Technology and the Standards-Based Mathematics Classroom

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INTRODUCTION

In the current standards-driven academic environment, success is most often measured by student achievement on state and national assessments with the end goal of preparing our students to be able to communicate effectively and to be critical thinkers. Technology is not addressed in many state standards (including Pennsylvania's), but as our society continues to develop and place more emphasis on the uses of technology, schools must learn how to incorporate technology into the classroom.

Hundreds of software applications exist for use in the mathematics classroom. Many of these packages were developed with academic standards in mind, but several other applications exist that are useful in both academic and non-academic settings. Considerable research has been conducted examining not only the effectiveness of technology as an instructional tool but also regarding the various learning styles of our students. I feel that it is imperative for all educators to explore the possibilities presented through the use of technology because, if implemented properly, technology can be a powerful aid in not only meeting academic standards but also in helping to prepare students for the technical climate of the "real world".

BY THE BOOK: WHAT THE STANDARDS SAY

In the *Academic Standards for Mathematics*, the Pennsylvania Department of Education (PDE, 2002) states: "Because our capacity to deal with all things mathematical is changing rapidly, students must be able to bring the most modern and effective technology to bear on their learning of mathematical concepts and skills." Within these standards, however, few provisions are made for the inclusion and use of technology in a mathematics classroom. For example, in Section 2.2, which lists 28 standards regarding computation and estimation for Grades 3, 5, 8, and 11, only one standard is listed that addresses technology. Section 2.2.11.F, a standard for students in Grade 11, states that students should be able to "demonstrate skills for using computer spreadsheets and scientific and graphing calculators" (PDE, 2002). Throughout the *Academic Standards for Mathematics*, the use of technology is included sparsely as separate standards, but the standards leave room for creative interpretation and implementation by teachers and administrators alike.

The National Council of Teachers of Mathematics (NCTM, 2000) has developed *Principles and Standards for School Mathematics*, which they feel presents the ideal goals of a mathematics curriculum. They have developed six principles that are intended to be the foundation for school mathematics programs and the basis for which educators make decisions regarding mathematics instruction. NCTM recognizes the importance of technology by listing it as one of the principles, stating: "Technology is essential in teaching and learning mathematics; it influences the mathematics taught and enhances students' learning."

Even though educators are not held accountable for being in compliance with the NCTM-developed standards, *Principles and Standards for School Mathematics* serves as a guidebook for non-traditional teachers who seek a well-rounded curriculum that is in tune with state academic standards as well as the modern social climate. Pennsylvania's state standards do not include or specify the use of technology as part of the plan for successfully achieving the standards; however, opportunities exist to incorporate technology into the instruction for the other academic standards if educators are properly prepared.

TECHNOLOGY'S BENEFITS IN THE CLASSROOM

Over the last decade, countless research has been conducted regarding the effectiveness of technology's use as an instructional tool and as a supplement to education. Since the Enhancing Education through Technology Act of 2001, the amount of research on this topic has drastically increased due to an increased urgency to fully understand how technology is and should be implemented in classrooms. The research has brought forth both advocates and opponents of the use of technology in schools; however, upon further inspection of the critics' views, common courses of action can be seen, such as the use of different methods of instruction and appropriate training for teachers (Kimble, 1999), and can be used to make technology a successful component of students' learning and academic achievement.

Even though there is no "best practice" regarding the use of technology in the classroom, numerous studies are readily available that quote positive outcomes of technology-based or -supplemented instruction in math as well as other academic areas. James A. Kulik from the University of Michigan analyzed 16 studies regarding the use of integrated learning systems (ILS), which combine drill-and-practice and tutorial lessons, in mathematics courses and found that, in all 16 studies, test scores were higher among students who were taught with the help of ILS software (Branigan, 2003). This type of computer-based instruction offers the additional benefit of individualizing instruction for each student based on needs, current knowledge, and learning style and has been found to increase student learning in a shorter period of time than traditional teaching (Schacter, 1999).

In a study on the effects of simulation and high-order thinking technologies, Harold Wenglinsky found that the proper implementation of these technologies, coupled with adequate professional development for teachers, led to increased math scores up to 15 weeks above grade level as measured by the National Assessment of Educational Progress (Schacter, 1999). One of his "negative" findings was that students who used these technologies only performed three to five weeks ahead of students who did not. Given the current pace of our education system in the race to teach all the content standards that will be tested, I would hardly count a three to five week advantage as a negative.

Other studies have shown that the use of multimedia software can decrease student anxiety and help students perceive math as being relevant to everyday life, that computer software can help students learn to solve multi-step math problems more quickly, and that students taught using mathematics software retain their math skills longer than traditionally-taught students (Chaika, 2005). Gorev, Gurevich, and Barabash (2004) feel that using computerized tools to solve routine and non-routine problems invokes students' ability to perform competently and methodically in familiar and unfamiliar situations. Regarding the use of calculators in mathematics classes, research has found that using calculators for instruction and testing "enhances learning and performance of arithmetical concepts and skills, problem solving, and attitudes of students" and that "teachers ask more high-level questions when calculators are present" (Apthorp, Bodrova, Dean, & Florian, 2001).

Considering the multitude of positive outcomes of technology-enhanced education, educators should realize the importance of this tool not only to enhance students' learning but also to help prepare them for the technology-laden world they will encounter outside school. When analyzing situations in which technology has become an important benefit in the classroom, several key factors are always present and should be made aware to administrators, educators, parents, and students.

PUTTING IT IN PLACE

Despite the pressure to integrate technology into schools, educators cannot simply walk into a classroom one day and begin teaching with technological resources. Technology undoubtedly affects academic achievement, for better or worse, but the type of effect it has depends on how it is implemented (Kimble, 1999).

Researchers have compiled strategies for properly implementing technology, and some of the most common guidelines are careful planning to determine the most appropriate and beneficial way to use technology in accordance with set curriculum objectives and proper training and professional development for teachers and other staff members (Kimble, 1999). Conner (2002) suggests that schools work cooperatively in this ven-