more and deeper learning opportunities for students. (Preservice teacher paired with a kindergartner teacher using *TableTop, Jr.*)**

> **The students could see the rotations they struggled with doing physically in the hands-on activity…They got to see all of their changes happen dynamically and they had fun with this…Student learning was supported by the visual environment which demonstrated immediate feedback. (Preservice teacher paired with a third grade teacher using *TesselMania! Deluxe*)**

Impact of Technology on Student Assessment

A vast majority of the preservice teachers commented on how using the software provided an additional means to assess students' mathematical thinking and learning. For example, using the notebook bar, a feature of *The Graph Club* that allows students to aurally or manually record their observations about their newly created graphs (see figure 1), a preservice teacher paired with a fifth grade

Figure 1. A combined first/second grade student's observations recorded in the notebook bar using The Graph Club.



teacher offered, "They saw things about their graphs that I never would have thought of! Having them use this feature gave me and my mentor teacher insight into their thinking." A preservice teacher working with kindergarteners using was able to tap into the students' thinking better and ask them what transformation was happening because of the software's amazing interactive and graphical nature."

Impact of Technology on Preservice Teachers' Attitudes

In their exit interviews, a majority of the preservice teachers expressed feeling "comfortable," "confident," and anticipated "little or no anxiety" with integrating the software into their future teaching of mathematics. However, preservice teachers' expressed apprehension over "classroom management in a lab setting," "lack of time to learn more about changing technologies," "not having lots of money to buy software," and "having access to computers and software." Several commented how "stunned" they were to realize the adeptness of even second graders' keyboarding skills. A preservice teacher working in the K-2 special education class who implemented a lesson using *The Graph Club* offered:

> **Even though I had to provide a lot of assistance because of their disabilities, I never would have thought that these kids could have figured out keyboarding or found the commands in the menu bar. They amazed me…They almost always get very frustrated when their work is not perfect. The software alleviated this negative response. Teaching with this program made class so much more enjoyable for me since normally they require a lot of classroom management.**

Additionally, a preservice teacher added, "The demonstration of the math software by both you and my mentor teacher strengthened my confidence in teaching mathematics and my desire to use technology in the classroom." Another teacher candidate asserted, "This real-life teaching experience with technology was better than any college course I have taken …I am so much more confident in my ability to teach math using technology with students now."

When asked to reflect on the collaborative partnership between herself and her inservice teacher, one preservice teacher described her team-teaching experience as "invaluable," providing her insight into "using software in a classroom setting versus a lab with students with disabilities," logistics that she would not have considered or experienced had she not engaged actual students in a computer-based activity. She added, "This is stuff they didn't tell us about, or would we get to experience, in our technology class. *Doing* is believing!" Other comments made by preservice teachers describing their reactions to their software-based, team-teaching experiences in elementary mathematics classrooms included:

> **This experience helped me learn classroom management and computer lab management. I didn't ever realize that there was such a thing as "lab etiquette."**
>
> **My mentor teacher was amazing. For someone who claimed to be a "techno-phobe," she came up with the best math ideas on using the software with her students.**
>
> **Being part of this team-teaching experience helped me understand the software in a different light. Features that I did not struggle with, some kids did. Knowing this can happen has better prepared me for teaching in a lab.**
>
> **It was great having two of us in the lab…to troubleshoot. Also, I learned management techniques from my teacher on how to keep all the kids on the same screen.**

Worth noting are some of the many comments offered by the inservice teachers who remarked how much they enjoyed and benefited from collaborating with their assigned preservice teacher in designing and implementing elementary mathematics lessons. This was exemplified by a first grade teacher stating, "As the saying goes, two heads are better than one. I enjoyed co-planning more than I thought I might." Similarly, a second grade teacher commented, "I really learned a lot from her. Lucky for me she was there because twice I forgot where a feature was." The multi-grades 1-2 teacher candidly offered how she "came to appreciate" working with a junior colleague, fearing that she would have to do too much "hand-holding." Instead, she added, "She held *my* hand and showed *me* what buttons to push." Additionally, a kindergarten teacher praised the project

noting, "What a great way to give a soon-to-be teacher a true experience of what it is like to teach in a lab."

Closing Remarks

Based on the field notes collected during the implementation of the software-based mathematics lessons and the anecdotal evidence obtained from the lesson plan reflections and the exit interviews of both the inservice and preservice teachers, the teaching of these authentic, elementary mathematics software-based lessons resulted in the formation of a cadre of preservice teachers who are more knowledgeable of and better prepared to tackle the realities of software integration in the K-8 mathematics classroom. The jointly-planned and implemented software-based mathematics activities benefited not only the preservice teachers in such areas including classroom management, lab management, and student assessment in mathematics, but also benefited the inservice teachers, who repeatedly cited the advantages of team-teaching when using technology as well as how the software provided another mode to assess students' understanding of mathematics. Additionally, a vast majority of the preservice teachers expressed higher confidence levels in their abilities to teach K-8 mathematics using software and all agreed that their own understanding of mathematics was enhanced by using the software.

Implications

It cannot be argued that preservice teachers need more and better preparation in the area of technology use and integration, especially in the K-8 mathematics classroom. But more does not mean better. That is, providing experiences where preservice teachers passively observe technology being modeled or simply learning features, capabilities, and *potential* uses of technology in the K-8 classroom are not sufficient. Instead, teacher educators need to provide preservice teachers with authentic technology-based classroom experiences, similar to those experienced by the preservice teachers who participated in this project. The author argues that perhaps the most opportune time to do this is during teacher candidates' methods semester when they are gaining observational and instructional time working in classrooms. Providing these types of collaborative learning opportunities, coupled with an emphasis on reflection, will promote the development of preservice teachers who are confident, adept, and savvy users of technology, cognizant of how to showcase the power of technology, especially in the teaching of K-8 mathematics. Further, inservice teachers benefit mutually from such partnerships. Thus, faculty, administrators, and school leaders should consider developing and nurturing university-based and school-based partnerships as a means to enhance and support the development of

preservice teachers and the continued professional development of inservice teachers.

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